THE NORWEGIAN AVALANCHE OBSERVER CORPS: SAFETY, QUALITY, TRAINING, PROCEDURES AND CULTURE

Markus Landrø[1]*, Rune Engeset[1], Andreas Haslestad[1], Jostein Aasen[1], Knut Orset[2]

[1]Norwegian Water Resources and Energy Directorate (NVE).
[2]Norwegian Public Roads Administration (NPRA).

ABSTRACT: Field observers are crucial to secure a steady flow of high quality observations from the field, which is necessary to provide a reliable avalanche forecast. To provide these observations, the Norwegian Avalanche Warning Service (NAWS) has its own observer corps. All observers are subject to standardised training courses, operating procedures and follow-up system. About 80 observers spend approximately 5,500 hours on observational field trips during a season, much of this time in or near avalanche terrain. The NAWS personnel safety strategy is designed to prevent accidents. It is focused on developing a sound safety culture within the observer network, as well as providing high quality courses and a systematic and transparent monitoring programme. Ensuring safety starts already in the recruitment process, and retains major focus at all levels of the observer-training programme. All observers use pre-defined observation routes. Each pre-defined route ensures sufficient safety margins under different conditions, and its use will depend on the prevailing avalanche situation. Further, NAWS established an incident reporting system. Example cases are discussed at the annual observer meeting, and the operating procedures and training courses are continuously improved. All observers receive written feedback on their observations each season and a personal follow-up by the senior educational staff. This approach requires significant human resources, but the idea behind is that increased knowledge through high quality training also contributes to increased safety. This paper describes the recruitment, training courses, daily work and support of individual observers.

KEYWORDS: Avalanche forecasting, Observer training, Safety.

1. INTRODUCTION

Norway has no heli- or cat-skiing operations, no avalanche control industry and limited avalanche competence at ski resorts, in contrast to North America and large parts of the Alps. Also, limited avalanche competence was available at governmental agencies. Thus, hardly any trained personnel was at hand to provide snow and avalanche observations in 2010, when Norwegian Water Resources and Energy Directorate (NVE) decided to establish the Norwegian Avalanche Warning Service (NAWS). However, UIAGM mountain guides in Norway provided a good basis for field-based experience.

Leading up to the launch of a public warning service in January 2013 (Engeset, 2013), NAWS had to recruit, train and employ their own network of observers. NVE collaborated with the Norwegian Public Roads Administration (NPRA) to build a professional observer corps.

During the first four operational seasons, the observers have been out in the mountains doing observations two to three times a week from the end November until the end of May.

Doing this kind of work in all kind of weather and avalanche conditions is potentially dangerous. In addition to focusing on getting high quality observations from the field, there has been a strong focus on preventing accidents among the observers.

2. THE OBSERVER CORPS

As of today, NVE has contracted about 60 observers on a part-time basis. In addition, more than 20 employees at the NPRA participate in the observer corps. Observations are also provided by personnel from the Norwegian Meteorological Institute (MET) and the Norwegian National Rail Administration (JBV).

Both NVE and NPRA have a leader of the observer corps (LOC), who are responsible for the observers. Another one or two senior staff members are assisting in the follow up and nearly 10 senior staff and observers have been instructors at

* *Corresponding author address:*
Markus Landrø, NVE, Postbox 5091 Majorstuen
0301 Oslo, Norway.
tel: +4790201696
email: mala@nve.no.

the observer courses. Between one and one and a half work year is required for the recruitment, education, monitoring and follow up of the observer corps.

All observers are subject to standardized training courses, operating procedures and follow-up system. The main tool to prevent accidents among observers was to develop a safety culture within the observer network, as well as courses and monitoring. This work starts with the recruitment process and retains major focus at all levels of the observer-training programme.

3. GENERAL RISK ANALYSIS

The basis of all measures to ensure observer safety was the general risk analysis (Fig. 1). This analysis showed that observation route selection, observer recruitment and competence are the most important risk reducing factors.

4. RECRUITMENT

The observers are contracted on basis of domicile in a forecasting region, and the possibility to combine doing observations with other work. Our experience is that it takes a few years for an observer to become experienced. That is how long it takes to have the in depth insight in the crafts of an observer and to fully understand the relationship between observation, forecasting and end user.

