VARSOM : REGOBS – A COMMON REAL-TIME PICTURE OF THE HAZARD SITUATION SHARED BY MOBILE INFORMATION TECHNOLOGY

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ABSTRACT: The regObs system is an open and mobile real-time system used for recording, storing and distributing data for assessing, forecasting and mitigating hazards. Most observations are entered on a smartphone app and all data are available on an open digital interface in real-time. An English version of regObs will be released during the 2018-2019 season. Professional (mountain guides, road managers, rescue workers, forecasters) and recreational users claim that the structure of the information chain (from field data collection to avalanche forecasting) is very valuable in their daily avalanche danger assessment and decision-making, as is the open data policy and the app for the field. regObs would be an efficient tool for warning services in other countries and more international collaboration.

KEYWORDS: Avalanche, hazards, forecasting, mobile applications, field data.

1. INTRODUCTION

regObs is a state-of-the-art open and collaborative system for forecasting of natural hazards, as well as sharing a common operational picture before, during and after hazardous situations (Fig. 1). It is open to everyone, through online and offline services for sharing observations and danger assessments. regObs stands for registration of observations and it is a public registry for snow, weather, flood and ice observations in Norway.

regObs consists of a mobile app (iOS and Android), a web site (regobs.no), a database and an Application Programming Interface (api.nve.no). The system is part of the Varsom portfolio. Varsom.no (Johnsen, 2013) is the national web site for warning of avalanche, flood, ice and landslide hazards. In 2018, it extends the number of hazards types to include large landslides and certain extreme weather phenomena.

The Norwegian Water Resources and Energy Directorate (NVE) develop and operate regObs, in collaboration with Norwegian Public Roads Administration (NPRA). Development started in 2011 (Ekker et al., 2013) in support of establishing the Norwegian Avalanche Warning Service (NAWS, Engeset, 2013) and Landslide Warning Service (Devoli et al., 2018).

Most major stakeholders use the system, including national and commercial avalanche warning services, rescue services, transport authorities, military, local authorities and recreational backcountry travellers, in addition to mountain professionals (e.g. Norwegian Mountain Guide Association, NORTIND), course providers, university students/researchers and consulting companies.

Figure 1: regObs enables direct reporting from the mountains with the unfortunate consequence of pulling the users attention away from the beautiful surroundings, down to the screen of the smartphone. However, in this way crucial information is shared in real-time for the benefit of others. Picture by Steinar Karlsen/regObs.

2. USE

In total 81,375 observations were shared since October 2012. 13,409 snow observations were shared from October 2017 to June 2018: 60 % submitted in real-time using the app, 16 % on regobs.no and 24 % using third party systems, such as ELRAPP from NPRA and automatic sensor systems (avalanche detections by radar and acoustic systems).

Last season we received a surge of crowd-sourcing data from individuals, and the system is widely used in avalanche education. In March 2018, the

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app had 14,000 users (51,000 sessions). 24,000 users (40,000 sessions) accessed regObs on the web, 65 % from mobile devices. A real-time data feed from regObs appears next to the avalanche forecasts on varsom.no and is thus accessed by many of its readers. Varsom.no had 132,000 users (253,000 sessions) in March 2018 (Norway has a population of 5.3 mill.).

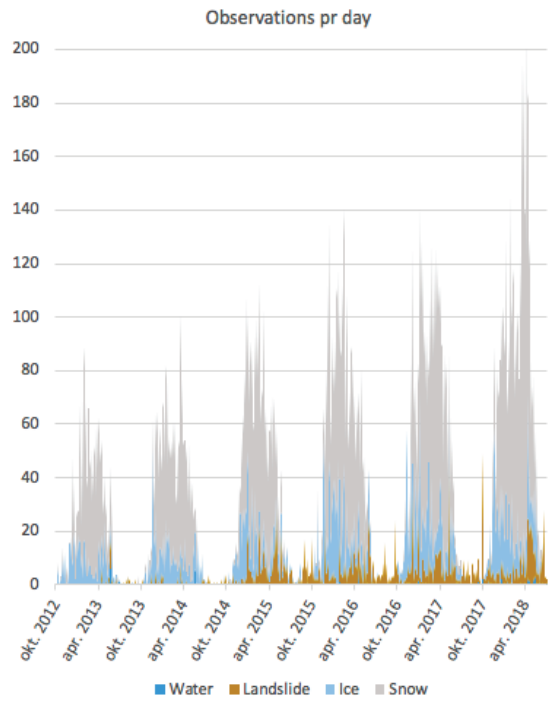
An *observation* in regObs is a collection of data submitted by a user when pressing "send in" on the web or app. Observations are geographically positioned and time-stamped. There are currently four types of observation categories: snow, ice, land and water used for avalanche, lake ice, landslide and flood warning respectively. Each observation contains one or more subsets (Table 1).

