JOINT INFORMATION PLATFORM FOR NATURAL HAZARDS IN SWITZERLAND

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ABSTRACT

Natural hazards cause severe economic loss and fatalities. Intervention measures of emergency management organizations and of affected people can help reduce these consequences. Key factors of effective and efficient intervention actions are comprehensive and timely information and warnings. Therefore, the Joint Information Platform for Natural Hazards, called GIN (German abbreviation for "Gemeinsame Informationsplattform Naturgefahren") as part of the national project OWARNA (Optimisation of Warning and Alerting in the Event of Natural Hazards) has been developed since 2008. This web-browser-based platform provides natural hazard experts a quick and simple access to relevant real-time information in order to assess upcoming natural events and to support them in the decision making process during events. GIN visualises meteorological, hydrological and snow related observational data from more than 700 sources as well as forecasts and warnings. The platform displays data in the form of maps, diagrams as well as tables. A special view to display warnings, called cockpit, is implemented in version 2.0 that was deployed in December 2011. Good visualization, interactivity and simple navigation and usability are important elements of GIN. Predefined and user-defined views help to use GIN efficiently, also by users with low IT-experience. GIN meets the needs of natural hazard and emergency management specialists of federal authorities, cantons and municipalities and is accessed in the meantime by more than 1'000 users.
In the conclusion and outlook, further work and integration of GIN into other national projects are sketched.

Keywords: risk management, natural hazards, decision support, real-time information system

INTRODUCTION

After the devastating floods in August 2005 in Switzerland, it was widely recognised that warnings and precautionary measures are crucial elements to reduce fatalities and damage in case of disasters (Bezzola & Hegg, 2007). Key factors for effective and efficient intervention actions are comprehensive and timely information and warnings. Therefore, the official Swiss warning centres for natural hazards decided to intensify cooperation. One outcome of this cooperation was the launching of the Joint Information Platform for Natural Hazards, called GIN (German abbreviation for "Gemeinsame Informationsplattform Naturgefahren") as part of the national project OWARNA (Optimisation of Warning and Alerting in the Event of Natural Hazards) (Hess &Schmid). This web-browser-based platform provides natural hazard experts with a quick and simple access to relevant real-time information in order to assess upcoming events and to support them in their decision making process during events.

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Since the beginning of March 2010 the platform is open for natural hazard experts on national, cantonal and municipal level. The web application runs independently of operating system or web-browser.
GIN provides information such as current observational data, forecasts and bulletins in pooled form. Currently, data from over 700 automatic measurement stations, delivering information on more than 90 parameters are displayed. Besides that, predictions, bulletins and radar images are available to the users. It is possible to combine this information in an interactive way. As an example, in spring, users can merge information about the current runoff, the amount of remaining snow in the mountains and the predicted precipitation in one map. This allows a quick assessment of complex and potentially dangerous situations.
GIN visualises data in the form of maps, diagrams as well as tables. As an example, the interactive platform allows users to select multiple measurement stations in the map and combine their parameters arbitrarily in diagrams or tables. Depicting animated raster images such as precipitation radar data or predictions in the form of raster images combined with observational data is possible too. Users can also save customized maps (so-called user-defined views) by defining measurement stations, with dedicated parameters and symbolisations.

DEVELOPMENT AND OPERATION OF GIN

The funding organisations of GIN are the federal offices engaged in early warning of natural hazards, that is FOEN (Federal Office for the Environment, for floods and landslides as well as forest fires), MeteoSwiss (Federal Office of Meteorology and Climatology, for weather related phenomena), SLF (WSL Institute for Snow and Avalanche Research for snow and avalanches) and SED (Swiss Seismological Service for earthquakes). To manage operation and development of the platform a GIN office has been established at FOEN. The development and operation is financed by the funding organisations.
The responsibility for operation, development and customer support is clearly defined and assigned to the involved organisations. Decisions about fundamentals of operation, data implementation and development are taken by a steering board, which consists of professional experts of the involved organisations. A technical committee supports the development on demand. Periodical user surveys ensure that development and configuration meet customers' needs in the best possible way.
GIN is operational since March 2010, with a 99.8% availability and 24h/7d support. Uninterrupted operation of the platform, especially during natural hazard events, is ensured by redundancy of servers at different locations. At the moment, more than 1.100 users have access to GIN. Around 10.000 users are expected to be registered – approximately three to four persons per municipality (Switzerland has 2596 municipalities); approximately ten persons per canton (Switzerland has 26 cantons) and on the federal level around 300 persons. Therefore, the system architecture of the platform is designed to support a high number of parallel accesses.
To manage this amount of users as well as to ensure that users get authorisation to access GIN, the user administration is delegated to the cantons. Potential users have to fill in a web application form. The responsible cantonal administrator receives automatically an email-notification to check open applications. With one click the administrator can accept or deny the login. Natural hazard experts, working for the public administration, have free of charge access and can participate in free of charge trainings.

