

The historical investigation as a tool to improve the hazard maps: the case study of the historical avalanche of Avieil (Valle d'Aosta - Italy)

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ABSTRACT: Some avalanches, which in the past resulted in catastrophic events, but no more observed, are often very poorly understood. Therefore, for rediscovering and for preserving the historical memory of these calamitous events it can be significant to rectify and to improve the hazard maps and to assure a proper land use planning. On Monday, 27th February 1888, after some days with strong snowfalls (new snow 3 days: 400 cm at Champorcher - 1400 m a.s.l.), a big avalanche occurred, between 9.00 a.m. and 10.00 a.m., at 1900 m a.s.l. from a wide southern slope, strongly deforested for the coal production, located in the municipality of Arnad (Valle d'Aosta-Italy). To cartographically re-create the inhabited nucleus, before and after the avalanche event, and the subsequent stages of maintenance and possible relocation of buildings, two maps, produced by the Office of Rural Architecture (Department of Education and Culture) have been analysed. The combined analysis of these maps together with the re-created avalanche dynamic allowed updating the perimeter and areas of the avalanche phenomenon in the avalanche cartography. As both within the regional avalanche cadastre and within the hazard maps (L.R. n. 11/1998, art. 37) this avalanche phenomenon is strongly underrated, not including the village, this historical investigation turns out to be a tool of great importance for the conservation of the lost historical memory and for updating the risk maps, too.

KEYWORDS: avalanche cadastre, Aosta Valley, year 1888, serious damage, historical memory.

1 INTRODUCTION

Some avalanches, which in the past resulted in catastrophic events, but no more observed, are often very poorly understood. Therefore, for rediscovering and for preserving the historical memory of these calamitous events can be significant to rectify and to improve the hazard maps and to assure a proper land use planning.

Fall within the definition of "historical events" avalanches that in the past had led to catastrophic events, causing substantial damages to local communities, often including deaths, and that now occur very rarely, resulting to be unfamiliar.

The research of historical documents related to avalanches is done by the technicians of avalanches office in libraries, newspaper libraries, parochial archives, municipal and regional offices, or by interviewing the local people. The work goes on by comparing the documents found and by reporting the information on cadastral map-

ping of the analysed area. The next step is to synthesize with the aid of GIS softwares all the information in order to define and draw as accurate as possible the avalanche phenomenon in cartography.

All the information acquired during historical studies on the major and minor avalanches are stored in the regional avalanche cadastre. In the avalanche cadaster documentation, signed in by the office staff, or information and reports, provided by the snow/weather observers, are collected, including printed documents, photographs and measurements. The avalanche cadaster has proven to be a useful tool to describe the occurred avalanche events and to preserve the memory.

2 STUDY SITE LOCALIZATION

The Region of Aosta Valley, located in the far north-western part of Italy, borders to the north and west with Switzerland and France and more than 60% of its territory is above 2000 m a.s.l. of altitude. The phenomenon described in the following pages falls within the territory of Arnad (361 m a.s.l.), a municipality located in the south-eastern part of the region. It is an area not prone to many avalanches but in 1888 several

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large avalanches took place, some of them with serious consequences (Fig. 1).

From the municipality of Verres, along the watershed separating the Central Valley from the bottom of the Val d'Ayas, the study area extends from the steep rock wall of the Mont-Carogne (910 m) towards the peak of Mont-Chizzagne (1812 m) and to the top of Cime-Granla (Fig. 2).

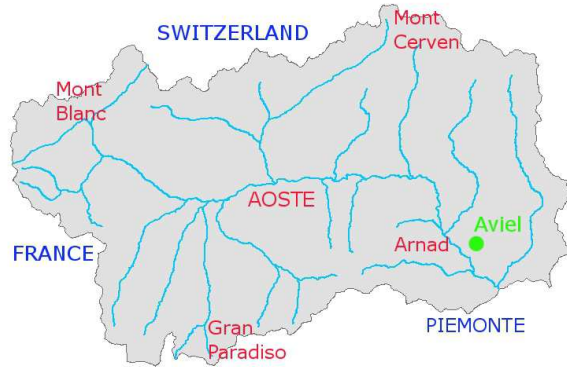


Figure 1. Map of Aosta Valley.

