

NEW GEOREFERENCED AVALANCHE DATABASE IN ANDORRA: A BRIEF CHARACTERIZATION OF ACCIDENTS OVER THE LAST 60 YEARS

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Introduction

From 1964 to 2024, 21 deaths due to avalanches have been reported in Andorra, as well as numerous damages to infrastructures. This study presents the first geo-referenced database of the avalanche accidents reported in the last 60 years and describes the main physical and temporal parameters of the accidents and incidents recorded.

108 avalanches with a human component:

- Natural avalanches that have caused death or injury
- Accidental avalanches (caught or escape)

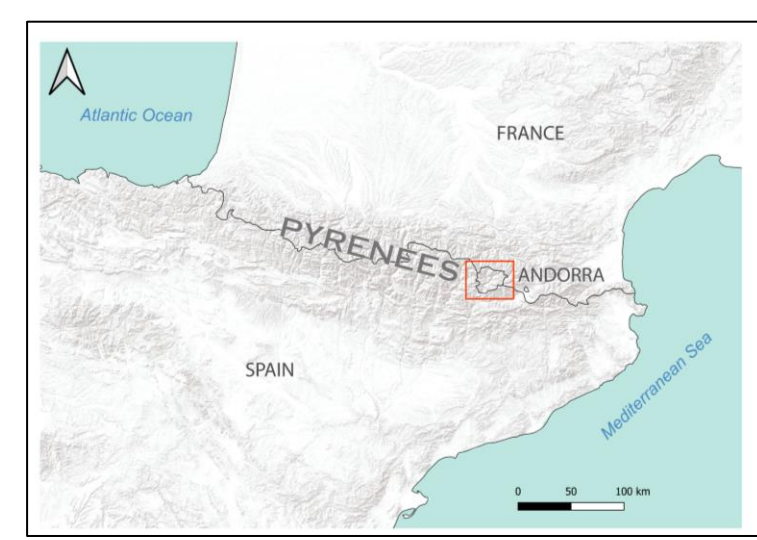
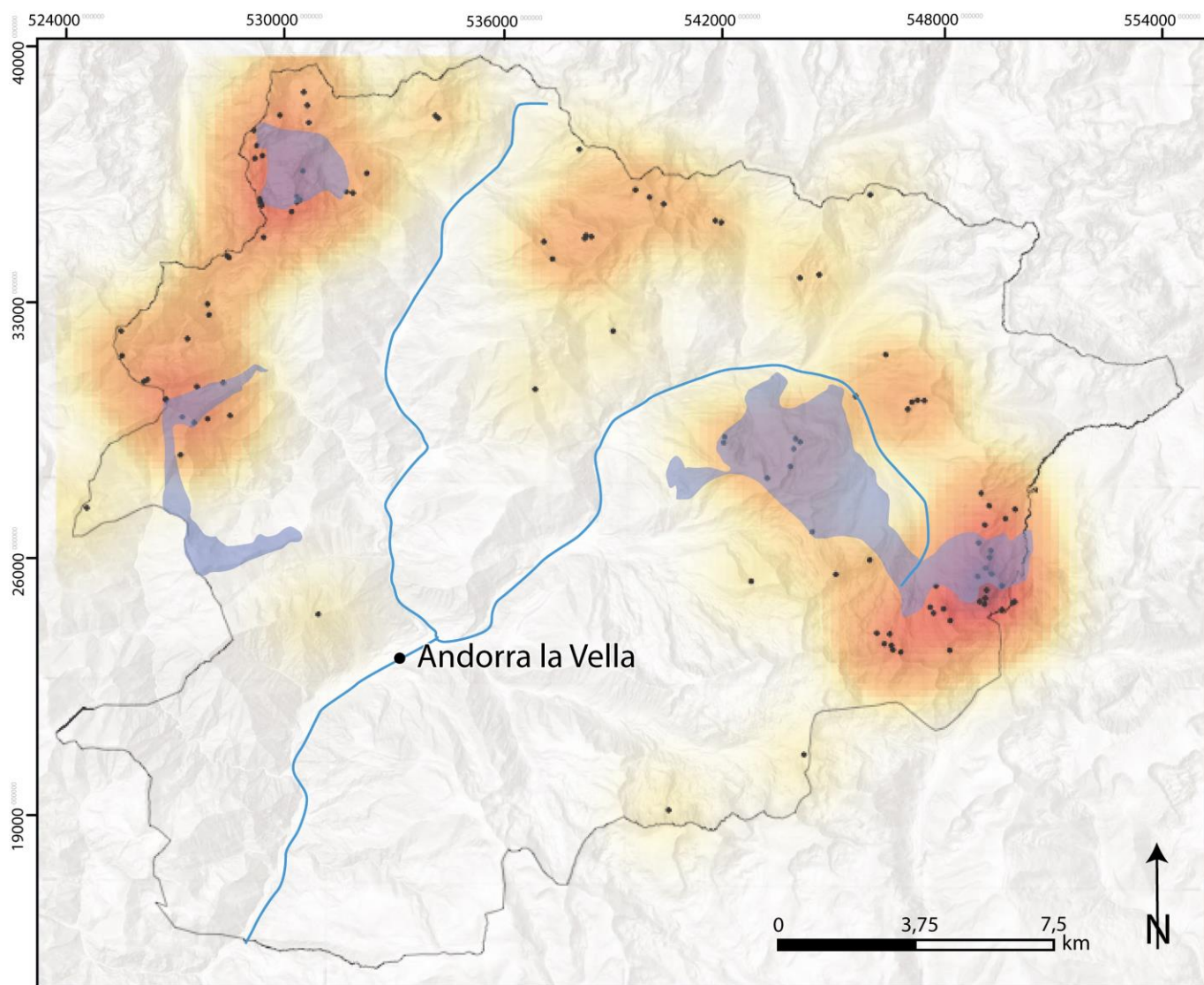


