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**MEDIUM-HIGH MOUNTAIN APPROACH TO AVALANCHE RISK.
THE VOSGES RANGE AS A CASE OF STUDY (FRANCE) ***

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RESUMO

O inverno de 1999-2000 repentinamente reatualizou a discussão sobre o perigo de avalanche, subestimado, esquecido ou até negado, mesmo sendo o risco natural mais mortal na Alsácia. Esta pesquisa interdisciplinar acentuou os mais de 250 eventos de avalanche, do final do século XVIII até hoje. Esses eventos são recolocados no contexto da variação climática e da evolução da ocupação dos solos. Também consideramos a tipologia e a escala de intensidade das avalanches, especificamente, em relação às montanhas de média altitude. Por fim, discutiremos o estado actual do risco de avalanche.

Palavras chave: Risco de avalanche, representação, "neve derretida", tipologia, vulnerabilidade, processo perigoso.

RÉSUMÉ

L'hiver 1999-2000 a subitement réactualisé un risque d'avalanche sous-estimé, oublié, voire nié, bien qu'il représente le risque naturel le plus meurtrier en Alsace. Ce travail interdisciplinaire a mis à jour plus de 250 phénomènes avalancheux depuis la fin du XVIII^e siècle. Les événements sont replacés dans les contextes du changement climatique et de l'évolution de l'occupation des sols. Se pose également la question d'une typologie et d'une échelle d'intensité des avalanches spécifiques aux massifs de moyenne montagne. Enfin, nous discuterons de l'état actuel du risque d'avalanche.

Mots-clé: Risque d'avalanche, représentation, coulée de neige, classification, vulnérabilité, aléa.

ABSTRACT

Although avalanche risk is the deadliest natural risk in Alsace, winter of 1999-2000 suddenly brought up this underestimated, forgotten, or even denied danger. This interdisciplinary research emphasized more than 250 avalanche events, from the end of the 18th century until today. We reset these events into the context of climatic variation and evolution of land occupation. We also considered a typology and a scale for avalanche intensity, specifically regarding medium-high mountains. Eventually we will discuss the current state of avalanche risk.

Keywords: Avalanche risk, representation, sluff, typology, vulnerability, hazard.

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Introduction: Do avalanches happen in the Vosges range?

To mention avalanche risks in the Vosges generally causes certain disbelief because of its modest height. Indeed there is a lack of knowledge, or even ignorance, about avalanche risk. This range culminates at 1.424 meters; most of the summits are rounded and covered in forests. It also presents an annual and seasonal variability of snowfall periodicity and snow height; yet snow contributes to representing any mountain. Therefore, for many people, little snow means low mountains and low mountains mean no risk of avalanche. Furthermore, the summits can be reached easily in winter as roads are regularly cleared from excess snow. Car parks are available at the summits nearby possible avalanche areas. Thus, there is an important frequentation during winter and no need for mountain climbing, which induces an image of "easy mountain"; its rather modest height means frequent variations of temperature and alternation of frost/thaw and this can either consolidate the snow blanket or make it disappear fast. Finally, the local media play an ambiguous role by sometimes warning against the dangers of Medium-high Mountain and sometimes by minimizing the risk when associating the words sluff and avalanche. So, this image of "easy mountain" makes us believe that avalanche events are either very small or even non-existent. And the preferential use of the term sluff rather than avalanche shows a certain reserve to name and recognize the possibility of important or deadly avalanches. Snow accumulation can be important, particularly on the Alsatian side. Slopes are steeper on the Alsatian side due to the particular erosion of the Alsatian glacier during the ice age and to the subsidence of the Rhine River plain. Furthermore, cornices are formed at the Alsatian break slope even if the Lorraine side is snowier. During winter of 2005-2006, snow reached a height of about 3.80mts at the "Grand Ballon" (summit of the Vosges). In January and February of 2000, fifteen people fell victim of avalanches and three of them died. These accidents suddenly drew attention to the fact that avalanche risk is underestimated.