3 AVIEIL AND THE AVALANCHE RELEASE AREA

The village of Avieil rises at about 915 m a.s.l., right in the middle of the slope just described, in a natural plateau covered by numerous old chestnut trees (*Castanea sativa*). Upstream, the town is sheltered by a rocky cliff, over that there is a second plateau which is mainly made up of meadows colonized in part by woods and large exemplars of chestnuts.

At about 1000 m a.s.l., above the farm road, the gully of the Torrent de Verdoyen is emphasizing more and more, and at this point it undergoes a marked deviation to the right bank. Going up the riverbed, it remains deeply graven into a single watercourse up to 1500 m of altitude, and then it splits into two branches that become progressively less graven, until it levels off on a wide open slope characterized by an average inclination of 36°. A little more upstream, you reach the area called Bois Noir and the ridge bordering with the Dondeuil Valley, nearby the peaks of Mont-Chizzagne and Cime-Granla (1899 m): just from this slope the avalanche that destroyed the village of Avieil on the 27th February 1888 released.

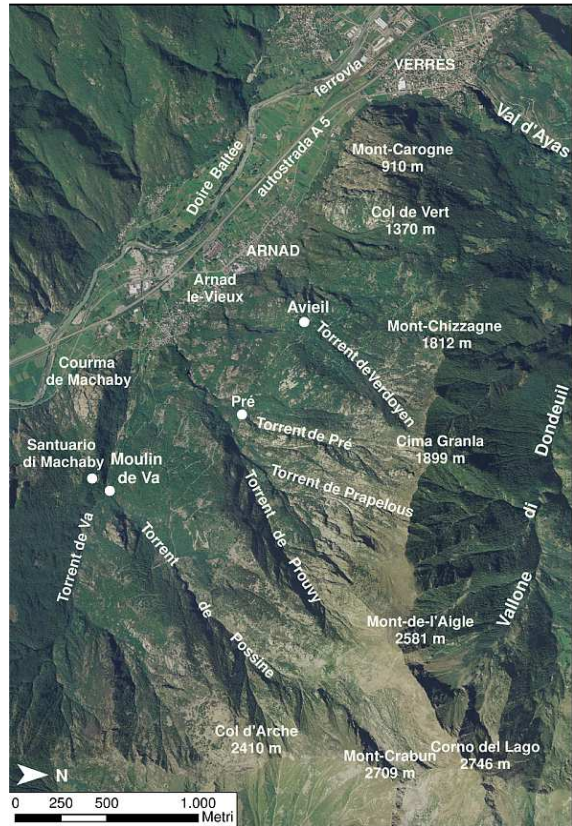


Figure 2. Study site localization.

4 AVIEIL BEFORE THE DISASTER

Before 1888, the village of Avieil was described as a "... pleasant residence, full of chestnut trees, picturesque for its little mountain houses and the happy peace of the mountain recesses ...". During summer it was peopled by many families, on the other hand in winter just a few of them remained on site.

The sustenance of the population was related to the practice of chestnut growing, the cultivation of rye, wheat and livestock, especially goats and sheep which remained in Avieil even during the winter season.

The chronicles of the period of the disaster tells us that the whole slope behind Arnad was characterized by sparse forest. The main cause of this situation is the deforestation carried out by the population in the decades before the avalanche, for the production of coal.

Already in the eighteenth century, the development of the steel industry led to a strong exploitation of the forest resource, the woods were used from the metallurgical industry that required a large amount of coal obtained from wood: this implied an extensive deforestation.

The deforestation for energy purposes was associated to the breeding of sheep and goats that certainly did not encourage the natural regeneration of the forest.

The strong exploitation of the woods had a fundamental role for creating the ideal conditions for an avalanche; in fact, the forest has a preventive function against snow-slides.