Figure 1: Hotspot map of Andorra with the 108 accidents reported in the studied period. Blue polygons represent the ski resort areas.

Data retrieval & methodology

- 2006: AR+I started a natural hazards database project in Andorra → Past events from media and reports from the rescue teams. First "modern" information from 1964.
- 2008: Real time information and start of observations on the ground after fatalities → information collected by e-mail, photographs, more accurate characterization of the avalanches.
- 2017: Social media app with the ski resort areas, the National Meteorological Service, mountain guides, rescue teams, etc. + mobile phone form for avalanche observations.

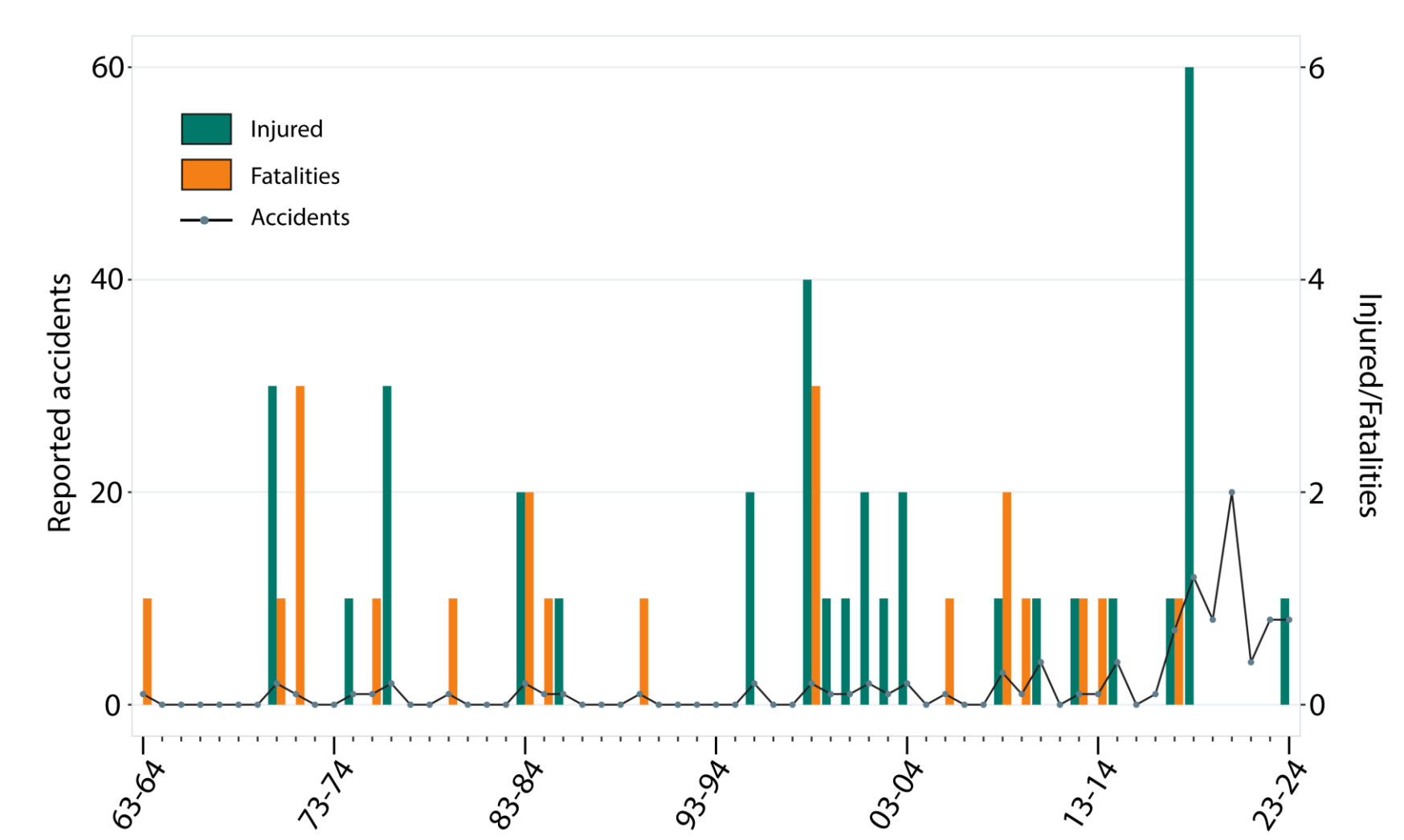
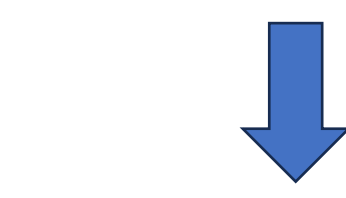


Figure 2: Number of accidents reported, and people injured and killed per accident in Andorra during the period 1964-2024. There is a slight increase in the number of accidents reported from the mid-2000s and a more important increase from the 2017-2018 season.