DATA

Data are the core of GIN. A good balance between quality and quantity is essential. Needs and requests of the GIN users and natural hazard experts are collected by the GIN office. Together with experts of the official warning centres the GIN office decides if a parameter or station is included. So far there exist no strict requirements for including data in regard to data quality and measurement interval. In regions with a high density of measurement stations, higher quality standards may be applied for integrating a station. In regions with a low density of stations, also stations with lower quality might be added. Especially in mountain regions, stations are often powered by solar panels

and hence the performance of sensors is limited and the measurement interval is low. Nevertheless the measurements are needed because no other information is available.
The majority of data on GIN are provided by federal offices and agencies, sometimes in cooperation with cantons. Some cantons and private institutions operate additional own networks of automatic measurement stations. These networks have in general own visualisation tools that experts have to query separately so far. Since GIN offers one unified platform instead of many and because it is funded by the official warning centres, the cantons are interested in the integration of their networks into GIN. The quality of the measurements of these networks is in general of high level. To enable an easy and quick integration, GIN is based on a generic concept and database. Metadata of e.g. stations can be defined in xml and added with a click to the platform.
Currently, observational data, forecasts, bulletins and warnings are available in GIN. The data type is numerical, raster image or text. Data can be assigned to objects, which are called data sources. Data sources can represent spatial point (like measurement stations), line (rivers) and area (regions) objects. More than 700 data sources from the official warning centres and cantons as listed in Tab. 1 are integrated in GIN.

Tab. 1 Table of available data in GIN and data providers**.**

FOEN	220	measurement stations (incl. predictions) hydrological bulletin
MeteoSwiss	117	measurement stations precipitation radar images satellite images COSMO-2 and COSMO-7 predictions detailed forecast, special predictions, alpine weather forecast
SLF/ Intercantonal Measurement and Information System	186	measurement stations national and regional avalanche bulletins
Canton Aargau	6	measurement stations
Canton Berne	46	measurement stations
Canton Lucerne	10	measurement stations
Canton Glarus	3	measurement stations
Canton Solothurn	16	measurement stations
Canton Ticino	18	measurement stations
Canton Thurgau	27	measurement stations
Canton Uri	3	measurement stations
Canton Valais	19	measurement stations
Canton Zurich	48	measurement stations
National Air Pollution Monitoring Network	9	measurement stations

There are more than 90 measured and predicted parameters available in GIN such as precipitation sums (1h, 3h, 6h, 12h, etc), precipitation radar images of different sums, temperature, wind speed, wind direction, runoff, water level, snow heights, new snow, etc. To support interpretation of data, thresholds are supplied by the official warning centres, especially from the FOEN for hydrological data (runoff and water level).
GIN originally only included meteorological, hydrological and snow data. In March 2012, earthquake data from the SED (Swiss Seismological Service) was integrated into GIN.
The access to parameters and/or data sources can be restricted by administrators. They can define black- or white-lists of user-groups and define a relation to parameters and/or data sources. GIN also contains data of hydro power companies and thus economically sensitive information, which should only be accessible for selected natural hazard experts.

NAVIGATION AND USABILITY

The explorer (navigation menu) on the left hand side and the map are the main navigation instruments for the contents. Time can be adjusted with the time-slider at the bottom of the GUI (Graphical User Interface).
The explorer is divided into four elements: 'Cockpit', 'Data Explorer', 'User Defined Views' and 'Predefined Views'. These elements contain specific trees which lead to maps, tables, diagrams, bulletins and images:

- 'Predefined Views' are prepared by the GIN office and allow an easy and quick access to often used views or products.
- Users can define own views interactively. Access and definition can be found under 'User Defined Views'. To support users, a special user group, called experts, can pass links of their user-defined views to other users. The experts still have full access of these views and changes are passed to the users.
- The 'Data Explorer' allows users to access all available information. There are two access-trees available: (1) ordered by parameters, like water – runoff-measured – runoff-max – runoff-max24h – rivers and lakes; (2) ordered by data sources/stations, like FOEN – rivers and lakes. These trees are also configured by the GIN office. It is also possible to access stations interactively by drawing a rectangle on the map.
- 'Cockpit' enables the access to the Cockpit module, which displays warnings (see below).

The time slider allows selecting the time, by moving the sliders or to enter time and/or date directly in the time field or the calendar icon (see Fig. 1). The blue slider in the middle is used to set the map, bulletin and image time. Both outer sliders define the time interval for diagrams, tables as well as the warnings of the Cockpit module. After changing the time, the user has to explicitly refresh the content by clicking the refresh button. By pressing the refresh button the necessary data are requested from the server. The vertical blue line in the time slider represents actual time. If a prediction is visualised, a vertical green line stand for the model initial time. In map views the orange slider shows the timestamp of the predicted data that are visualised.