5 WEATHER CONDITIONS

Historically the winter of 1887-88 is remembered as one of the snowiest and tragic because of the effects of the occurred avalanches: in the Alps, avalanches of huge size were produced, causing numerous victims and serious damages.

On the Italian side of the Alps was counted a total of 248 victims. In Aosta Valley the deaths were at least 34, and a lot of damages to buildings, forests, fields and livestock were surveyed.

The chronicles of the time described the winter of 1887-1888 as very premature, long lasting and characterized by premature and frequent snowfalls, which continued with more energy during the winter until March, among all the last snowfalls of the end of February were disastrous.

The presence of a high pressure on the area from the British Isles through the north of Germany, Scandinavia, central Russia and in extension towards south, obstructed the eastward shift of the depression: such a scenario caused the persistence of bad weather over the whole Alps until the 28th February.

While at low altitude, around the Aosta valley floor, a wet snowfall occurred, from the evening of 25th February until the morning of the 28th, higher in the mountains a dry snowfall took place almost continuously.

In the final step of the perturbation a rise in temperatures increased the snowfall limit and consequently the snowpack became wet and heavy: this particular is very important to establish the trigger factor that led numerous avalanches to develop in those days.

6 THE DYNAMICS OF THE AVALANCHE OF THE 27th FEBRUARY 1888

In 1888 the village of Avieil was composed of eighteen houses and a chapel dedicated to Saint-Clair and Saint-Défendent, all occupied in the summer season. At the time of the catastrophe in the village there were only thirteen people because "...in winter the village was almost abandoned so that out of eighteen houses there were only two or three families living there. There were: the family Janin, composed by the father Martino, aged 50, with his son Giuseppe, aged 14; the family of Laurent Ambrogio of 34 years old, with his wife Teresa Janin, aged 30, and their children Martino, aged 7, Francesca,

aged 5 and Giuliano, 3 years, ; and the family of Champorney Elisabetta, aged 38 (wife of Laurent Giuseppe, brother of Ambrogio, source registry of Arnad), with their children Agostino, aged 10, Adolfo, aged 9, Andrea, aged 5, and Rosina aged 5 years old as well. In addition to these families in the village was present also such a Champorney Marcellino, aged 40."

Monday, 27th February 1888 between 9:00 and 10:00 o'clock, after several days of bad weather, the balance that allowed large masses of snow to remain stable on slopes above Arnad is less and all the snow fallen slide downhill eroding and incorporating the underlying snowpack accumulated in the weeks and months before, anything but poor in snowfall (Fig. 3).

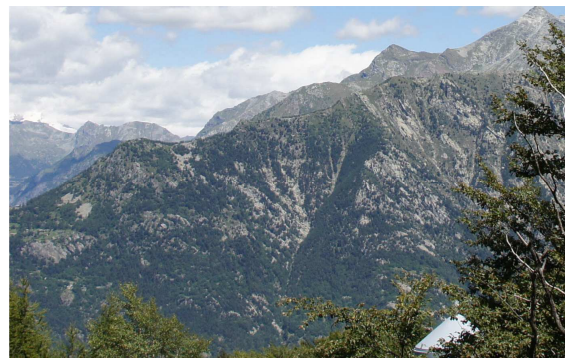


Figure 3. The release area of the avalanche of Avieil. Photo taken from the Col de Courtil (1508 m a.s.l.).

Once the avalanche releases on the hillside below the peaks of Mont-Chizagne and Cima-Granla, it canalized in the Torrent de Verdoyen.

The avalanche reached 1000 m of altitude, in the section of the gully where the incision weakens and the torrent turn right, continuing straight and damaging some houses in the hamlet of Ansermet (993 m a.s.l.). In a while it travelled along the plateau upstream the village of Avieil uprooting many chestnut trees. At this point the avalanche easily exceeds the ravine behind the village falling from above on the buildings occupied by the people, unaware of the danger and intent in their daily works (Fig. 4).

The news of the disaster reached the town of Arnad at around 11:00 am, and reached the Verres only at 16:00 pm. The bad road condition was the main reason of this long delay in the news dissemination.