Heterogeneity in data collection



2 types of entries

Point data: poor/limited information: 38 entries

Polygons: well-known release zone

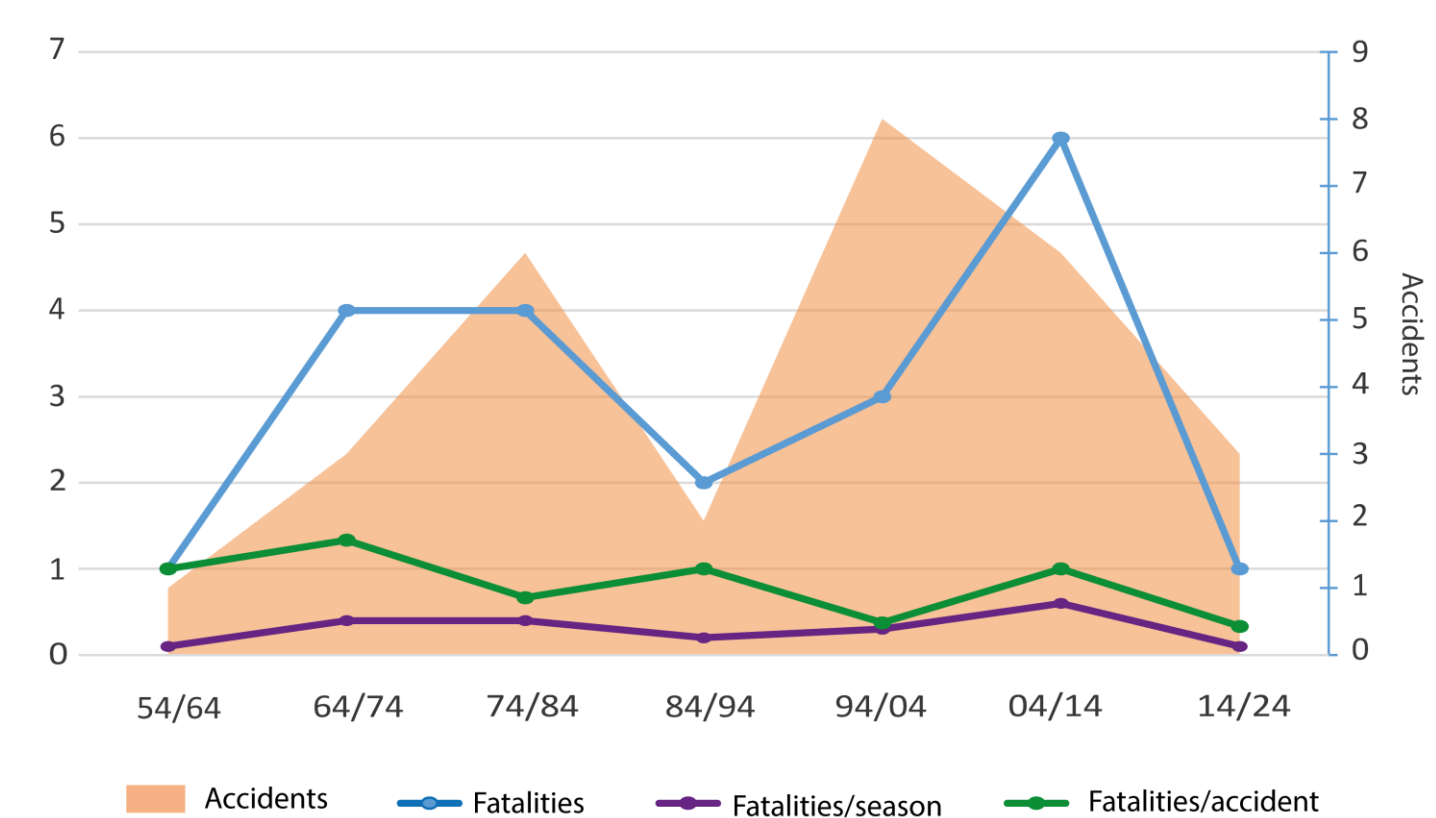
Low precision: poor info on arrival zone: 16 entries

High precision: well-known geometries: 53 entries

Results and conclusions

1. General overview

In the period 1964-2024 a total of **21 deaths** and **35 injuries** were reported in Andorra in a total of **108 accidents involving people**. The average number of deaths per season was 0.35; and the average rate of deaths/accident involving rescue teams was 0.72, even though this rate varies greatly depending on the decade (Fig. 3).



The number of deaths does not show any trend, but the deaths/accident and deaths/season rates show a decreasing trend.

Figure 3: Number of accidents reported by the rescue teams (orange area), and evolution of number of deaths, deaths per season and deaths per accident, per decade.

Most of the victims, both fatalities and injuries, were led by human-caused accidents (96%); in a mountain area outside ski resorts, and the victims were mainly practicing backcountry skiing (44%) (although in recent years there was an increase in the skiing accidents in boundary areas of ski resorts).

