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EDITOR'S NOTE

Translation: Accent Mondial

Introduction

1 In intermontane valleys the development of large conurbations has for a long time been conditioned by the contrast between the valley and dynamic mountain systems, which are subject to considerable instability. However, in recent decades in the Alps urbanisation has expanded into areas where low ground adjoins mountainsides (Briquel, 2001; Dezert *et al.*, 1991; Giraud, 1983). This urbanisation has led to the increasingly dense occupation of areas that had previously been subject to tacit or regulatory restrictions due to their potential dangers.

2 In this context it is therefore of concern that this hazard may have been minimised in the sense of the technical definition given for this term (Department of Humanitarian Affairs, United Nations, 1992). Here, a hazard is understood to mean the combination of a potential hazard with a vulnerability. The latter, defined as the extent of potential losses, is dependent on the number and characteristics of the elements exposed to a risk. Indeed, D'Ercole (1994) shows that in addition to exposure, vulnerability can also be defined as the propensity of an area or a social structure to be damaged. In this respect, various factors such as knowledge of the phenomena, awareness of the hazards and memory of past events help to reduce this vulnerability.

3 Periurbanisation in mountain basins therefore results in a clear increase in the elements at risk; but does this mean that these elements, and more specifically the population, are necessarily vulnerable? How can we measure both the increase in the elements at risk and the vulnerability of these elements? It is with this in mind that we undertook an analysis of the current hazards in a catchment basin in the Grenoble region subject to periurbanisation.

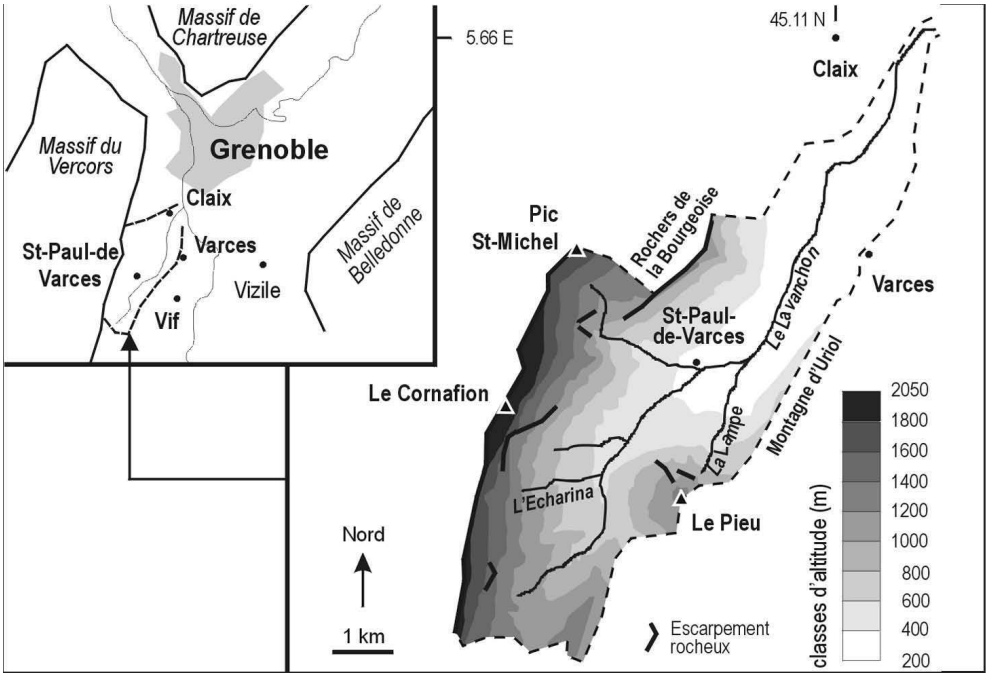
4 From this point of view the urban expansion of the Grenoble conurbation is an interesting example. In a few decades the urban area of the Upper Grésivaudan valley, subject to unprecedented real estate pressure, has covered all of the low ground and spread to the mountainsides. Several communes, such as Le Touvet, La Buissière and more recently Lancey, have already revised their flood prevention plans and this same phenomenon has been observed in the western part of the Vercors massif. The catchment basin of the River Lavanchon appeared suitable to us as a test site in which the objective is on the one hand to use a diachronic study to show the development of human activity and the elements at risk in this area and on the other hand to evaluate the awareness that individuals have of the hazards present.