The mayor of Arnad raised the alarm and started to organize the rescue, a large group of rescuers from Arnad reached Avieil at around 17:00 p.m..



Figure 4. Overview of the avalanche site: the white area is that affected by the avalanche of the 1888.

In the late afternoon the Praetor of Verres and the police Brigadier arrived at Arnad to support the rescue operations; they were joined in the evening by the commander of the Fort of Bard with fifty soldiers, together with eighty other residents of Arnad, reached Avieil late at night.

6.1 Avieil seen by rescuers

The rescuers found "...the hay, the beams, the branches and an ensemble of uprooted trees mixed with blackened snow; these elements formed the visible layer of the avalanche. Above it you could see trunks of trees, plucked up by the power of the avalanche, a forest almost beheaded by a brutal force. Across Avieil only the chapel was standing alone, the avalanche has levelled the gentle slopes and the tortuous streets of the village, it overtook the houses and created a new topography of the area (Fig.5).

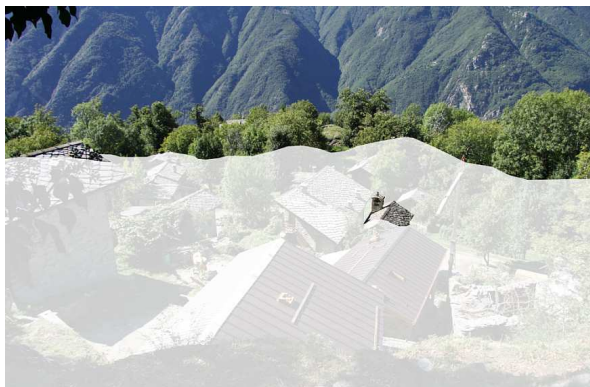


Figure 5. Reconstruction of how Avieil had to appear in the eyes of the first rescuers.

6.2 Computing victims and damages

The budget of the avalanche in terms of victims was thirteen buried, among these three were extracted alive, but one of them died immediately after, the other ten were found dead.

All the eighteen buildings that composed the village of Avieil were interested by the avalanche; only the chapel of Saint-Clair remained untouched, and just the bell, inside the small tower, was torn by the avalanche powder and found far away. Considerable damages were reported among livestock, many goats and sheeps lost their lives in their stables, which were destroyed, too.

The avalanche in the track area also caused damages to some buildings of the Verdoyen and Ansermet villages and broke down many secular chestnut trees.

7 AVIEIL AFTER THE AVALANCHE

Analysing the maps in scale 1:500, produced by the Office of Rural architecture (Direction of Protection of Architectural and Landscape, Department of Education and culture), in particular the map of the volumes built up at different time that lists the dating of the various buildings or parts of them and the map of comparison that provides information related to the period when some buildings became ruins and eventually have been restored, it is possible to reconstruct the location of the core of the village before and after the avalanche event, the following steps of restoration of buildings, the possible delocalisation of parts of the village and finally identify the buildings destroyed by the avalanche. The cartographic base for this work consists of the map of the old land cadastre (Fig. 6), it shows the buildings (red polygons), the paths (red lines), hydrography (blue line) and the contour lines (grey lines).

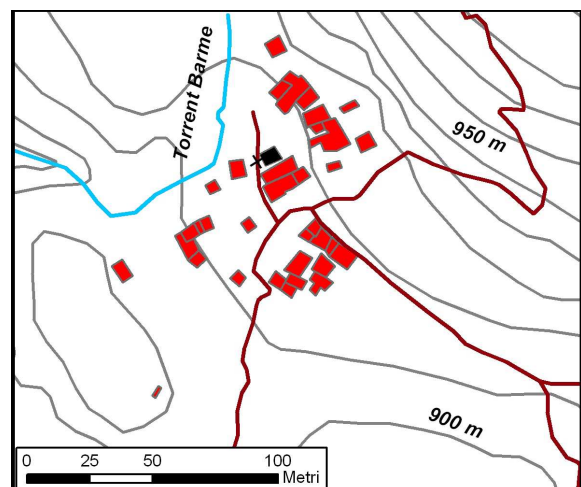


Figure 6. Map of the old nucleus of Avieil.