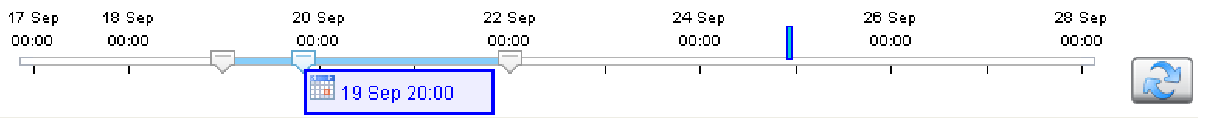

Fig. 1 Time slider: inner (with calendar date) slider is used to set the map, bulletin and image time; both outer sliders are used to set the time interval for diagrams, tables and warnings (Cockpit); vertical line represents current time; the box with time field and calendar icon shows selected time and can also be used for manipulation; on the right refresh button.

VISUALISATION

GIN is an interactive platform. It is moderated, that means, visualisation is defined by so-called moderators, the staff of the GIN office. They define, for example, colour and visualisation style of parameters in diagrams or the symbolisation on the map as well as the pre-defined views.
The user can choose a type of visualisation depending on the kind of data. In general numerical data are displayed on maps, in tables and diagrams. Raster images such as precipitation radar images are visualised as layers on maps and non-geo-referenced images are displayed separately; bulletins are shown as text.

Diagrams have the following functionalities: A single diagram can have up to two different units. To enable a detailed data analysis, a reference line can be inserted by a mouse-click. By moving the mouse cursor over the diagram, the reference line moves simultaneously and a pop-up legend displays the exact numerical values at this line (Fig. 2). The user can interactively combine and split diagrams. Combination of measured and predicted data in one diagram is activated for certain data combinations by the moderators.

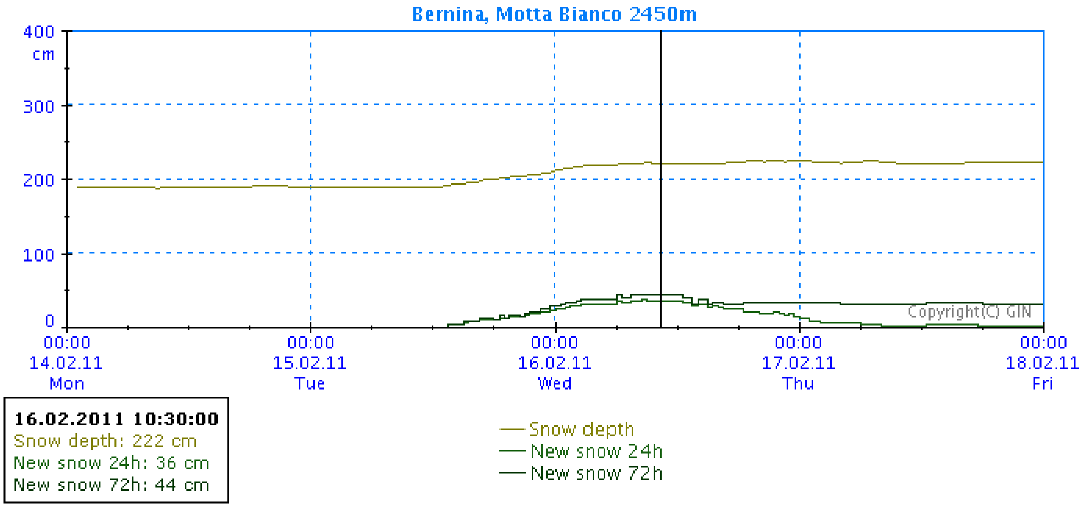

Fig. 2 Screenshot of diagram with a vertical reference line.

GIN supports thresholds and distinguishes between official ones from the warning centres and user-defined ones. If a threshold for a parameter and datasource is defined, the user may interactively switch between them, switch them off or enter a value manually. By default the official thresholds are displayed (Fig. 3). GIN enables model predictions with an arbitrary number of members such as COSMO-LEPS with 16 members. Due to this large amount of information the functionality of the reference line is not available for diagrams with predicted data. In predictions with more than one member, minimum, maximum, average and the quantile ranges are coloured (Fig. 4). The user can change the quantile ranges interactively or switch them off and choose a so-called spaghetti-plot visualisation. The diagrams are generated on the server.