Study site: the Lavanchon basin

5 Because of its geomorphological history, the Grenoble region is unusual in that it consists of both a wide and particularly flat valley and very high, steep-sloped mountain systems. The former provided a site favourable for settlement by man and then for urban growth once the shifting courses of the rivers Isère and Drac were brought under control; the latter are the site of dynamic morphological processes and many unstable areas. The development of the city very quickly became conditioned by this contrast and for a long time the mountainsides formed an obstacle to urban extension. Even so, over the last few decades the region's economic boom has led to the conurbation expanding into areas where low ground adjoins mountainsides.

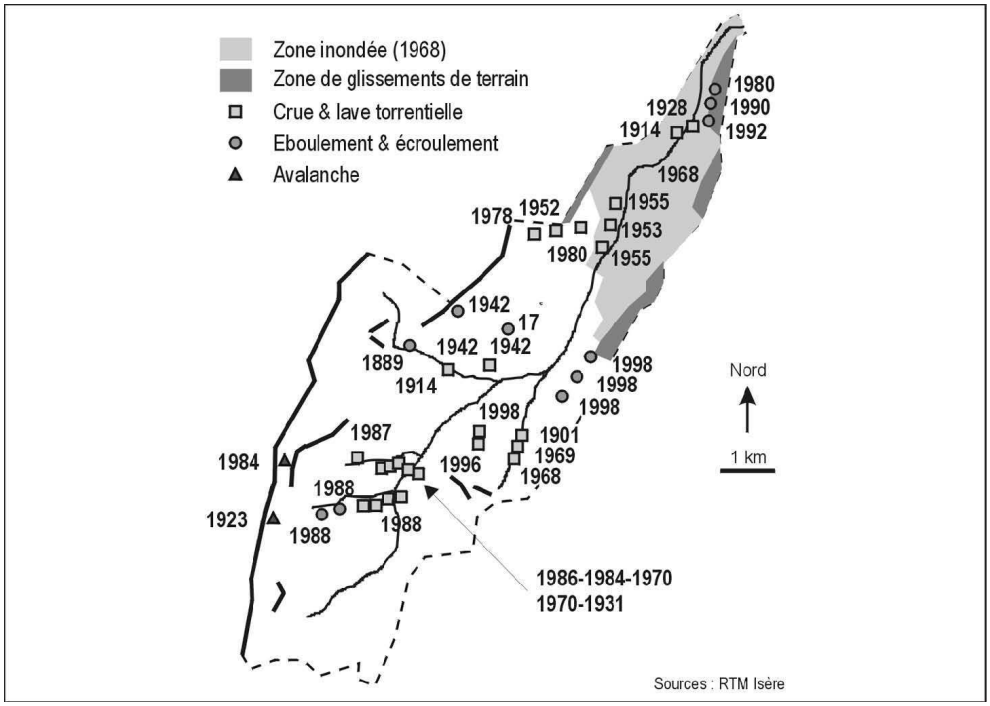
6 The Lavanchon catchment basin (52 km²) is emblematic of the way activity is being brought into closer contact with potential hazards. It is located southeast of Grenoble (Figure 1) and includes the territory of the communes of St-Paul-de-Varces, Claix and part of Varces-Allière-et-Risset, where it forms a very distinctive geographical entity between the high rocky ledges of the Vercors (average altitude 1 800 m) and the Drac valley (250 m). It presents both a concentration and an unusually wide diversity of slope processes and is also an appeal for the development of human activity, making St-Paul-de-Varces one of the communes most subject to potential natural hazards in the department of Isère (Allignol, 1992). It is particularly representative of the different urbanisation phases of the major conurbations, with the building of high-density housing and the arrival of industry in the 1970s and 1980s and then, in the following decades and more peripherally, developments of individual houses, high-technology industries, new communication routes and, lastly and more recently, the building of rurban housing on the lower slopes of the mountainsides. As a result, since the 1970s the communes in the basin have seen an increase in their populations associated with the accumulation of natural and migratory surpluses. Consequently, the population of St-Paul-de-Varces increased from 460 in 1968 to 1,845 in 1999, representing a fourfold increase in 30 years; at the same time, the number of dwellings increased from 260 in 1975 to 630 in 1999 and 686 in 2001.