Figure 6 is the result of analyses of the information contained in the map of the volumes built up in successive phases, it was produced by the technicians of the architecture and minor historical detector office: from this map it is possible to find all the buildings constructed before the avalanche and so to know the state of the village at the time of the disaster. Looking at the map it can be seen how the old town core (red polygons) was concentrated around the chapel (black polygon), leaving free the flat land in front that was exploited for chestnut culture, grasslands and grazing.

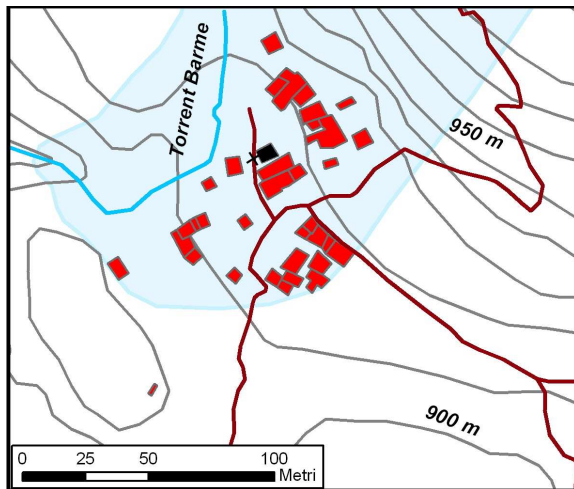


Figure 7. Map of the old core and the limits of the avalanche.

Combining the data from the chronicles of the time with the information provided from the map of comparison (on the state of ruin of the buildings and any renovations carried out), it is deducible that all the buildings of the old core (red polygons) have been affected by the avalanche (blue hatching) (Fig. 7).

7.1 Inscriptions on the stones

The inscriptions on the walls of the buildings are very useful to reconstruct the history of Avieil: many houses report, mainly on the stones located on the edges of the perimeter walls, the date of construction or reconstruction of the building itself (Fig. 8).



Figure 8. Inscription on stone of a building located to the south-east from the chapel, the date indicates the year of reconstruction.

Analysing the dates identified on the houses of Avieil, two houses are dated 1889: in one case the date evidences a restoration, the other one refers to the construction of a new building in an area not previously built and not affected by the avalanche of 1888.

Two other buildings are dated 1891 and another 1897.

After the tragedy, the people of Avieil decided not to leave the village realizing the exceptional nature of the rare event that has affected them, at the same time, however, they've implemented a preventive strategy in case of possible recurrence of the avalanche by displacing the new buildings in areas not reached by the snow in 1888.

7.2 Map of buildings built or rebuilt in the twelve years after the avalanche

Analysing the dislocation of the buildings erected between 1888 and 1900 (orange polygons), shown in Figure 9, it is possible to remark an expansion of the buildings in the areas previously used for agro-pastoral practices as people tried to move away from areas affected by the avalanche.

There are few buildings reconstructed (orange circles) in the twelve years following the avalanche (Fig. 9).

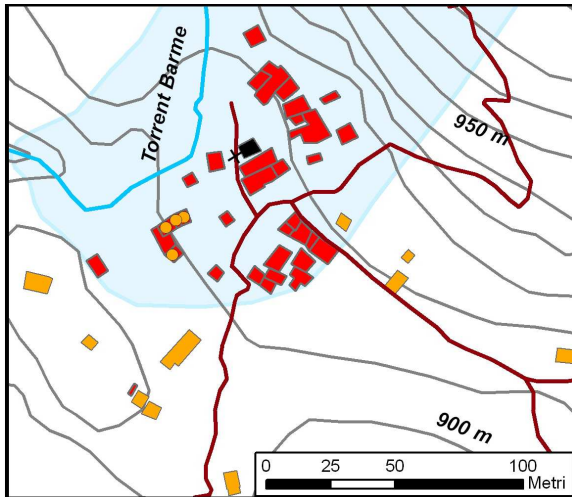


Figure 9. Map of buildings built or rebuilt in the twelve years after the avalanche.