During these first years of doing snow observations, the understanding of the difference between private ski touring and observation trips becomes clearer. So does the observers consciousness concerning personal safety within this kind of work. Therefore, we try to recruit observers with a long time perspective. Nevertheless, most important is their winter mountain skills and the ability to take care of themselves.

All observers have a high level of competence before they start as observers. Many are UIAGM mountain guides, avalanche instructors (alpine club) or have similar competence through years of mountain travel. NPRA-observers are mainly engineers or geologists employed by the NPRA, with sufficient winter mountain skills

Given this background, everyone has at least basic snow and avalanche knowledge when starting the observer training. In addition, they are familiar with handling avalanche risk before starting as an observer.

Phase	Factor (affecting safety)	Risk	Possible consequence	Risk reducing measures
Selection of observation routes	Unfamiliar terrain Inadequate maps Knowledge	Wrong basis for selection of observation routes Mistakes in avalanche evaluation	Routes with limited or no possibilities given current avalanche conditions.	Observers who work in familiar terrain. Provide good maps Leader of observation corps approves the routes. Observers with experience. Training avalanche evaluation at all levels of observer-training.
Choosing observation route	Current danger level and avalanche problem. Weather.	Choosing route with too high rest risk.	Avalanche triggering	Leader of observation corps approves which routes that can be used base on danger level and avalanche problem. Observer knowledge. Consideration of the weather forecast.
Observation trip	1. Weather 2. Snow and avalanche conditions 3. Terrain 4. Observer	1. More difficult weather than expected 2. Higher danger level or different avalanche problem than expected. 3. Terrain that is steeper or more exposed than shown on map 4. Running out of time. Deviating from planned route. Broken avalanche equipment. Not using avalanche equipment.	1. Difficult navigation, increasing avalanche danger. Avalanche triggering 2. Higher likelihood of triggering an avalanche 3. Avalanche triggering 4. Mistakes in avalanche evaluation. Higher consequences in case of avalanche triggering.	1. Observers with lot of experience in winter backcountry travel. Low threshold for terminating a trip. Choosing routes where level of evaluation is in agreement with current condition. Choosing routes that are possible to do even with low visibility. 2. Well trained and experienced observers. Continuous reevaluation. Change route selection or terminate trip. 3. Well trained and experienced observers. Continuous route selection. Annual revision of observation trips. 4. Well trained and experienced observers. Selecting routes that can be done within given timeframe. Focus on human factors during training. Avoiding combination of observer trip and private ski touring. Terminate trip if equipment is broken or lacking.

Fig. 1. General risk analysis.

During the courses, we therefore focus on teaching the methods and the workflow chosen by the NAWS and start at a higher level than we could with inexperienced participants.

5. TRAINING AND COURSES

NVE has developed its own training programme for NAWS. Before doing so, observer courses by the Norwegian Geotechnical Institute (NGI, Norway), Swiss Institute for Snow and Avalanche Research (SLF, Switzerland) and Lawinenwarndienst Bayern (LWDB, Germany) where attended. The Canadian Avalanche Association (CAA) training programme was also considered. NGI conducted training courses during an early stage of the test and development phase (2010-2011).

Finally the decision was made to develop our own training program, inspired by the courses that where attended. This was due to cost, flexibility and the possibility to tailor the programme to our needs. The educational programme has developed in parallel to the warning service and new courses have been added when needed.

As of today the training programme is modular and are thematically organized as a number of modules in five tiers (tier one is not being used):

2 – Rescue training,

3 – Winter travel,

4 – Observations,

5 – Forecasting.

To become an observer, you have to complete the following courses:

2a – Basic companion rescue,

3b – Travel in avalanche terrain,

4a – Observer course.

All observers have to attend these courses, regardless of their prior competence and experience. The NAWS also organises the following advanced courses:

4b – Intermediate observer course,

4c – Experts observer course,

5a – Avalanche forecasting.

All courses are held by instructors employed by the NAWS partners (mainly NVE) and are for people within the observer network. In some cases, people from other institutions or volunteers have attended.

The training is crucial both for the quality of the observations, but also with regards to personnel safety. The observers are trained in the methods and tools used by the NAWS in addition to learning the work and travel patterns used when doing observations. These patterns have been developed to ensure what is regarded as sufficient safety margin.