Figure 1. The Lavanchon catchment basin.



7 The Lavanchon catchment basin is subject to extremely active erosion, which is responsible for a large number of natural events such as boulder and rock falls, collapses (the collapse of part of the Rochers du Pré du Four rock outcrop in 1889, which is thought to have buried the old village of St-Paul-de-Varces on the site of what is today the “Les Ruines” housing development, and the collapse of the Echarina in 1988), mudflows (the mountain streams L’Echarina, La Lampe and Le Rif Talon), floods (the Lavanchon’s "flood of the century" in 1968) and avalanches (Figure 2). The Mountain Terrain Reconstruction (RTM) Department for Isère has recorded at least sixty major events in the catchment basin. Furthermore, their likelihood of being recorded depends on their intensity, the damage caused to buildings and therefore vulnerability, the existence of a monitoring system, etc.

Figure 2. Major events recorded in the Lavanchon catchment basin.



8 Despite this context, hazard management is provided by a collection of players, each focusing on a different area and space (the limits of which are sometimes vague) and with different operational methods. In terms of regulations, only the communes of Varces and Claix have a hazard prevention plan (PPR) (since 1998 and 2001 respectively); St-Paul-de-Varces has only very recently (1996) drawn up a land-use plan and in the case of natural hazards relies solely on article R-111.3 of the urban development code. The basin's main player in terms of hazards is the RTM Department; it is responsible for managing the stateowned forest and in this capacity is responsible for certain active mountain streams (La Lampe) and the upstream section of the bed of the River Lavanchon. But the majority of mountain streams, which are not on state-owned land, are the responsibility of landowners, and from 1850 the downstream section of the course of the Lavanchon was managed by the Association des Digues du Lavanchon, whose objective was flood prevention (through bed excavation and raising dykes). Since 2000 this part of the river has been managed by the Syndicat Intercommunal du Lavanchon, which has a more cultural and recreational vocation. Furthermore, since 1987 and the decision to build the A51 Grenoble-Sisteron motorway, the Rhône-Alpes motorway company AREA has become a major player since the route passes through the lower part of the basin and crosses the flood-risk area (damming effect, dense drainage and river diversion network). Lastly, a new body is due to come into play with the "Drac Lower Tributaries" river contract, which includes the Lavanchon and its catchment basin and is provided for in the Drac-Romanche River Management and Development Plan (SAGE). This situation, together with the lack of coordination, sometimes leads to conflicts between the objectives, views and actions of the various public and private bodies involved.

9 The choice of this site is therefore justified by the combination of a number of issues, namely the juxtaposition of processes connected with the area's unstable mountainsides, rocky ledges, torrentiality and the presence of alluvial cones, threats to dwellings, the

density and cost of protective developments and structures put in place since the mid-19 th century (RTM structures, dykes, drainage, etc.), the development of the infrastructures in the lower part of the basin (industry, shops, a barracks and the motorway), and planning and consultation documents that have yet to be drawn up.

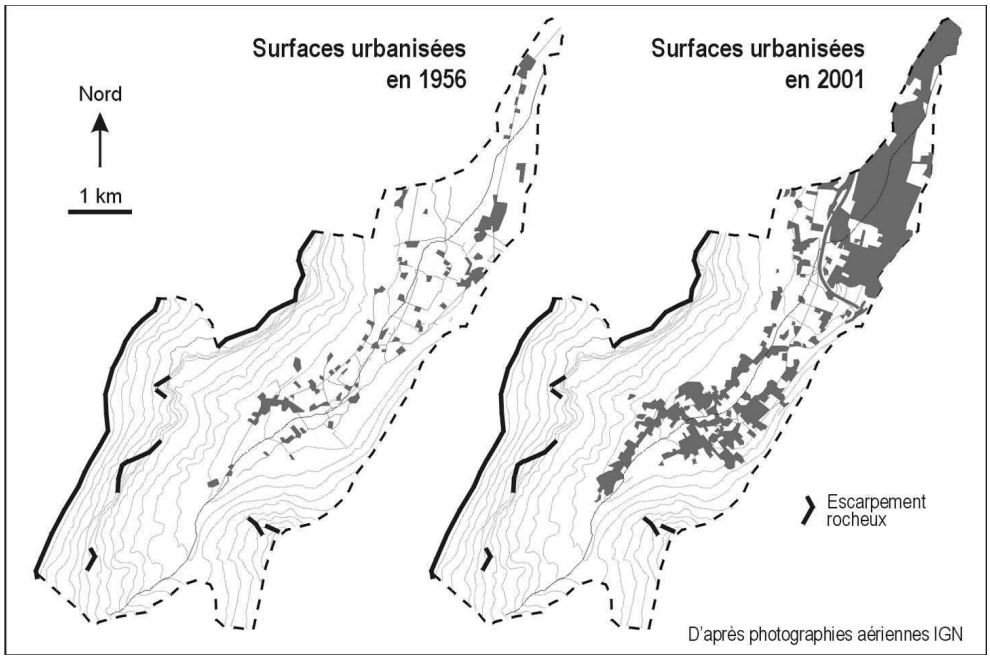
Changes in land use: diachronic study from 1956 to 2001