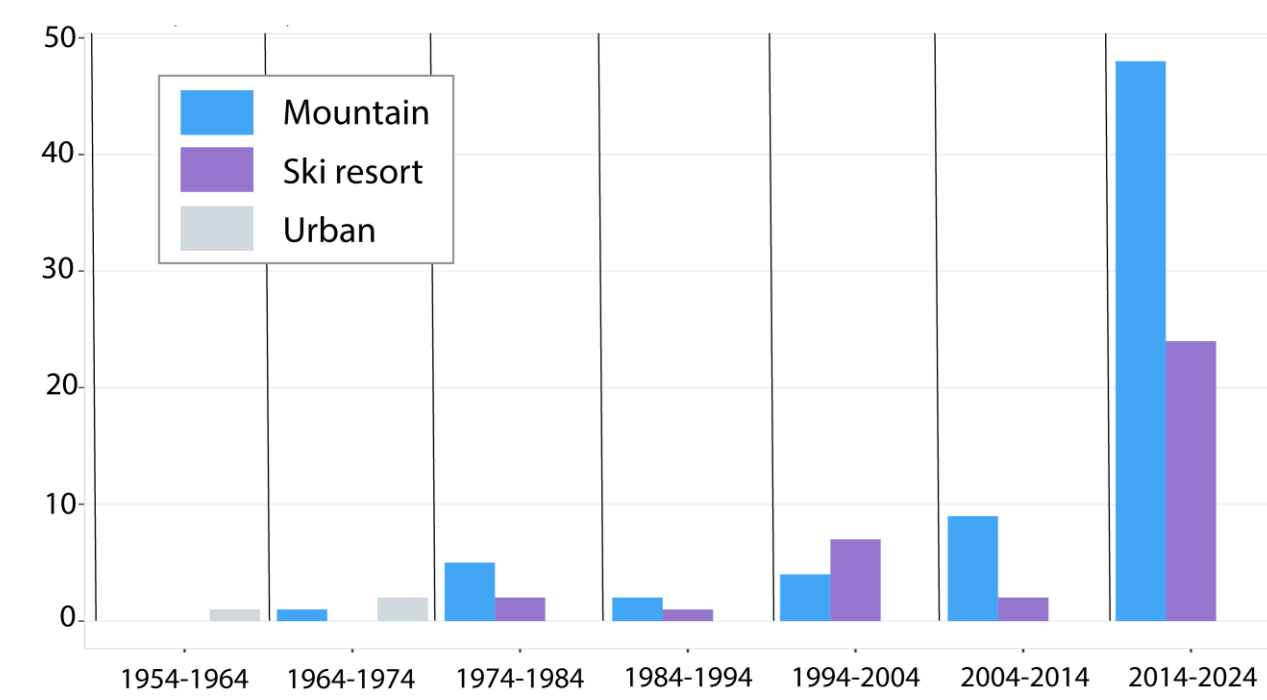


Figure 4: Area in which accidents occurred, per decade (n=108)