6. OBSERVATION ROUTES

All observers use pre-defined observation routes. The observers define a set of different routes in their region in order to, according to their experience, retrieve the best possible information about the different avalanche conditions. Every route is described considering what kind of avalanche situation that may be observed, cellular phone coverage, test slopes, snow pit spots and known avalanche slopes. In addition, the routes are analysed and categorised using the Avalanche Terrain Exposure Scale, ATES (Statham et al., 2006).

A document including a description of general weather and avalanche information from the region, ATES classification and argumentation for each route and maps, is sent to the leader of the observation corps (LOC) for approval. An example of a map and classification is shown in Fig. 2. The LOC analyses the routes and if needed, minor changes are done after discussion with the observer.

Looking at the total amount of observation routes, 70 % are in class 1 – simple and 30 % in class 2 – challenging terrain. None are in class 3 – complex terrain. Approved observation route descriptions are filed on the observer corps website (obskorps.nve.no) and are available to all members including forecasters.

How to analyse and make these descriptions are taught during the course *3b – Travel in avalanche terrain*. The process of describing the different routes has proven to increase observers consciousness considering personal safety.

Tur 2	
Bratthet	<30 grader
Terrengform	jevnt
Trebestand	Åpent terreng
Terrengfeller	Noen bekkedaler, noe overliggende skredterreng.
Skredhyppighet	Lav. Størrelse 1 og 2
Utløsningsområder	Få. Åpne områder
Utløpsområder	Enkelte. Definerte områder. Spredt avsetting
Skredområde	Kun utløpsområde
Rutevalg	Terrenget tillater mange valg
Eksponeringstid	Lav. Kun kryssing av utløpsområder

Fig. 2. Example of an observation route ATES class 1 - simple. IS – indicator avalanches, G – snow pit, T – test slope. Map on the top, ATES classification on the bottom.

In each region, the observers can choose between up to ten routes, which have sufficient safety margins depending on the prevailing avalanche situation. At a given day, one of the routes is chosen. The same routes are used when the regions forecasters or the LOC are visiting.

Every spring the observation routes documents are revised. Routes that have proven to be unsuitable are removed, and new ones are added. New insights concerning specific avalanche related topics that apply to this region are also added. In case of new observers taking over in an area, the documentation is a way to transfer some region specific knowledge.

7. INCIDENT REPORTING SYSTEM

In case of an incident, observers reports to the LOC and fill out an online incident reporting form. In case of an accident, both the LOC and chief of NAWS as well as the emergency staff at NVE will be notified. So far, we have had no accidents.

Incidents are analysed and in some cases, e.g. repeating causes, changes are made in the training programmes and in the work pattern. Reports from the incidents are published on the observer corps website. Incidents are presented and discussed during the annual observers meeting.

Since the start of regular observations in December 2012, we have had four known avalanche-related incidents. One incident where a group of observers were driving in their cars along an open road, when an avalanche released and stopped few meters from the road. This incident was analysed and a report with recommendations was published on the observer corps webpage. Three incidents involving test slopes. The incidents where presented and discussed during the observers meeting. A revaluation of existing test slopes and following revision of observation routes was done. The use of test slopes has been reduced in general. Instead, observers use systematic snow cover diagnosis and process thinking (Kronthaler et al. 2013) to locate the current avalanche problem and the distribution of it. In addition to these incidents, we have had one traffic incident where the observer's car slid of the road.

8. OBSERVER MONITORING AND FOLLOW-UP

8.1 Annual observer meeting

The observer and forecaster meeting takes place every autumn. As well as being a kick-off and networking event before every new season, this is where changes concerning the avalanche forecast, new technologies and new methods are presented.

Incidents and other topics that are of concern to everyone are presented and discussed in plenary. The rest of the meeting is organised as workshops dealing with specific topics, e.g. metamorphism, meteorology or coordination of work.

8.2 Observer feedback

During the forecasting season, observers get written feedback on the content and quality of their observation. This is done by the LOC. Our experience is that the observers appreciate the feedback

and it helps them to improve their work. Improved knowledge and competence also improve safety.

8.3 Observer visits

All observers are visited periodically by the LOC. The visit starts with choosing one of the approved routes that will give the best information about the current situation. Together they conduct a regular observation trip including online registrations of the field data on www.regobs.no or its smartphone app. During the day, professional issues and personnel safety are discussed. These visits are resource intensive, but regarded to be important in the safety work.