7.3 Map of houses built or rebuilt between 1945 and 2011

In the map of Figure 10 we can observe the further urban expansion (yellow polygons) that occurred in Avieil after 1945 and the renovation/reconstruction of buildings destroyed by the avalanche (yellow circles). Analysing this map it can be seen that the population has started again to build in those areas affected by the 1888 avalanche event. This trend to re-use areas previously avoided is confirmed by the reconstruction of buildings destroyed in 1888 (Fig. 10).

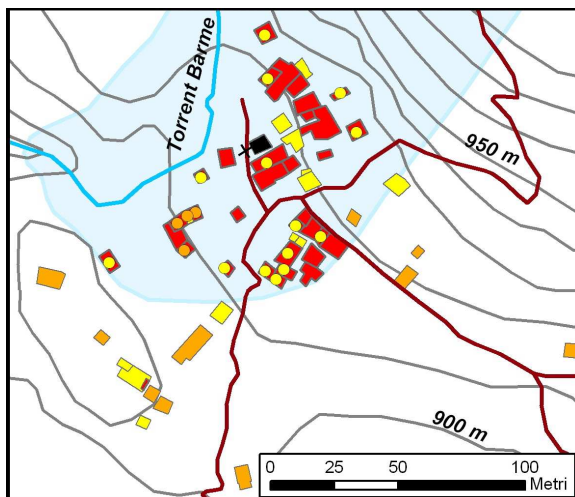


Figure 10. Map of houses built or rebuilt between 1945 and 2011.

8 CONCLUSION: THE LIMITS OF THE AVALANCHE OF THE YEAR 1888

In figure 11 we can see the white pattern that delimits the deposit area of the avalanche that fell on the morning of 27th February 1888. The dashed blue line and the purple pattern indicate respectively the limits of the phenomenon known by the cadastre and those the avalanche hazard maps, the red polygons are the representation of Avieil's buildings in 1888 (Fig. 11 and 12).

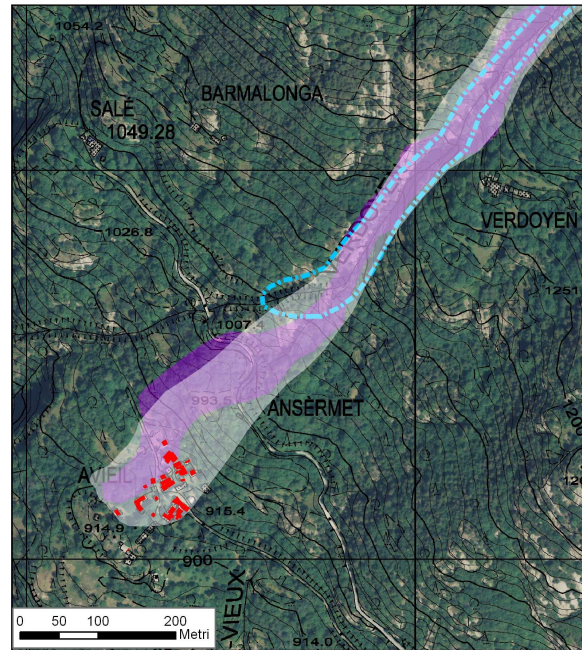


Figure 11. Deposition area of the avalanche event occurred on February 27th 1888, at the conclusion of the historical research.

The combined analysis of these maps together with the recreated avalanche dynamic allowed updating perimeters and areas of the phenomenon in the cartography of the avalanche cadastre. Before the historical research both in the regional avalanche cadastre and in the hazard maps (L.R. n. 11/1998, art. 37), avalanche was strongly underestimated, not including the village. This historical investigation turns out to be a tool of great importance for the conservation of the lost historical memory and either for updating the risk maps (Fig. 12).

A special thanks to all the technicians of the snow and avalanches warning service of the Regione Autonoma Valle d'Aosta that in the past have worked for the historical research of the avalanche cadastre.



Figure 12. Cartographic extract of the avalanche from release zone to accumulation area, at the end of historical research.

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