10 We carried out a diachronic study using aerial photographs and computerised spatial analysis techniques in order to provide an accurate description of the changes in the Lavanchon basin over the last 45 years. The variables used were the proportions of urban areas and rural areas, designed to show the expansion of urbanisation, and the proportions of woodland and eroded areas to illustrate the expansion or healing of active areas on the mountainsides.

1956-2001: urbanisation and changes to the landscape

11 Figure 3, which shows changes in size of the urbanised areas, provides the best illustration of the transformation of land use in the Lavanchon basin. The urbanised area has quadrupled in 45 years, increasing from 0.9 km²to 4.3 km², namely from 3.5% to 15.6% of the basin's total surface area. However, there has been a difference in this change between the north and the south of the catchment basin. In the lower part (in the north), which is closest to the Grenoble conurbation, considerable densification has taken place. Further up, in the commune of St-Paul-de-Varces, in 1956 the housing was particularly widely dispersed around the village; there were many hamlets and small settlements and a number of small huts and houses were isolated in the middle of fields or on roadsides. In 2001 the predominance of the old village has disappeared and the hamlets have spread and branched out, particularly along the roads.

Figure 3. Change in urbanised surface area in the Lavanchon catchment basin between 1956 and 2001.



12 If one compares the distribution of the urbanised environment with that of parcels of land it becomes apparent that the agricultural areas of 1956 have been consolidated and replaced by urbanised areas. The farmland has lost a large number of parcels in 45 years. In 1956 the area occupied by parcels of cultivated land was 7.9 km²(29.1% of the total surface area of the catchment basin); in 2001 it has shrunk by half to 4.5 km²(16.6% of the basin). Most parcels have been replaced by urbanised areas. The entire northern part of the catchment basin (Varces), which was farmland in 1956, has seen its land use change completely in 2001. Indeed, until 1980 the general context of urbanisation encouraged urban rather than agricultural development and it has only been since the farming blueprint bill of July 1980 that there has been more interest in periurban agricultural policy with a view to improving the status of these areas. However, farming no longer has a place in a valley like this in the face of real estate inflation.

13 Lastly, regarding the mountainsides, the eroded areas became slightly smaller between 1956 and 2001: the area affected was 4 km²in 1956 (14.8% of the basin's surface area) and 3.1 km²in 2001 (11.4% of the total surface area). Healing of the mountainsides is shown through the change in the amount of woodland present. Covering an area of 14.3 km²in 1956 and 15.4 km²in 2001, the amount of vegetation has increased slightly in 45 years (from 52.5% to 56.3% of the basin's total surface area), despite the widespread disappearance of hedgerows observed in the lower part of the basin, where urban expansion has occurred.

14 This expansion has therefore greatly modified the area, increasing the residential nature throughout the basin. But are these new inhabitants aware of the natural hazards to which they are exposing themselves?

A vulnerable population?

15 Our aim here is not to go into a highly detailed analysis of vulnerability but to characterise the population in terms of vulnerability by observing certain factors referred to in previous studies (D'Ercole, 1991; Leone *et al.*, 2006). This observation was made through a quantitative survey that enabled us to carry out a spatial analysis of the different factors included.