2. Time and seasonal distribution

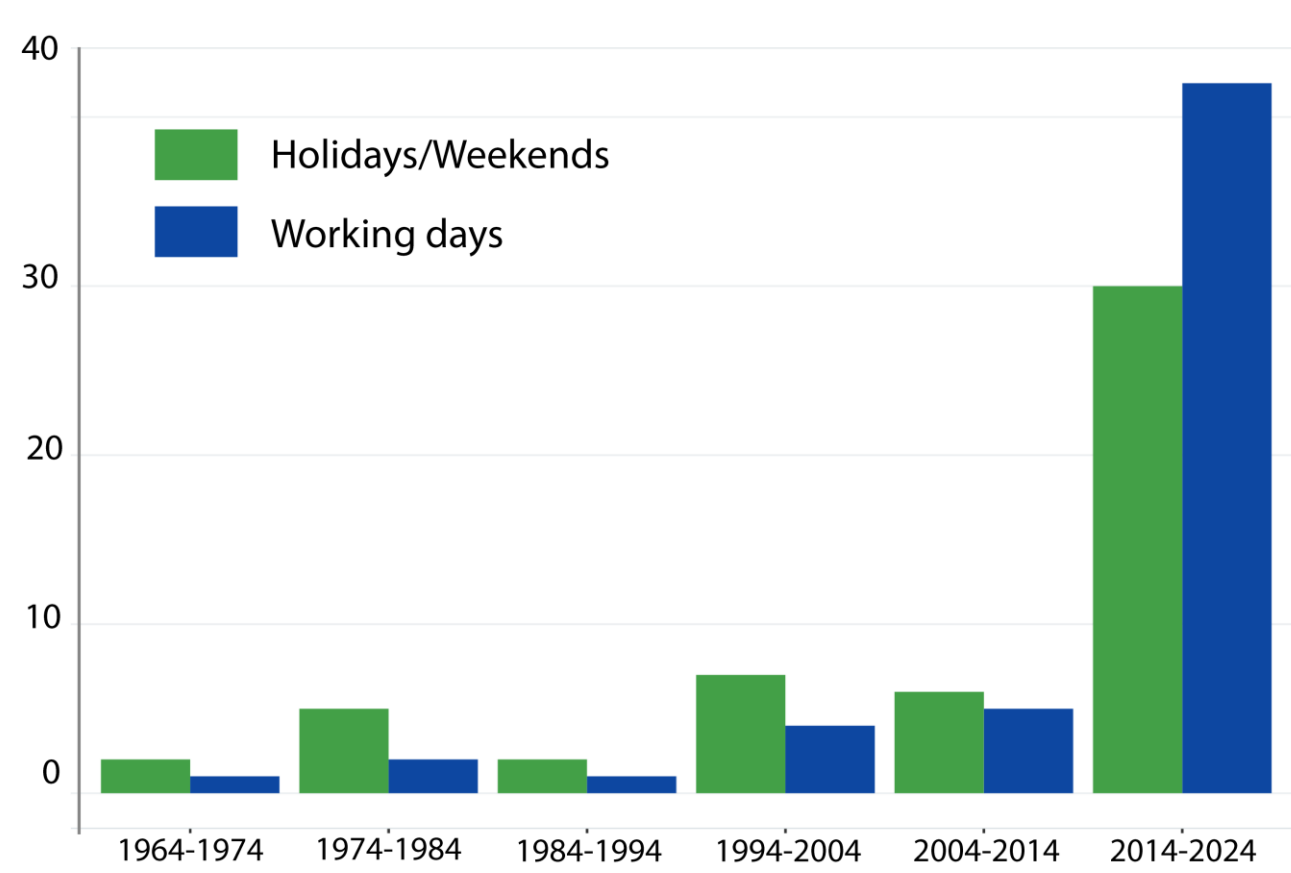


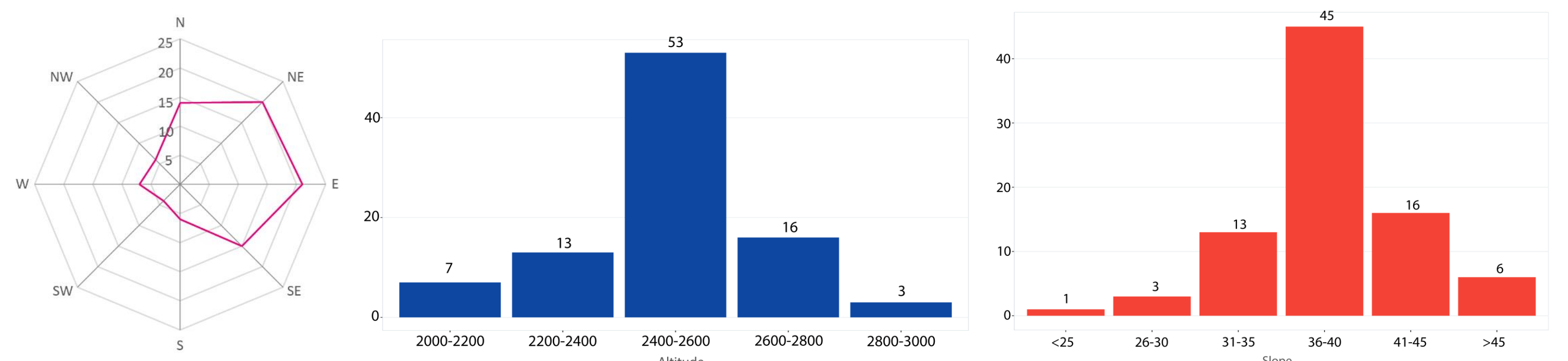
Figure 5: Frequency of accidents on holidays or weekdays, per decade. N=107.

Until the last decade, most accidents occurred on holidays, but this trend was reversed in the last decade.

75% of accidents occurred on blue sky days.