Objectives and method of research

First, this geo-historical study about avalanches in the Vosges range required the establishment of a sources corpus about the avalanche phenomena. Even if historians started to be interested in the thematic of the natural risk by the end of the 1990s, they already showed their ability to contribute to

interdisciplinary research about risk. These first researches allowed to assert that the natural risks represent an "object" for the historians, that history is a science and that the contribution of historians is of utmost necessity to other sciences and the other way around (GRANET-ARISSET, 2000 and 2002). If the study of avalanches as a physical phenomenon does not constitute an object in itself for a historian (which it actually is for climatologists, or even for the geographers), he studies avalanches because of the risk they can generate for humans. History has to study any possible consequences to people or properties as well as the humans' involvement in triggering these natural processes.

The objective of our research is to collect data to establish a diachronic study of avalanches over a period of at least 2 centuries; this reveals several characteristics: localization, typology, frequency, dynamic, and evolution. The goal is to create cartography and an assessment of the risk of avalanche.

The many research and methodological articles dedicated to studies on avalanches in the high mountain ranges do not, unfortunately, raise any concerns about medium-high mountain ranges for which the problem is different and obviously more complex. For example, there is no study or inventory of avalanches in the medium-high mountain ranges, whereas they are commonplace in France in the Alps or Pyrenees, done by the services "Restauration des Terrains de Montagne" (BESSON, 2005, p. 218-223; DEROZ, 1997, p. 53-72). Furthermore, avalanches are not mentioned often enough in archives. Therefore a corpus of data has been done, based upon local publications, toponymy, press, and especially oral sources (Fig. 1). Most of the information over the past 50 years came from oral source and local media. Finally, we also concentrated on handwritten, printed, and oral sources as well as on observations; all of this enabled us to check the existence of ruins at various locations and to evaluate the probability of avalanche events in some areas according to topography (GIACOVA, 2008, p. 48-88).

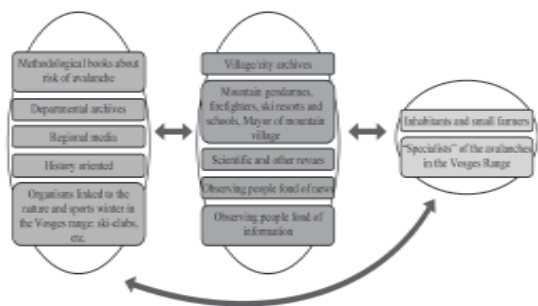


Fig. 1: Process of constitution of the corpus of sources about avalanches in the Vosges range. The primary sources supplied research tracks for the secondary, then tertiary, with feedback.

Results

The results of this historical research exceeded all expectations. About 270 avalanche events have been reported since the end of the 18th century; they happened in about 60 avalanche paths. 4 departments and 3 regions are affected by risks, even though most of the avalanche events took place on the upper Rhine side for previously mentioned reasons (Fig. 2).

These 260 events have been recorded through direct observations (recent period) and/or because they caused damages and consequently there were clues in the archives (Fig. 3). Here it is necessary to take into account that the harmful avalanche events have unquestionably been talked about and remembered most, certainly as they were out of the ordinary. This is why they are over represented.