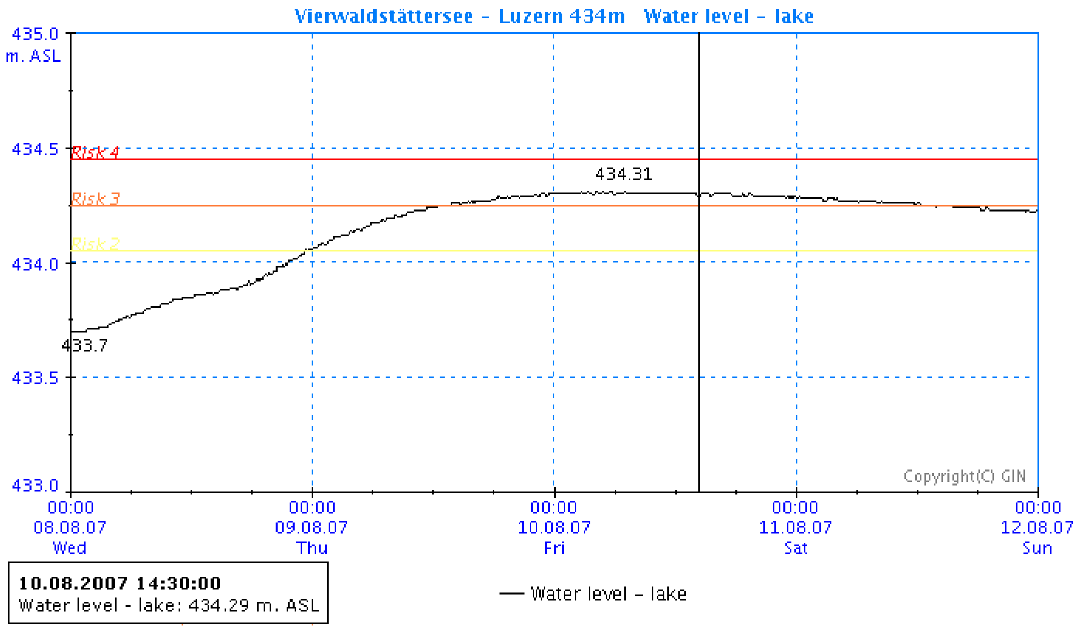

Fig. 3 Water level of the Lake of Lucerne in early August 2007 with three threshold lines (Risk A, Risk B, Risk C).

Numerically measured and predicted data can also be displayed in tables. Predictions with more than one member are reduced to minimum, maximum and average values. The visualisation of combinations of measured and predicted data is possible (Fig. 5). Measured data can also be exported into csv-files.

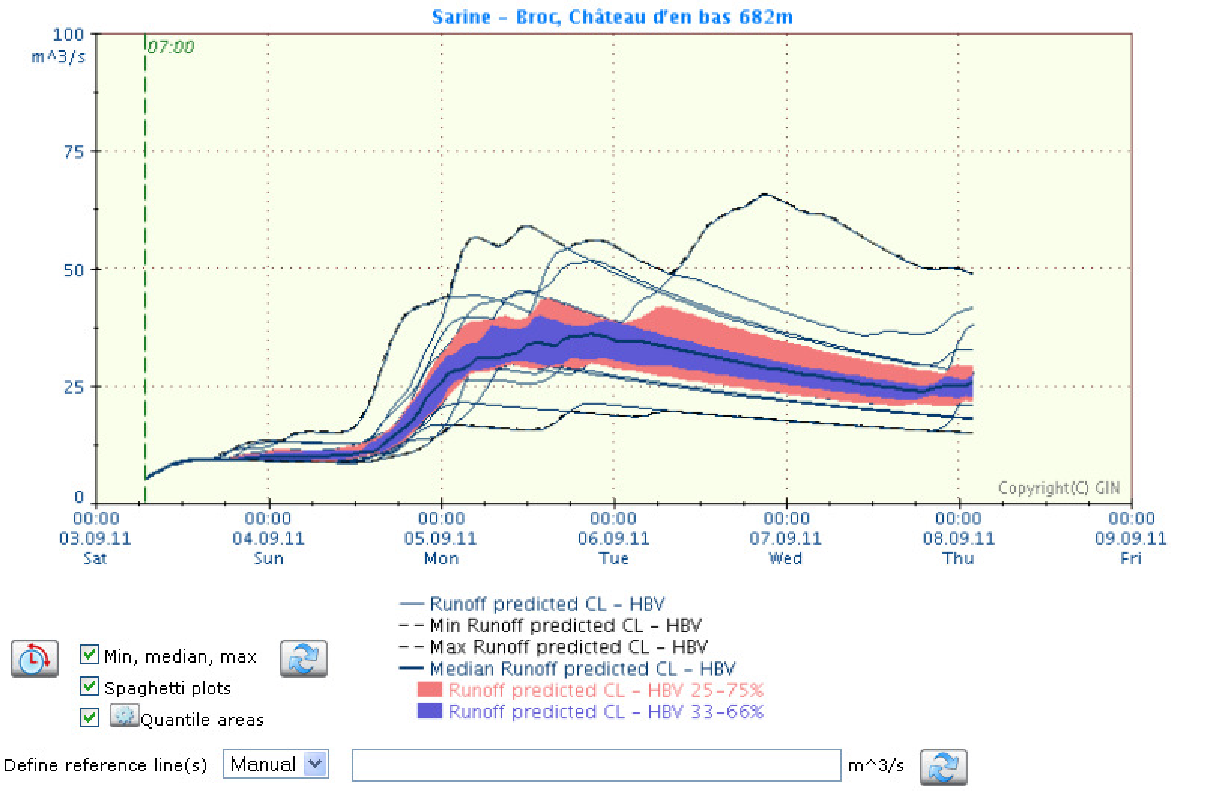

Fig. 4 Screenshot of a prediction-diagram with outputs of different runoff models for the station Sarine, Broc, Château d'en bas.