Table 1: Observation types grouped by hazard category. Each observation subset includes a number of different parameters.

Categories	*Observation type*
Snow	Weather Danger sign Avalanche event Avalanche activity Snow cover Column test Snow profile Avalanche problem Avalanche danger assessment Accident/incident Notes
Ice	Danger sign Ice cover Ice thickness Accident/incident Notes
Land	Danger sign Landslide event Notes
Water	Water level Damages Notes

Observations are used for documentation and decision-making during risk management and preparedness operations at the slope, local, regional and national levels. regObs is mostly used for avalanche-related observations, but is increasingly used for sharing data from other natural hazards, such as river and lake ice, floods and landslides.

As Fig. 2 shows, not only is there an increase in the total number of observations every year, but there is also an increase in the maximum daily activity on days of interest, typically during winter/Easter holidays or flooding incidents.



	2012-13	2013-14	2014-15	2015-16	2016-17	2017-18
Snow	5659	7116	8456	9508	11173	13409
Landslide	169	215	1620	1622	2102	1827
Water	65	55	20	30	54	197
Ice	2016	2427	2699	3510	3981	3445
Total	**7909**	**9813**	**12795**	**14670**	**17310**	**18878**

Figure 2: The plot shows the number of observations submitted to regObs per day since October 2012. The associated table lists the annual totals (summed from October to October each year).

3. VALUE

The true value of systems targeted at collecting and exchanging information, lies in their value for the users. Although primarily designed for avalanche forecasting, it also serves several other user groups that share the same target – preventing and avoiding accidents. regObs collects data regarding instability, snowpack structure and snow and weather factors.

3.1 User feedback

A recent user survey shows that 94 % of the users access regObs on mobile devices, 82 % rated regObs as very useful and 58 % said that the user friendliness is great (Fig. 3). Several improvements were implemented on the smartphone app in 2017 and 2018, including a high-quality map-centric main screen, as well as quick and easy search and display of observations. We plan to release a quick and easy tool for data entering in the app during the 2018-19 season. It will significantly improve the user friendliness for novices and volunteers, a user group suffering lack of

knowledge or motivation when introduced to the full capability of the app.

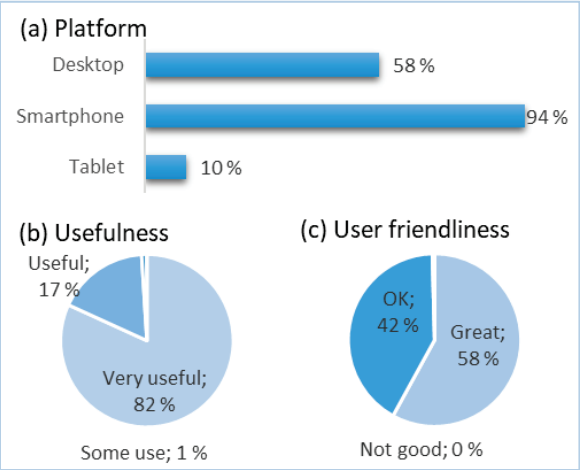


Figure 3: Feedback from users of regObs: (a) which platform is used to access regObs? (b) how useful is regObs? (c) how user friendly is regObs? Data from March-April 2018 (N=274).

3.2 *Open data policy*

The users highly value the open data policy of regObs and provides very positive feedback on the avalanche warnings and regObs (Engeset et al., 2018, Hisdal et al., 2017). User involvement and open data has been an integral and important part of the regObs development and user satisfaction is regularly measured.

3.3 *Examples*

Value is also illustrated by examples:

Regional forecasting

A forecast is based on an observed initial situation, which will change based on expected development of the weather. Especially for avalanche forecasting, conditions may change quickly, and if a forecast is based on old observations, it may be wrong. Thus, observations need to be as fresh as possible when a forecast is published.