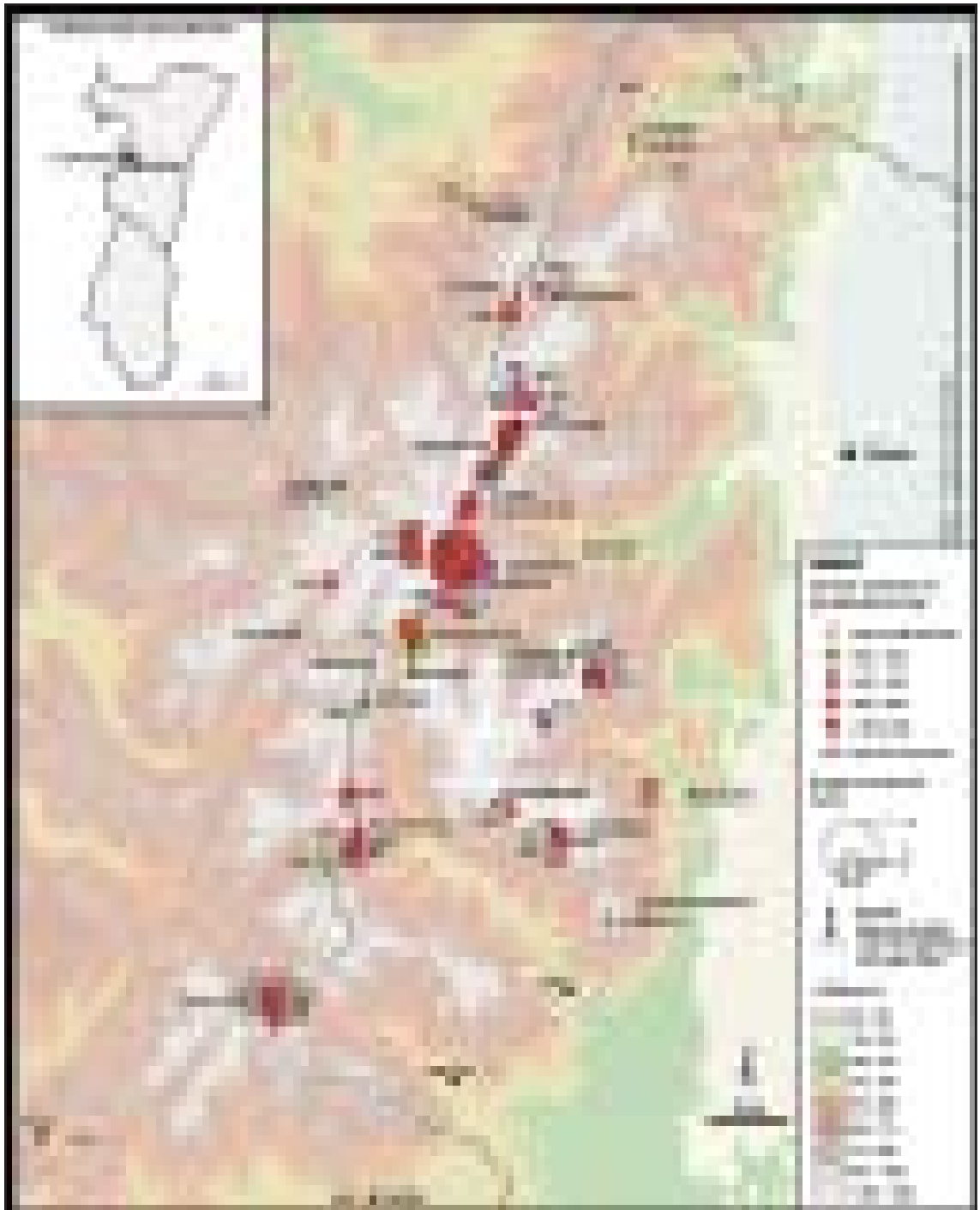


Fig. 2: Localization of avalanche occurrences in the VOSGES range between 1784 and 2008.

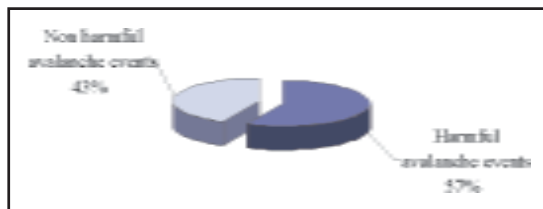


Fig. 3: Characteristics of the avalanches

paths from anthropological origin reforestation where specific vegetation was threatened (Mémoire de Kaysingswald, 1887); this prevented a regular avalanche dynamic and maintained artificially the occurrence of avalanche events (RÉSERVE NATURELLE DU TANET-GAZON DU FAING *et al.*, 1999). Therefore, the avalanche phenomena in the Vosges range might be partly artificial because of deforestation and pastoral