Surveys and spatialisation

16 The quantitative survey was carried out in 2003 among residents chosen using an arealtype sampling method, which appeared to us to be the most suitable method for spatial analysis of the different vulnerability factors (Ghiglione, Matalon, 1998; Lacambre *et al.*, 2003; Morel, 2000). The parent population included 1,750 addresses. The sample of people surveyed was selected initially on the basis of the selection of different neighbourhoods. For this, the area was subdivided into 24 neighbourhoods on the basis of the divisions made by roads and commune boundaries and the spatial vicinity of the different addresses. Secondly, the addresses of the people in each neighbourhood were listed and some chosen at random to ensure that one tenth of the population of each neighbourhood was surveyed, representing a total of 175 individuals aged over 15 years.

17 A preliminary survey having been used to test the relevance of the factors included in principle in the local context, the final questionnaire was divided into five topics. The first of these covered moving to the area and origin in order to distinguish between established and recent residents and to find out where the more recent residents had come from and their reasons for moving there. Next was knowledge of potential hazards, firstly regarding the prominence of natural hazards in relation to the other environmental problems in the catch-ment basin and secondly the individuals' knowledge of the different existing natural phenomena, those that are most feared and those to which the individuals feel they are exposed. This subdivision of the topic of knowledge enabled us to consider the level of awareness of hazards. In addition, the topic of memory and the passing on of local experiences regarding natural events (experienced first- or second-hand) and disasters was used to complement this first approach. Lastly, the final topic covered any practices enabling individuals to observe these phenomena, in particular during leisure activities (from walks to sports training).

18 The "neighbourhood" variable was cross-referenced with each of the other variables arising from the questionnaire using Sphinx 2000 software. The mapping was designed with MapInfo using a scale map of the neighbourhoods as the background.

A new population

19 Our first observation was that in our sample there are as many inhabitants living there for less than 5 years (1/3) as there are residents living there for more than 20 years; 45% of the inhabitants surveyed had been living there for less than 10 years. In the case of the recent arrivals (living there for less than 10 years), the living environment, the proximity to Grenoble, the low cost of land and in some cases the opportunity to live nearer family

members were the main justifications given for coming to live in the Lavanchon basin. Most had left the Grenoble conurbation (65%) to buy or build a property.

20 One inhabitant in seven (14%) felt that he/she was fairly well informed about hazards. For one third of the people surveyed the primary source of information was word of mouth. In addition, 33% of the sample asked for more information about hazards.

The relative prominence of natural hazards as a potential threat

21 The survey shows that 57% of the people questioned thought that there were environmental problems in the area in which they live. However, natural hazards were not their primary concern, coming third after pollution and industrial hazards, in that order. A large part of the population (41%) thought that there were no natural hazards in the Lavanchon basin; nevertheless, three inhabitants in five identified certain natural phenomena as potentially dangerous to their place of residence.

22 The most feared phenomena were, in order, boulder falls (rock falls) and collapses of rocky cliffs (23% categorised these as their number one concern), landslides, floods, rivers overflowing and mudflows (22% categorised these as number 4) and avalanches. When answering the question about which phenomena they felt most at risk from, the classification changed: floods, streams overflowing and landslides were cited in second (27%), third (22%) and fourth place (14%) respectively.

23 The majority of the population (60%) believed that no one place was more dangerous than any other in the catchment basin. The particularly dynamic torrential activity on the sides of the basin were cited in only very few cases. La Lampe, the most emblematic of the mountain streams in the basin in terms of its dynamism and the density of the protective structures built by the RTM Department, was the stream that the inhabitants were least aware of, even those living immediately below it. The protective structures (sills, sediment traps, rock fall protection walls and dykes), an indication of the existence of a hazard, were however identified by almost a third of the population (31%).

24 It also appears that there is less awareness of natural hazards among residents having moved there recently. 72% of individuals who have lived there for more than 20 years considered that the basin was subject to natural hazards whereas barely half (49%) of individuals who have lived there for less than five years described it in this way.

Selective and vague memory of events

25 Slightly more than a quarter of the population surveyed (29%) remembered having experienced a natural phenomenon; 75 different seen or experienced events were cited, most of which were said to have occurred in the 1980s. More significant catastrophic events (the collapse of the Echarina in 1988) and chronic events (spring rock falls) were particularly frequent memories.

26 However, the processes involved were often confused, dates were not always clearly remembered and the location recalled sometimes only vaguely. Some phenomena such as mudflows, which do however occur all over the basin, were almost absent from the inhabitants' memories. It therefore appears that the inhabitants of the Lavanchon basin have a rather vague memory of the natural phenomena that have affected the area.