With regObs, observations may be submitted in real-time, so the forecaster can base the forecast on be best possible initial condition. The observers and others may also evaluate the published avalanche forecast: Is the forecasted danger level and avalanche problems in agreement with your impressions in the field? Your evaluation is shared in real-time and is open to everybody.

Local/slope-scale forecasting

All the forecasts (avalanche, landslide, flood and ice) on Varsom.no are regional forecasts describing as good as possible the conditions in areas of 100-10,000 km^2. The forecasts give travel advice and/or advice on how to mitigate the current situation, but it will be poor on details about local conditions.

If a mountain guide, ski resort, entrepreneur for roads or railways, a skating club or a military unit report what they see related to geohazards, they will strengthen the regional forecast for the same area. They will also contribute with a more local dataset that can be used by other people in that area, thus giving them a better dataset to evaluate the potential danger themselves.

Also, several local forecasting operators, such as Wyssen, Skred AS and NGI use regObs as their field data management system.

Crisis management

If a crisis occurs and we have a hazard that must be mitigated, it will involve several organizations and professions. The best way to cooperate across organisations and professions is in our opinion to share relevant data with each other thus keeping everybody informed of the situation in real time.

regObs gives this possibility. In regObs we can keep track of when and where avalanches are released together, so we can better know which avalanches are fresh in case of rescue or evacuation. In regObs we can keep track of water level during a flood and check it against the models before issuing updated forecasts. In regObs we can report hazardous areas on ice-covered lakes so that skiers, snowmobilers or skaters may plan alternative ways across.

Research and development

We prepare for future geohazard events by studying the previous events. Over the last six years, regObs has received 81,375 observations. This data can be used to calibrate models and to validate forecasts and possibly help improve the decision-making routines. Data can be linked on incidents to better understand when and why accidents occur, or we can analyse where incidents occur over time and plan new infrastructure based on how a hazard affects the area.

3.4 *Systematisation of information and structured workflow*

regObs has implemented a structure, which supports the users in systemising the information collection and avalanche danger assessment processes. This structure builds on the systematic snow cower diagnosis and process thinking (Kronthaler et al., 2013). This structure leads to a workflow that is the same for information gathering (observers), reporting (regObs), production of forecasts (forecasters) and avalanche forecast presentation (varsom.no).

Our experience is that this structure contributes to a uniform way of communicating and handling different avalanche problems across different user groups. Professional users, such as mountain guides, road authorities and rescue workers, claim that the structure that permeates the whole chain from information collection to avalanche forecast, is very valuable in their daily avalanche danger assessment and decision-making.

4. DATA POLICY AND ACCESS

4.1 Open data policy

All data in the system are open and licensed according to creative commons (currently CC BY 3.0). Data are accessible on api.nve.no and managed by NVE in compliance with General Data Protection Regulation (GDPR).

4.2 Data access using the API

Both reading and writing data from/to regObs is done through Application Programmable Interfaces (API's). These are accessible to the public and we encourage other applications to use our data and we also encourage integration with applications to write data directly to regObs. Note that in the latter case, access is regulated with an application key. The code in Fig. 4 is an example of how to retrieve data from regObs. Using Python's requests module, you may post a query to our URL. Observations can be parsed to JSON.

```
import requests as rq

query = {'LangKey': 2,
         'FromDate': '2018-03-01',
         'ToDate': '2018-03-04',
         'NumberOfRecords': 500}

url = 'https://api.nve.no/hydrology/' \
      'regobs/webapi_v3.2.0/' \
      'Search/Rss?geoHazard=10'

observations = rq.post(url, json=query).json()
```

Figure 4: This Python code may be used to get observations in the first days of March this year. The API of regObs is as important for data distribution as the webpage itself.

5. TECHNICAL OVERVIEW

5.1 Technology

The structure of the system is illustrated in Fig. 5. It uses a SQL-database with a REST application programmable interface for access (REST-API). The webpage is a C# web-app and is being rebuilt to use only the REST-API for data access. The app is a cross platform Cordova-app, giving us the benefit of developing most of the app simultaneous for iOS and Android. The app uses the REST-API for reading and writing data. We use the same API that we offer third party users like Varsom.no and ELRAPP. This way we are confident that we offer a well-functioning interface. A well-functioning API is as important for data gathering and distribution as the webpage and app.