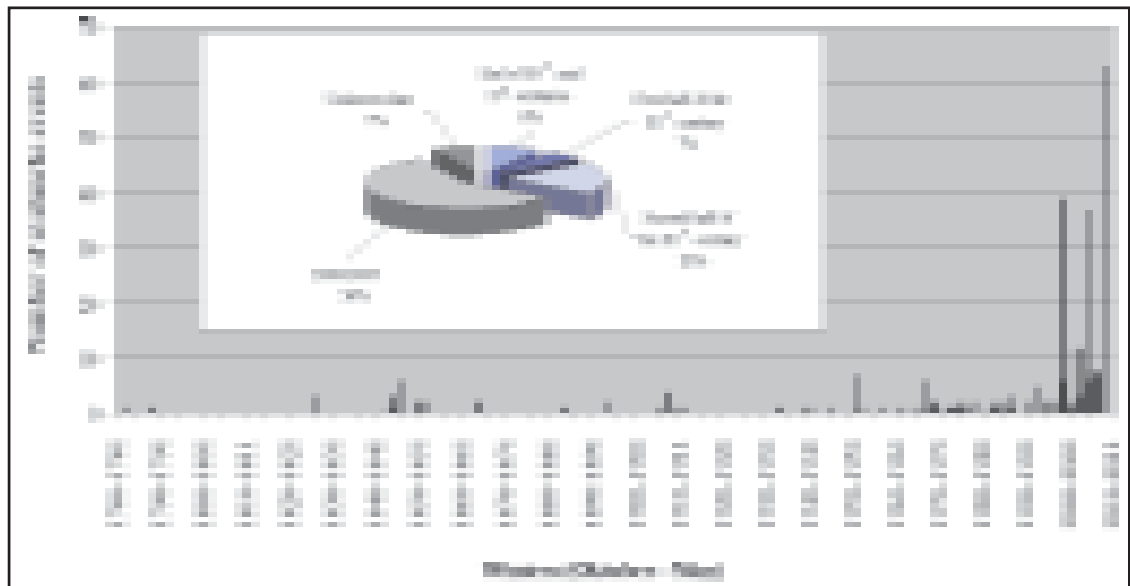


Fig. 4: Chronology and temporal distribution of reported avalanche events

As Fig.4 shows, distribution of avalanche events is very irregular, despite covering the entire period. Indeed, due to several factors, this chronology shows evolutions in its spatial and temporal distributions of avalanche events. First, the increase of known avalanche events since 2000 is rather due to more winter sports adepts than to more avalanches. More observers (our sources) means more reported cases over the last ten/fifteen years. The snowiest years in the Vosges range cannot necessarily be linked to the years with most reports about avalanche events or especially avalanche accidents. This makes sense, particularly for the last decades, as many avalanches start because of reckless skiers, climbers, snowboarders, regular or snowshoe hikers; they end up being victims of avalanches.

The evolution of land occupation explains, at least partially, the occurrence of avalanche events that took place in some areas like valleys during the 19th century; this happens no more nowadays in these once deforested valleys (GRNIER, 2004), as reforestations and decreased snowfall or snow cover changed this pattern. The same pattern is noticeable in glacier carries after decades of natural reforestation due to cattle pasture and to altitude farmers' activities. In the late 90s at the Lac Blanc, botanists cleared avalanche

activity. The global warming may also contribute to the present reforestation of certain sections. We can wonder whether avalanche events as strong as those displayed on this map – strong enough to reach the valleys as in February of 1895 in Wildenstein – could still occur (Fig. 5).

Presently, the increase of wooded areas prevents their development. The Crest Road that was built at avalanche starting spots on the west side of the Rothenbachkopf during WWI may as well be an avalanche barrier (Fig. 5). Since 1895, we have no knowledge of any avalanche event on this side.