9. EQUIPMENT

All observers are equipped with a standard kit of avalanche equipment. This includes avalanche airbag, beacon, shovel, probe, bivibag and a snow study kit. Those who travel in areas without cellular phone coverage are equipped with an Emergency Position Indicating Radio Beacon (EPIRB) in addition.

10. TYPICAL OBSERVERS WORKDAY

Looking at the current weather and avalanche conditions, the route that gives the best possible information is chosen. The NVE observers then has to inform his or her dependent about which route that has been chosen.

The observer and the dependent are responsible for agreeing on and following up deviation from the plan, such as in the case the observer does not return from the trip. A list of each observers dependent is registered on the observer corps website.

Before heading out a short message about the chosen route and what kind of avalanche problems the observer will be looking for is submitted in the NAWS registration system, www.regobs.no. This way the forecasters know who is going where and what they will be looking for. During the day, the observer follows pre-defined route. Using the regobs smartphone app (available in app store and google play), the observer can submit observations in real time during the day.

After the tour, an end-of-tour message is submitted on the regobs app. All observations and analysis may be submitted with the regobs app in field, or the registration can be completed using computer at home. More than 50 % of the 33 000 regobs observations submitted last season were submitted using the smartphone app.

11. PROGRAMME REVIEWS

NAWS was reviewed by Grant Statham in April 2014, who made the following observations on workers' health and safety:

"Field observers often work alone in the mountains, which can present significant risk. Specific policies, procedures and training must be in place to manage this risk. NAWS has developed strong policy in this area by implementing a system of approved field-observation trips that are designed to ensure minimal or no exposure to avalanche hazard. This system reduces the avalanche risk to individuals, and every observer seemed well aware of their need to follow this system."

Furthermore, Statham states that

"NAWS has invested significant effort to minimize the probability of an accident by promoting the following: - A risk-averse culture, - Procedures for oversight of field observer trips, - Ongoing training, - Openness about near misses, and - Recruitment of experienced staff whenever possible. Continuing work in this area should always be considered an ongoing priority."

These points have been addressed before and after the review and are in line with the NAWS system and practices.

The facets of the observer corps described in this paper have also been presented to the senior line managers of the NVE, NPRA, JBV and MET – the managers who make up the Steering Committee for the NAWS and the National Landslide Warning Service.

12. OBSERVATIONS

The observer corps has submitted more than 100 000 observations to the observational database on www.regobs.no, see Fig 3.

Fig. 3. Map of avalanche danger observations from the previous four seasons.

13.CONCLUSIONS

As far as we know, the NAWS has a sound strategy, system and culture for managing observer risk. We have tried to create a system that provides sufficient safety margins for our observers without being too much of an obstacle to efficient data collection or making it difficult to combine data collection with other work during the week. This would have created a lot of frustration and resistance against using the system. Our impression is that we have a good balance between limitation and possibilities.

All NVE observers are out alone. If an accident happens, it may be better to be more people to handle the situation. On the other side, being more people may increase the probability of releasing avalanches, given the provided level of training, competence and culture. Thus, our focus has been on preventing accidents in the first place. Several observers report that operating on their own reduces the possibility of triggering an avalanche. This is our experience and feedback from observers:

- Observers focus on finding the current avalanche problem, not the best snow or exiting slope for skiing.
- The pre-defined routes are analysed and eventually approved, with personal safety and quality of information in mind. The list of routes is easy to choose from: These conditions suggest this route, thus avoiding distracting temptations.
- People are generally less willing to take risk when out on their own.
- The provided avalanche equipment is looked upon as a mean for reducing consequence, not a green card to enter dangerous situations.
- Low threshold on reporting and discussingincidents. Eventually leading to structural or educational changes.
- Close contact and communication during winter between observers, forecasters and LOC.
- High level of competence through training, feedback, meetings and visits, leading to less willingness for risk exposure.
- Personnel safety is a returning topic in all courses and meetings.
- Low threshold for terminating and returning from a trip if conditions are different than expected.

Given the total exposure time and uncertainty involved traveling in avalanche terrain, accidents may happen. Hopefully, the avalanche equipment and communication means will reduce the consequences of these accidents.

Therefore, this way of organizing the observer corps is not perfect and has room for improvement. Our assessment, given the experience we have up until today, is that it is safe enough.

Other risks, such as traffic accidents on the way to the to the field or skiing or falling accidents, are also considered and discussed.

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