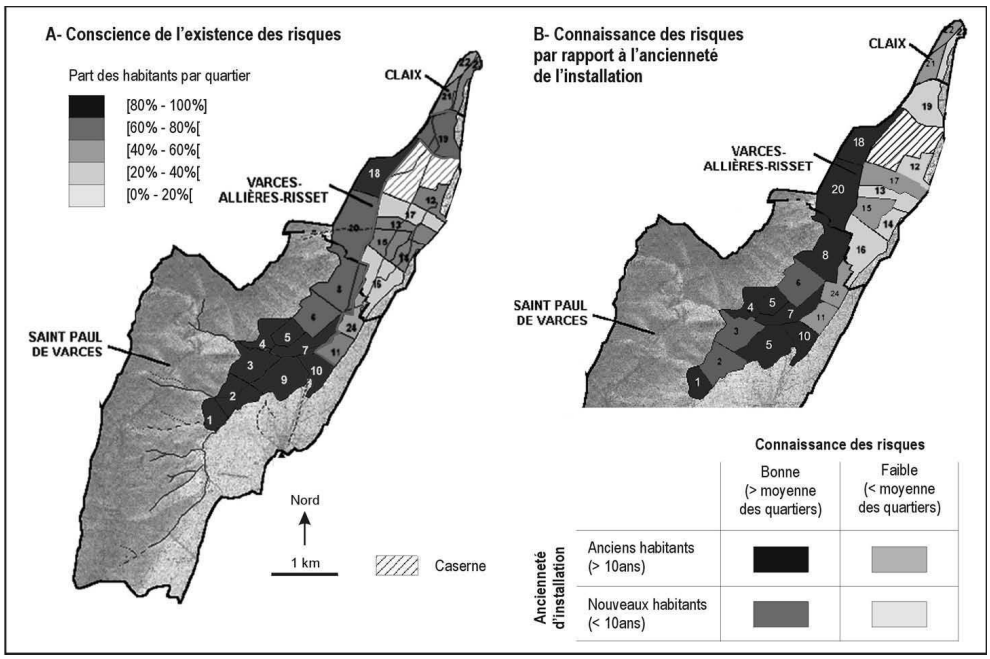
Contrast between low ground and mountainsides and the proximity factor

27 Attempting to spatialise the survey results gives rise to two remarks: the first concerns the very different way in which the inhabitants of the valley and those living at the bottom of the mountainsides relate to natural hazards; the second concerns the close relationship between awareness of the hazards and proximity to areas at risk.

28 Figure 4a shows a clear contrast between the neighbourhoods in the valley bottom and those on the mountainsides. In the latter, most inhabitants (80 to 100%) were extremely aware of the natural hazards. On the contrary, in the valley-bottom neighbourhoods the proportion of the population characterised by a high level of hazard awareness was less than 40%.

29 The map showing knowledge of natural hazards in relation to the length of time living there (Figure 4b) shows this contrast more clearly still. We stated above that in our sample those who had moved recently to the area were less aware of hazards. The map sheds additional light on this observation. The darkest colours correspond to those neighbourhoods in which individuals had better than average knowledge (63.8%). Here, we can see that neighbourhoods 2, 3 and 6 have good knowledge of the natural hazards even though the majority of inhabitants are recent arrivals. Conversely, neighbourhoods 11, 15, 17, 21, 22 and 23, representing mainly long-established inhabitants, have below-average knowledge of the natural hazards. It would appear from this that the factor of being located in the valley bottom or on the edge of the mountainside is more significant than the length of residency. However, the current sample does not permit a reliable statistical verification of these correlations.

Figure 4. Spatial distribution of the perception of natural hazards by the inhabitants of the Lavanchon basin: a. Awareness of the existence of hazards; b. Knowledge of the risks in relation to duration of residence.



30 The analysis of the survey and the graphic presentation of the responses obtained does however show the essential role that location plays in the relationship that populations have with the hazards to which they are exposing themselves in small mountain catchment basins. The proximity of the phenomena does appear to be an essential part of the way the hazard is regarded.