Material vulnerability decreased as land occupancy patterns changed. No inhabited houses were destroyed since the second half of the 19th century. The valley areas prone to avalanches are not affected any more. In addition, from the second half of the 20th century on, no damage has been reported for altitude farm (inhabited only in summer). On the contrary, human vulnerability increased. During the 19th century, human winter presence in the mountain was essentially linked to trade activities between valleys, as was the case between La Bresse and Munster (Fig. 5). Some roads, not all of them though as seen on this map crossed avalanche areas (Fig. 5). Even if these roads were not as busy during the winter, accidents linked to snow did

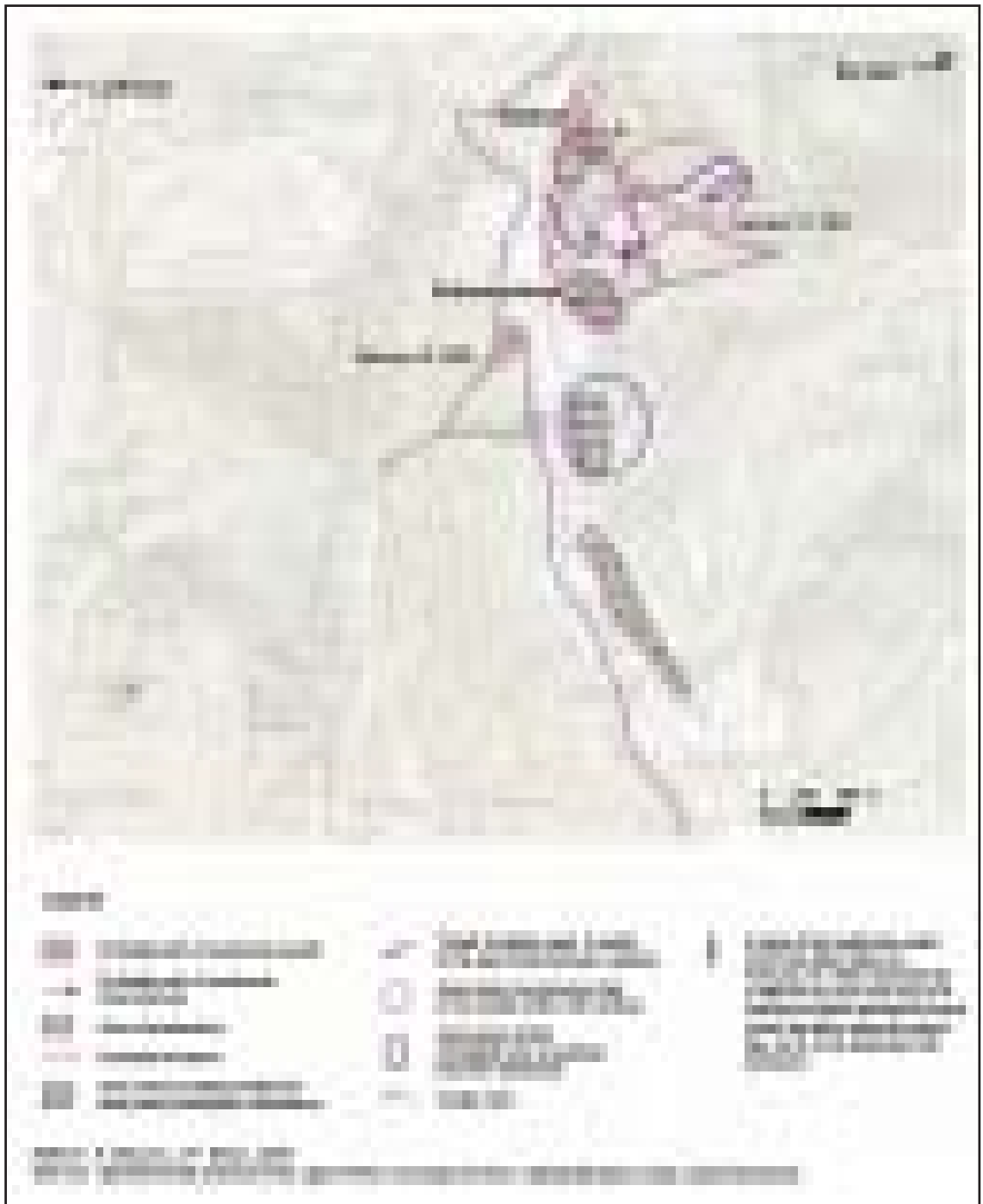


Fig. 5: Localization of the avalanche paths in the sector of the Rainkopf-Rotherbachkopf.

occur. We found an example of avalanche accident in the section of the Rainkopf-Rotherbachkopf in the middle of the 19th century (Fig. 5). Then, from the beginning of the 20th century on, skiing became more and more popular (GUGHER, 2001).