Alp - Einsiedeln 840m

		Sun, 4 Sep, 03:00			Sun, 4 Sep, 05:00	Sun, 4 Sep, 02:00
		Sat, 3 Sep, 14:00			Sun, 4 Sep, 05:00	Sun, 4 Sep, 02:00
	Alp - Einsiedeln	Runoff predicted CL - PREVAH m^3/s			Runoff predicted C2 - PREVAH m^3/s	Runoff predicted C7 - PREVAH m^3/s
Date & Time	Runoff m^3/s	Min.	Median.	Max.		
04 09 2011 - 02:00	0.474					0.72
04 09 2011 - 03:00	0.457	0.72	0.72	0.72		0.72
04 09 2011 - 04:00	0.468	0.72	0.72	0.72		0.72
04 09 2011 - 05:00	0.452	0.72	0.72	0.72	0.72	0.72
04 09 2011 - 06:00	0.452	0.72	0.72	0.73	0.72	0.72
04 09 2011 - 07:00	0.463	0.71	0.71	0.74	0.72	0.71
04 09 2011 - 08:00	0.457	0.71	0.71	0.74	0.72	0.71
04 09 2011 - 09:00	0.452	0.71	0.71	0.77	0.72	0.71
04 09 2011 - 10:00	0.468	0.71	0.71	0.83	0.71	0.71
04 09 2011 - 11:00	0.474	0.71	0.71	0.92	0.71	0.71
04 09 2011 - 12:00	0.49	0.71	0.71	0.98	0.71	0.72
04 09 2011 - 13:00	0.474	0.71	0.71	1.08	0.72	0.73

Fig. 5 Runoff data and predictions for the Alp river near Einsiedeln (840 m). Columns from left to right: Timestamp; runoff measured; runoff predicted (with more than one member) with the meteorological model COSMO-LEPS, initial time Saturday, 3 September 2011, 14:00 h and hydrological model PREVAH, initial time Sunday, 4 September 2011, 03:00 h with min, median and max values; run-off predicted with meteorological model COSMO-2, initial time Sunday, 4 September 2011, 05:00 h and hydrological model PREVAH, initial time Sunday, 4 September 2011 05:00 h and runoff predicted with meteorological model COSMO-7, initial time Sunday, 4 September 2011, 02:00 h and hydrological model PREVAH, initial time Sunday, 4 September 2011, 02:00 h.

Data can also be visualised on maps. For the map visualisation, ESRI ArcGIS JavaScriptAPI is incorporated (Fig. 6). Visualising combinations of different parameter with one symbol is also supported; e.g. wind direction is represented by arrows and the average wind speed by the size of arrows or the snow height by colour and the new snow height of the last 24 hours by the size of the symbol. Overlaying multiple symbols allow to show combinations. Due to this complexity the definition of arbitrary symbolisation is restricted to moderators. Users can define arbitrarily user-defined views and choose defined symbolisations, if they are defined for the selected parameters. The labelling can also be activated or rather start automatically above a given scale. Labels may overlap, due to limitation of processing capacity on the client side/browser.