Conclusion

31 Comparing maps showing the evolution of urbanisation with those illustrating awareness of hazards shows that the most widely urbanised areas are also those in which the population is least aware of the natural hazards. The sectors located at the bottom of the mountainside, which are particularly at risk, grow more slowly than those located further down. They are currently occupied by people who are aware of the hazards, even those who have arrived recently. However, the situation is entirely different in the other sectors.

32 The Lavanchon catchment basin is a particularly dynamic mountainous area and an environment that is undergoing rapid urban development. By increasing the number of infrastructures and activities in the valley bottom, on alluvial cones and at the bottom of mountainsides, people have greatly increased their vulnerability while at the same time increasing the number and effectiveness of protective structures. The intensification of urbanisation is causing the decision-makers to push back the boundaries of risk. This course of action enables communes to increase their residential potential.

33 For their part, in some cases, particularly in the lower parts of the basin, new inhabitants are sometimes unwilling to accept the reality of natural hazards, even if some memory of past events does appear to persist. However, it is apparent that for the inhabitants of the Lavanchon basin the crucial issues are those connected with pollution and industrial hazards rather than natural phenomena. The low incidence of significant natural events, coupled with the effectiveness of the protective structures that have been built, seem to have generated a feeling of safety from these types of phenomena, leading almost half of the people surveyed to be unwilling to accept the existence of natural hazards.

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ABSTRACTS

In mountainous areas in recent decades urbanisation has expanded to areas where low ground adjoins mountainsides that are unstable in a number of respects. Periurbanisation in mountain basins with unstable sides poses specific problems that local players have to address. The Lavanchon basin (southeast of Grenoble), which is subject to very rapid urban growth combined with particularly dynamic mountainsides, is representative of the way activity is being brought into closer contact with potential hazards. A diachronic study of changes in land use between 1956 and 2001 shows how valley infrastructures at the bottom of mountainsides have become increasingly dense. In this context, a survey was carried out among a number of residents in the Lavanchon basin in an attempt to evaluate the degree of awareness that the population has of the natural hazards to which it is exposed. The results show that slightly more than half of the population surveyed was aware of the problem of natural hazards being present in the area, with most inhabitants being more concerned about industrial and pollution hazards. New residents were unaware of or were unwilling to accept the reality of hazards. The low incidence of significant natural events, the effectiveness of the protective structures built, the absence of information provided by the public authorities and the division of the basin between several management bodies appear to have engendered a feeling of safety from natural phenomena. The geographical distribution of appreciation of the hazard clearly shows a distinction between those inhabitants living on the low ground and those at the bottom of the mountainsides, and this corresponds fairly closely with the historical and current location of the main potentially hazardous events that have occurred.

Dans les territoires de montagne, les dernières décennies ont vu l'expansion de l'urbanisation vers les zones de contact entre la plaine et les versants, lieux d'instabilités multiples. La périurbanisation au sein de bassins montagnards aux versants instables pose des problèmes spécifiques auxquels les acteurs locaux tentent de faire face. Le bassin du Lavanchon (sud-est de Grenoble), qui combine un accroissement urbain très rapide et des versants particulièrement dynamiques est représentatif de ce rapprochement entre les aléas et les activités. L'étude diachronique de l'évolution de l'utilisation du sol entre 1956 et 2001 montre la densification des infrastructures dans la vallée et au bas des versants. Dans ce contexte, une enquête a été réalisée auprès d'un certain nombre de résidents du bassin du Lavanchon dans le but l'évaluer le degré de conscience que les populations ont des risques naturels auxquels ils sont exposés. Les résultats montrent qu'un peu plus de la moitié de la population interrogée a conscience de la problématique des risques naturels sur ce territoire, plutôt marquée selon la plupart des habitants par les risques industriels et de pollution. Les nouveaux résidants ignorent ou occultent la réalité des risques. La faible fréquence d'événements naturels marquants, l'efficacité des ouvrages de protection réalisés, l'absence d'informations de la part des pouvoirs publics et le morcellement du bassin entre plusieurs gestionnaires semble avoir généré un sentiment de sécurité par rapport aux phénomènes naturels. La répartition géographique de cette appréhension du risque montre clairement une distinction entre les habitants de la plaine et ceux des bas de versants, qui correspond assez bien à la localisation historique et actuelle des principaux aléas.

INDEX

Mots-clés: conscience du risque, évolution diachronique, montagne, périurbanisation, risque naturel
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