The nature of damages evolved over the last two centuries: essentially material related during the 19th century and the first half of the 20th century, damages became bodily from the 1960s on. Environmental

damages continue to happen over the studied period, but their importance is variable. The worst damages have been reported in 1847, February of 1895 (more than 300m² of forest destroyed on the west side of the Rotherbachkopf, Fig. 5) and in 1952. Some functional damages have also been reported.

Concerning injuries, about 40 avalanche events have affected 105 persons - among them 25 injured and 32 dead (TABLEAU I).

TABLE I - Type and temporal distribution of injuries of the avalanche victims in the Vosges range.

Type of damages/ bodily injury	Periods					Total
	18 th – 19 th centuries	First half of 20 th century: 1900-1953	Second half of 20 th century: 1954-1999	21 st century: 2000-2008	Unknown date	
Victims	23	5	43	28	6	105
(Buried in snow)	?	-	(5)	(5)	-	(10)
Safe	-	-	12	7	-	19
Injured	-	-	17	8	-	25
Dead	20	-	7	5	-	32
No information	3	5	7	8	6	29

This number is quite important, as most victims have been reported during the last decades. This seems to be forgotten or even denied, but it represents the deadliest natural threat in Alsace. Underassessments on the subject of mountain, ignorance of risk, insufficient preventive actions, or security personnel reinforce the gravity of phenomena even of modest proportion. There are only 10% of victims completely buried under the snow. Among avalanche victims, 3 times less among them are buried than dead. Snow does not seem to be that murderous; more importantly during the 18th and 19th centuries it was the collapsing of houses and during the 20th century trees and buildings which are on the way of avalanches were the real danger. It is essential to consider the reforestation process to understand the specificity of Vosges avalanches. Since the 60's, victims are mostly leisure adepts of winter sports and trekking as opposed to victims of collapsed houses or just wandering by for unknown reasons; this fact worsened as of winter of 1999-2000. Winter sports adepts feel better when practicing in sluff risky areas. Avalanche victims tend to find an ideal "culprit" who supposedly started the avalanche; it cannot be them, of course! Some of them even point fingers to adepts endangering everyone more than they do. Risk is more or less accepted as part of the sports activity. Some are aware but didn't necessarily inquire about the dangers and others are in denial (GROU, 2008, p. 221-235).

Applications

We still need to invent a specific cartography of avalanche risk for the medium-high mountain and its practices. Roads and farms in altitude can be in trouble even if houses or skiing slopes are not; the question of obstacles on the avalanche paths might be worth considering.

A typology of avalanche and a scale for avalanche intensity are being elaborated. The existing ones, meant for the Alps or the Pyrenees and generally for High Mountains, could not be used the Vosges range (ANCEY, 1996, 2006; ANENA, METEO FRANCE, 2003; BOLOGNESI, 2000, DE QUERVAIN, 1981; LEBRE *et al.*, 2002; SIVARDÈRE, 2003; *Site de l'Institut Fédéral pour l'Etude de la Neige et des Avalanches de Davos*). The typology that distinguishes dense flow avalanches and power cloud avalanches (CHAFFLIER, 1996) is not applicable as avalanches in the Vosges are of the dense flow avalanches type. We have to use interdisciplinary work to launch as soon as possible a specific typology based on examples of Vosges events. It is obvious already that cornices are an important part of it as they are to be found on almost every avalanche path; some accidents are due to the breaking of cornices. However, our goal is to go beyond the local frame and establish a typology and a scale for avalanche intensity which would be applicable to all medium-high mountain ranges; team work with specialists of snow and avalanches as well as with specialists of medium-high mountain ranges is mandatory.