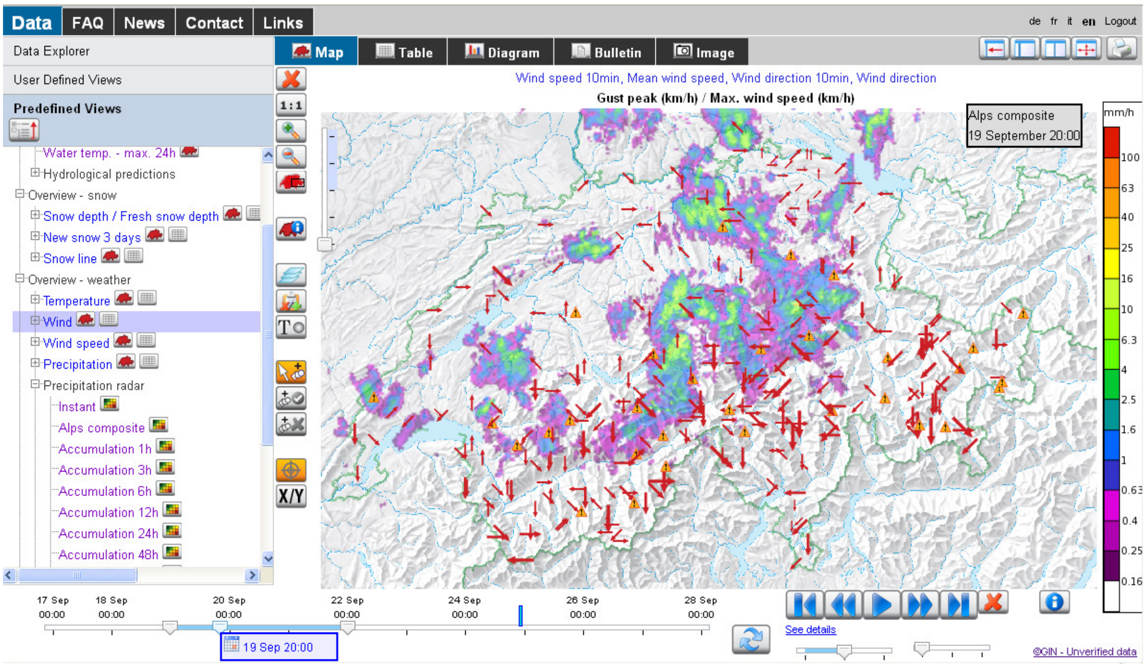

Fig. 6 Map visualization: Wind directions (arrow direction) and wind speed (arrow size) combined with radar precipitation image.

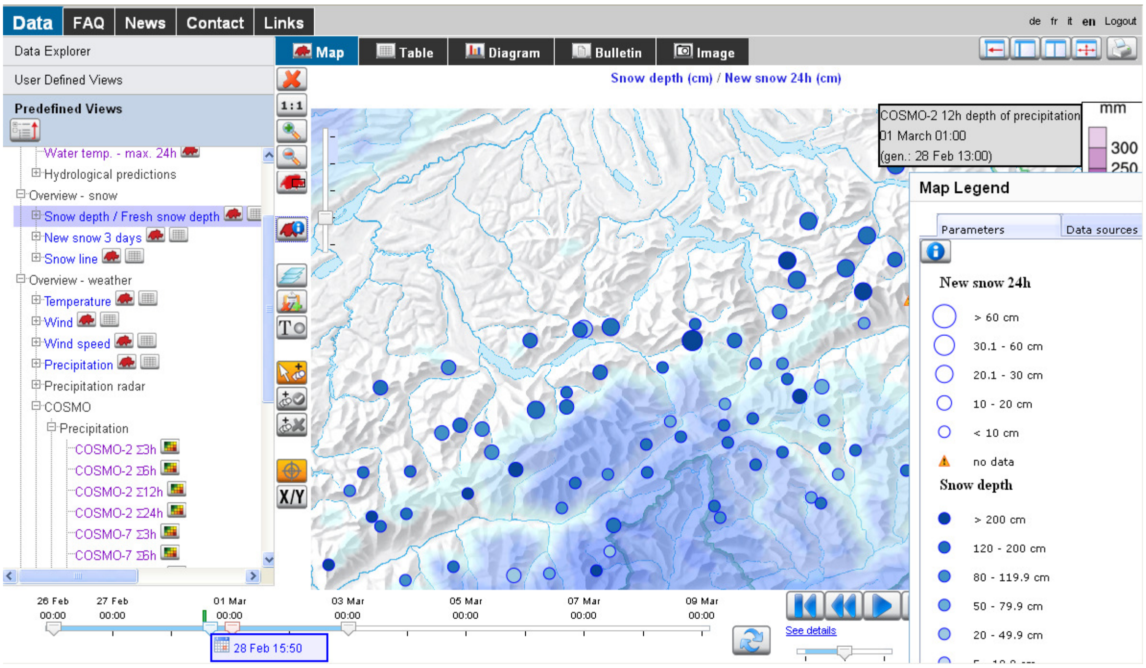

Fig. 7 Snow depth and new snow combined with forecasted COSMO precipitation image. On the right hand side the legend of the symbols is displayed.

Raster images, like precipitation radar images or COSMO precipitation images, are geo referenced and can be interactively added as layer on the map (Fig. 6 and 7).
Satellite images are also available but not geo-referenced on the map. The available satellite images cover usually Europe. Due to the small scale, zoom-in is not reasonable. Therefore, satellite images are displayed as an own type, with the functionality to play loops, next image, previous image etc.
Bulletins are displayed as plain text or formatted if delivered as html. Warnings are handled separately and are described in the section below.

COCKPIT

To detect and to assess a hazard situation, measured and predicted data, but also bulletins must be interpreted. To facilitate this interpretation especially for the user-group of natural hazard experts in the municipalities a "Cockpit-View" is implemented in GIN. This cockpit permits a very quick overview on hazard levels in a 'traffic light system'. The "traffic lights" are compliant with five warning levels 1 (low, no risk – green) to 5 (very high risk – dark red). Those warning levels are linked with physical or probabilistic parameters and are standardised by definition and agreement between the official Swiss warning centres. In general three types of warnings are distinguished:

a) Warnings "officially" issued by the experts of the official Swiss warning centres after interpretation of data and model outputs (shown in Cockpit by coloured map, see also Fig. 7)
b) Warnings activated automatically when measurements or forecasts exceed threshold levels set by the official offices (shown in Cockpit by hatched/grey map)
c) Warnings activated automatically when measurements or forecasts exceed threshold levels set by the user, which allows to define 'personal early-warnings' (shown in Cockpit by hatched/grey map)