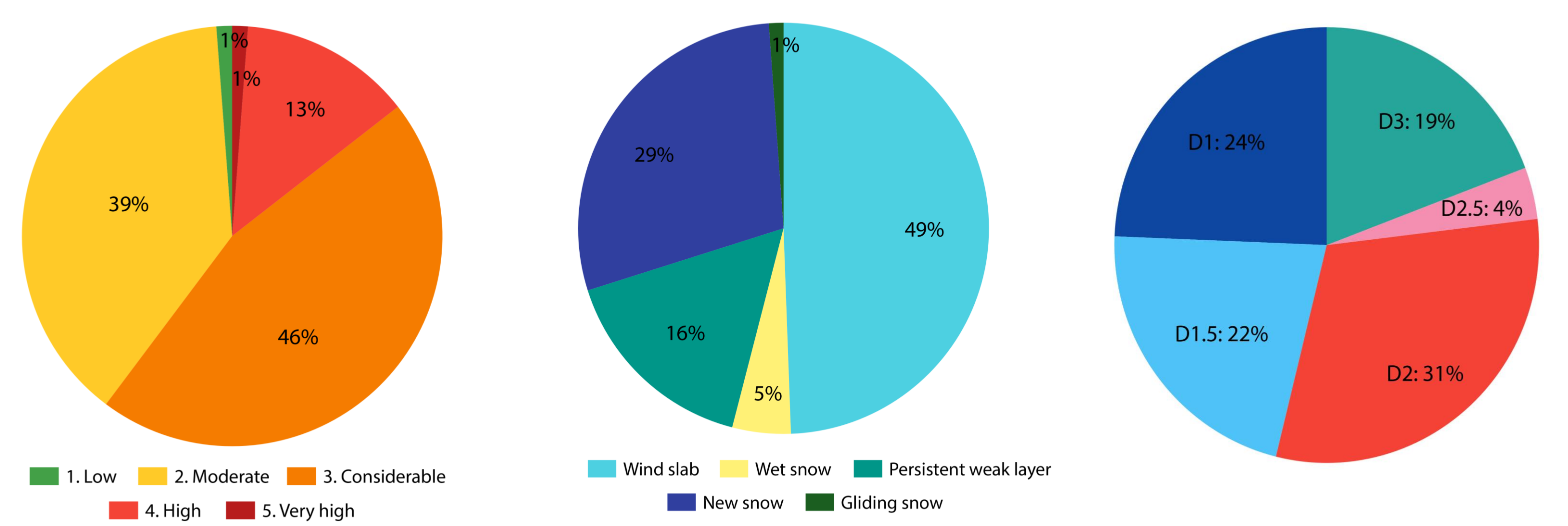
The months with the highest number of accidents are January, March and December.

3. Terrain and avalanche characteristics



Figures 6, 7 and 8: Frequency of accidents according to the orientation of the release zone (n=93); the elevation range of the release zone (n=92) and the angle of the release zone (n=84).

Most of the avalanches occurred in **ATES** complex terrain (87%) and on slopes with a component from N to SE. The **altitudinal range** of the starting zones with more accidents was from 2400 to 2600 m (53%). Starting zone **slope angle** of most accidents was between 36 and 40 (54%).



Figures 9, 10 and 11: Frequency of accidents according to the degree of danger reported to the avalanche report (Data from 1993) (n=83); frequency by type of avalanche problem (n=87); and frequency according to the size of the avalanche (n=78).

Most of the accidents occurred with a **hazard level** of 3 (46%) and 2 (39%) due to problems of wind slabs (49%) and recent snow (29%). The **avalanche problem** of persistent weak layers represented 16% of the accidents. Most of the accidents occurred in **avalanches sizes** <2 (46%). All accidents with fatalities were of size D3, in contrast with the data collected in other sectors of the Pyrenees. This data is considered very skewed due to the low number of fatal accidents for which information on the measure is available (n=7).

Ongoing work

- Relationship between the avalanche danger level / problem with size
- Relationship of the accidents with the weather circulation patterns
- Cause of death of the fatalities.

Joint this database to the neighboring Catalan Pyrenees accident database (of which Andorra is a geographical part) → characterize the accidents in the Eastern sector of the Pyrenees to better understand them and prevent them.