The same applies to the scale for avalanche intensity, as the thresholds that are currently defined are not representative for the Vosges range. For example, the scale for avalanche intensity established by Richard GUILLANDE and François RAPIN (2005) considers many parameters about the phenomena itself (affected area, average thickness of moved snow, volume deposited and pressure of impact); it also considers the actual and potential damage on people, buildings, substructure, and natural area. Our sources of information do not mention these parameters. To reach our goal it is necessary to implement permanent follow-ups of avalanche activity

and to make sure reliable observers help us; easier said than done! It is essential to manage with the data we already have for these medium-high mountain ranges in order to "invert" criteria that are specific and relevant.

What about the present risk of avalanche?

Avalanche events in the Vosges don't have the magnitude of alpine and Pyrenean ones; nevertheless they deserve to be considered carefully as they do exist and can be destructive and fatal. Historical research shows the existence of large avalanches big enough to reach to the valleys (Fig. 5). One of the challenges of our thinking process about the risk of avalanche consists of both estimating the likelihood of bigger events over a 50 to 100 years period and evaluating the progress of the risks for this range.

What about the present risk of avalanche? Is the underestimation or even the negation of the avalanche risk justified? Would a better awareness of the risk be beneficial? Would an underassessment be a factor of over-risk?

The risk of avalanche is sporadic, localized, and individual. Since the winter of 1999-2000, some accidents could have been avoided if the victims would have been fully aware of the existence of avalanche events in the Vosges and of the danger of cornices.

Has the risk of avalanche increased during the two last centuries? According to which pattern? The risk is the addition of hazard and vulnerability; is the frequency and the intensity of these hazards increasing or is human vulnerability increasing? Are populations more at risk or more vulnerable than in the past, and why? (VÉRET, 2004, p. 140)

The decrease of snow cover and snowfall associated with an alteration of land occupation with results in a larger woody area leads to a decrease of the occurrence of avalanche events, particularly of the larger ones. On the contrary, elements tend to prove that the risk is getting higher. Some formerly avalanche prone areas are not any more nowadays and no building has been destroyed there since 1953; nevertheless, vulnerability has increased because of the expansion of winter sports in general and of the number of off-piste skiers in particular. Associate these facts with a lack of the knowledge about the mountain, and you have the recipe for catastrophe. This underassessment of the risk of avalanche is quite obviously responsible of over mortality and linked to vulnerability questions. The increasing trend for off-piste skiing is without a doubt linked to well-kept roads and car parks nearby the risky area. This also speeds up the appearance of new practices like snowshoes that enable hiking in sectors that were

difficult to get to. The inconsistency of snow cover and snowfall influences the frequency and intensity of avalanche hazard. The annual and seasonal variability of snow cover also influences the representation of the risk of avalanche. Finally, boulders and especially trees spread on avalanche paths increase the risk as avalanche events usually end up in trees. Therefore we are now rather in a logic of increase of avalanche risks.

Conclusion

After all, is it still necessary to question the legitimacy of such a research? The occurrence of harmful avalanche events and the important number of avalanche victims favour a positive answer, especially when comparing the first decade of the 21st century with the previous decades.

This research shows that it is definitely possible to rebuild the geo history of avalanche events for a medium-high mountain range as their number is not negligible and as information is available. It would be possible to do a comparative analysis and to think it over together by adjusting our approach to that of other French or European medium-high mountain ranges – Jura, Cévennes, and Massif Central. For example, it would be interesting to establish common procedures for prevention and information and to better understand the importance of anthropological factors in the occurrence of avalanches for this type of range. We have to create a cartography of the risk of avalanche by adjusting it to local characteristics (small dimensions, factors of over-risk upstream and downstream); we also have to do so by involving mountaineers, professionals, elected representatives, public service to set up a policy about prevention and information that would be rational, long-term and coordinated. An in-depth study over a longer period of time and about more areas would certainly help answer questions such as: have avalanches been a result of deforestation and expansion of pastoral activities in ranges entirely covered by forests up to the top? How have climatic factors of the Little Ice Age influenced the dynamic of avalanches? Right now, the evolution of avalanche intensity is to be linked to the context of global warming. The risks of avalanche may not decrease because of less snow coverage and snowfall as meteorological extreme phenomena like strong snowfall followed by moistening of the snow blanket, would favour avalanches (BUR et al., 1998, p. 113-119).

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