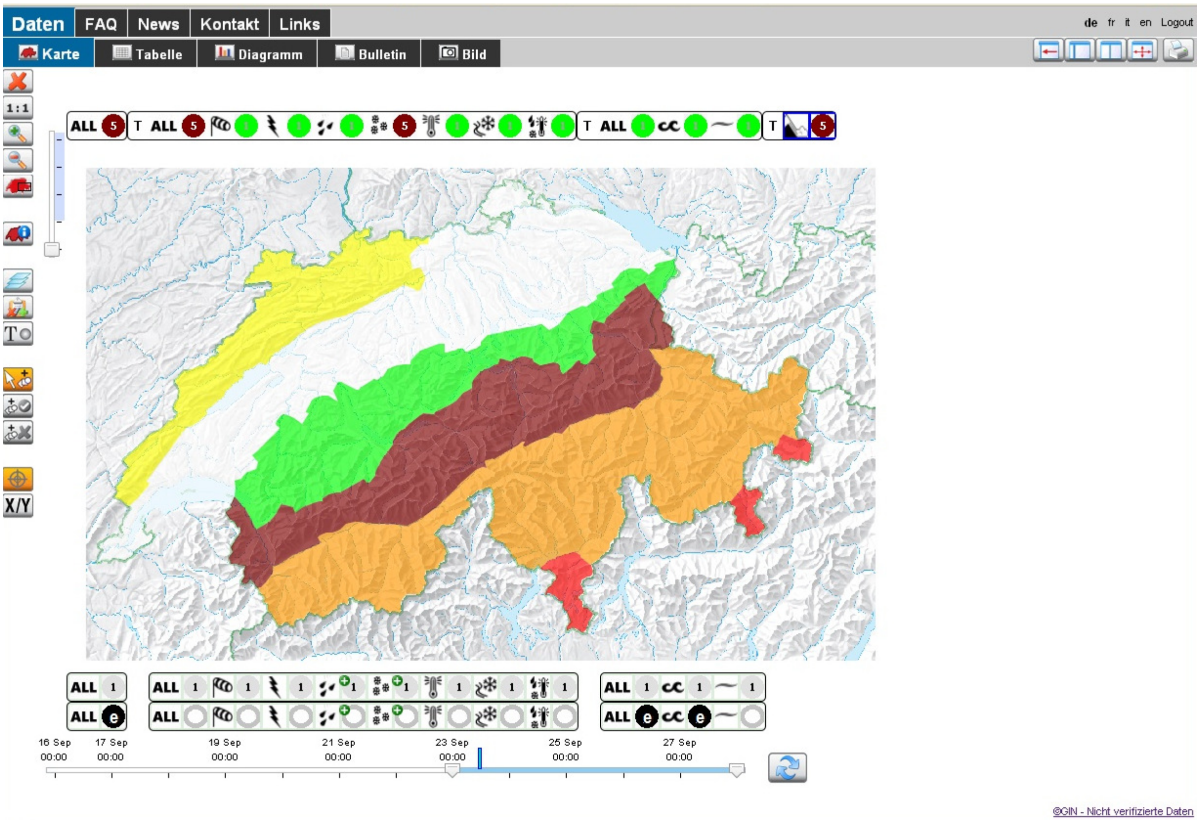

Fig. 8 Map with official warnings – top (first) function-bar: official warnings; bottom function-bars: automatic warnings based on official hazard-levels (second) and user-defined hazard-levels (third) – with mouse-over text.

This visualisation of predicted data in combination with thresholds was first realised in the predecessor MAP D-PHASE (Arpagaus et al. 2009). In modification to MAP D-PHASE, Cockpit also

integrates official warnings. Users are able to interactively choose between different visualisations: official warnings or alerts derived from model predictions.
Warnings are visualised in the Cockpit-module as maps and as diagrams. In the map view flood warnings are done for river sections and lakes. For meteorological and avalanche warnings, the previously differing warning regions were harmonized to so-called base warning regions (Fig. 7), which represent meteorological warning regions and avalanche warning regions. These sets are not necessarily equal for meteorology and avalanches.
Warnings can be visualised on a map for all or for singular types of natural hazards: wind, thunderstorms, rain, snowfall, heat wave, slippery road, thaw, high water (rivers and lakes) and avalanches (Fig. 8). The top function-bar allows a direct visualisation of the different phenomena and their combinations. Besides the icon for a specific hazard, the maximum hazard-level is displayed. Additionally the bulletins for whole Switzerland can be accessed directly (via 'T'-button). With the two time sliders the warning interval can be selected. Mouse-over leads to detailed information for a warning region: hazard-level and warning text, if existing (Fig. 8).
A click on the map delivers a detailed diagram of hazard-level as a function of time in one-hour-steps for a selected region and warning type (Fig. 9). Shift-click leads to an aggregated overview diagram with one-day-steps.