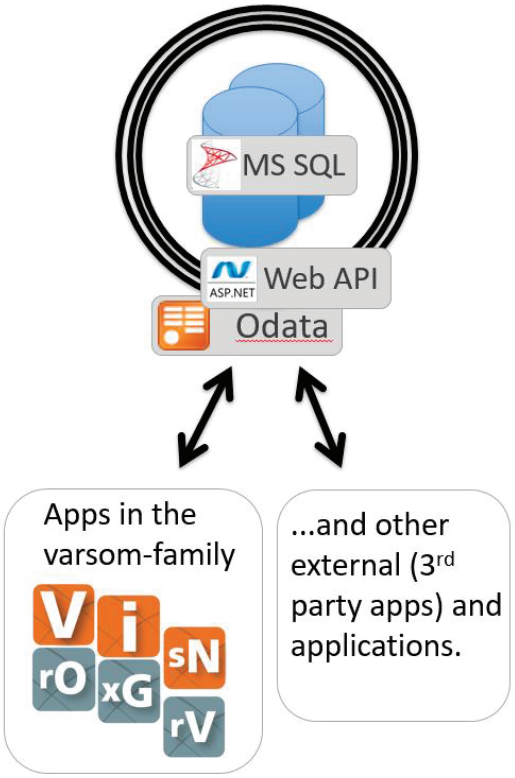


Figure 5: regObs system schematics showing the database for storage and the API's for access.

5.2 Development method

regObs is developed through an iterative process to meet the needs of our users, releasing functionality continuously when developing. Some released functionality is as prototypes, which gives us user feedback before final development. At the end of every development phase, we summarise what we didn't do and make plans for what we wish to do next. User involvement is extremely important when developing and manging regObs. We have regular meetings with an expert panel with representatives from all major stakeholders and a Facebook group where we meet our users with issues ranging from "How do I reset my password" to "How to best choose a location for a snow pit" and "Adding a map to the app would be so cool". The group has close to thousand members and we see that other users often answer questions before the regObs-team.

An iterative development strategy and extended user involvement were important to test new features at low costs and low overall risk of failure.

5.3 Benchmarking

Iterative development requires some benchmarking parameters, we have had special attention on:

- Response time when searching in data, because nobody likes waiting.
- The time difference between when something is observed and when it is registered, because we want a minimum of delays.
- We need a well performing app in areas with little or no mobile internet connection, because that is where many of our users are.
- Logging of server downtime and errors, because we need to know to fix them.

Annual questioners are used to ask our user how we are doing. We vary the questions as little as possible so that we can compare the development from year to year.

6. INTERNATIONALISATION

regObs is developing into an international system (2017-2019), which implies multi-lingual support in the front-end web and app interfaces, storage of language-independent data, storage of time in UTC time and time-zone conversion to local time at user interfaces, OpenTopo map will be the standard base map globally, country-specific topographic and thematic maps will be add-ons. In Norway, these include the national topographic map series and NVE maps of slope inclination, weakened ice and flood inundation. Other country-specifics could be access to warnings from relevant AWS' and presentation of data according to warning regions, administrative units and user organizations. User support, educational material and public relations are crucial country-specific functions to be addressed by the AWS' or other community members in the different countries.

regObs has proved to an efficient and effective tool in Norway. Users in other countries could benefit from the Norwegian investments and experiences. Increased number of users and countries would add complexity and costs to maintenance and country-specific needs. On the other hand, we could establish a community in order to share costs and ideas. The benefits could be significant in terms of continually improving the system and a systematic approach to collecting, storing and retrieving observations, assessments and feedbacks from the field.

7. OUTLOOK

The development plans until the end of the 2018-2019 season includes these app improvements:

- Access to relevant warnings based on app position. Replace the Varsom app
- Entering and editing of snow profiles
- Trip planning and tracking, including ATES
- Access to measurements from automatic hydrological and meteorological stations
- Improved user-forecaster communication

We also develop the API's and web site, making them faster and more effective. At the same time, we are working on long-term developments:

- Migration to cloud to improve scalability, load balancing, maintenance and development
- Integrating higher resolution forecasts from the Avalanche Problem Solver (semi-automatic forecasting, Müller et al., 2018)
- Integrating dynamic and automatically generated avalanche terrain exposure data
- Adding a decision-making observatory by allowing users to share their tracks, decisions, reasoning and feelings

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