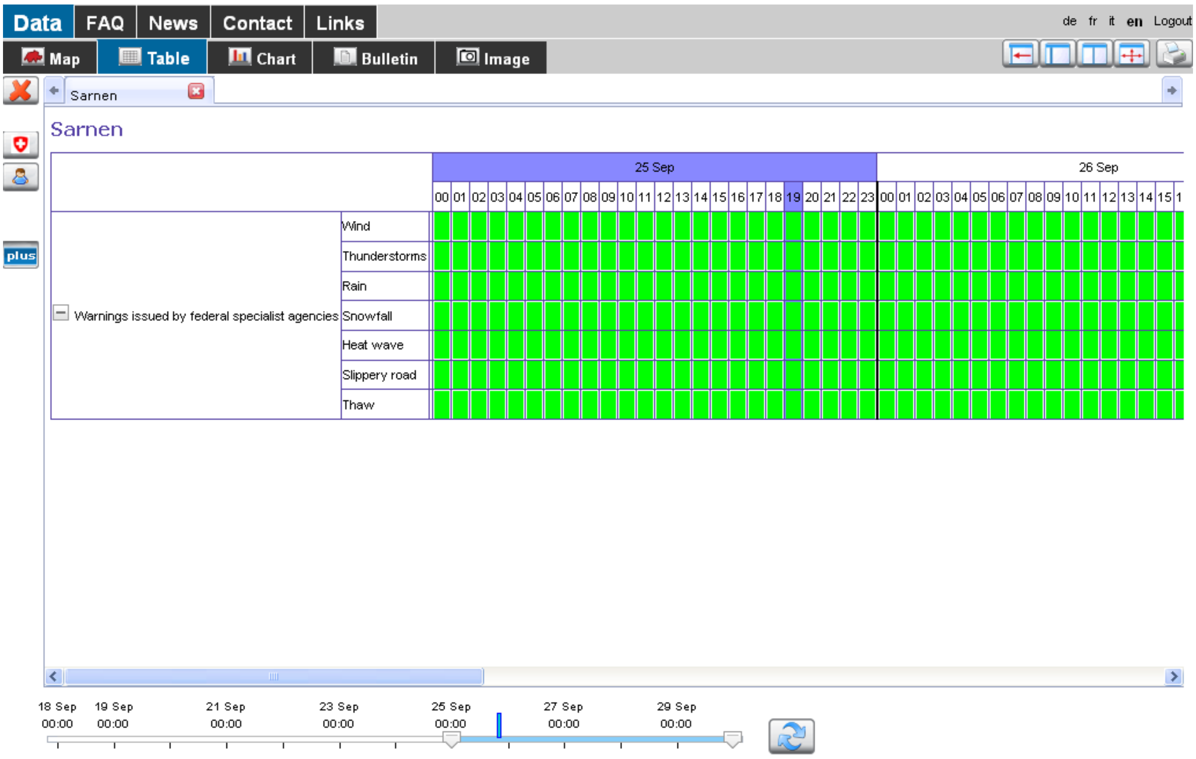

Fig. 9 Diagram with meteorological hazard-levels for the region of Sarnen in one-hour-steps.

CUSTOMISATION

GIN has to meet a wide range of needs: On one hand, it should cover the whole of Switzerland; on the other hand, it should also meet needs at the local level. Moreover, the range of users goes from specialists to educated laypersons and from people familiar with this kind of platforms to persons who rarely use internet and computers.
To cover this variety, GIN offers personalised features. Each user has an individual account. Users can define and store individual settings, views – so-called user defined view – and thresholds. In the profile, the user can set a language, start view – either a predefined or a user-defined view – and map regions – map zooms automatically into a defined region.

So a natural hazard expert in Davos will see after login all relevant information, e.g. snow and hydrological stations around Davos, while a natural hazard expert in Verbier will see e.g. precipitation measuring stations around Verbier combined with the current precipitation radar image.

CONCLUSION AND OUTLOOK

By launching the OWARNA project, Switzerland has intensified its effort to reduce risk of natural hazards. In this project, GIN is the information hub for data, forecasts and warnings and thus a core element. At this time GIN fulfils many of the needs of the natural hazards experts.

The next major milestone will be the possibility for users to enter observations. Observations, for example of avalanche occurrences, are crucial especially for avalanche predictions. It is also planned to implement additional data of cantons, communes and private operators. Furthermore, establishing links between GIN and the electronic information platform (ELD) of the National Emergency Operations Centre (NEOC), which mainly provides information for civil protection authorities, is foreseen. The idea of expanding the available information on GIN also in the field of technical hazards and risks is discussed.

In coordination with GIN, which is a platform for natural hazard experts, a platform for public users will be established in the next years.

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