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Research Dissertation in Geography

Known Hazard, Fatal Decision: An Analysis of Avalanche Fatalities and the Human Factors Behind Disasters in the French Alps

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i. Declarations

Submitted as an integral part of the MA Single Honours Degree in Geography, University of St Andrews, April 2026.

I declare that this dissertation is 9971 words in length, excluding appendices, bibliography and figures.

I declare that the School of Geography and Sustainable Development informed me of, and that I have agreed to abide by, the Ethics, Risk Assessment, and Local Health and Safety rules, codes and procedures associated with this part of my degree; that I have completed and signed the relevant Ethics Self-Assessment and Risk Assessment forms and that I have obtained appropriate Ethics Approval for this project.

I certify that I have read the University's Policy on Academic Misconduct; that the following work is my own work; and that significant academic debts and borrowings have been properly acknowledged and referenced.

Signature:  Date: 22/04/2026

ii. Acknowledgements

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iii. Abstract

Avalanche fatalities in the European Alps claim around one hundred lives every year, yet existing research on the human factors behind these deaths remains almost exclusively North American in focus. This dissertation addresses that gap by examining avalanche mortality and recreational decision-making in the French Alps, a context institutionally distinct from North America due to the structural ambiguity of terrain boundaries and the absence of formal demarcation between controlled and uncontrolled terrain. Drawing on 43 years of ANENA archival data (1980-2023), an online survey of 156 recreational off-piste/backcountry users, and five semi-structured expert interviews, this study pursues two objectives: determining spatiotemporal patterns in avalanche fatalities, and examining how risk perception, education and heuristic decision-making shape behaviour in uncontrolled terrain. Key findings reveal that 94.3% of fatalities occurred in uncontrolled terrain, with randonnée deaths rising to dominate from 2014 onwards. Most fatalities occurred at danger level three out of five, reflecting a systematic misinterpretation of the avalanche bulletin. The possession of modern avalanche equipment correlates with risk-taking behaviours – the conflation of rescue equipment with "safety equipment" representing a particularly notable concern. While formal avalanche education tends to correlate with safety-oriented behaviours, it does not resolve the gap between knowledge and its application under pressure. Familiarity and expert halo emerged as the dominant heuristics influencing survey participants' decision-making, with social media amplifying established heuristic traps. Future researchers may consider investigating decision-focused education interventions and whether institutional terrain differences produce measurable variation in heuristic susceptibility across Alpine nations.

iv. List of Abbreviations

EAWS – European Avalanche Warning Services

EPA - Enquête Permanente sur les Avalanches (French avalanche survey)

SIP – Short Intervention Programme

FACETS – Familiarity, Acceptance, Consistency, Expert Halo, Tracks/Scarcity, Social Proof

RO1 – Research Objective 1

RO2 – Research Objective 2

UTREC – University Teaching and Research Ethics Committee

GDPR – General Data Protection Regulation

ANENA – Association Nationale pour l'Étude de la Neige et des Avalanches (French Association for Snow and Avalanche Study)

SAR – Search and Rescue

LABC – Lift-access Backcountry

USA/US – United States of America

GPS – Global Positioning System

ESDAC – European Soil Data Centre

IGN - Institut National de l'Information Géographique et Forestière (French Institution for Geographical and Forestry Information)

DEM – Digital Elevation Model

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1. Introduction

Few pursuits capture the essence of mountain freedom quite like freeride[1]. Away from the groomed pistes[2] and lift queues of the resort, the backcountry[3] offers solitude, untracked snow and an intimacy with the alpine environment that is difficult to replicate elsewhere. For a growing number of recreationists across alpine environments, this freedom has become not merely a leisure pursuit but a defining element of mountain identity. Yet this freedom carries an inherent and unforgiving cost. The same snowpack that offers the perfect descent conceals one of the world's major natural hazards – the avalanche.

Avalanches are defined as the rapid downslope movement of snow, ice, rocks, soil or vegetation on steep terrain (Schweizer, Jamieson & Schneebeli, 2003). Physical avalanche release depends on the interaction between four primary factors: terrain (slope angles exceeding 30º are optimal for avalanche occurrence), weather (particularly rapid snow accumulation through precipitation or wind-loading), snowpack stability (the layered accumulation of snow over the winter that may contain critical instabilities), and triggering mechanisms (natural or human) (Schaerer & McClung, 2006; Schweizer, Jamieson & Schneebeli, 2003). While physical conditions determine whether an avalanche is possible, they do not explain why people find themselves in its path.

Across the European Alps, avalanches claim an average of one hundred lives every year. This winter alone (2025-26) has already accumulated 143 fatalities, with France (n=32) consistently recording among the highest national fatality rates (EAWS, 2026; Techel *et al*., 2016). These figures are not simply a result of a hazardous physical environment; they are, overwhelmingly, a reflection of human behaviour. As Tremper (2008) notes, in approximately 90% of global avalanche incidents, the avalanche is triggered by the victim or someone in their party, fundamentally challenging the traditional characterisation that avalanches are random, unpredictable, purely physical events.

What makes this pattern particularly troubling is that most victims are not uninformed. Research consistently demonstrates that fatal avalanche incidents disproportionately involve avalanche-aware, often formally avalanche-educated, and sometimes highly experienced recreationists (Atkins, 2000; McCammon, 2000, 2002). The problem is seldom an information deficit, but rather a failure of judgement – a systematically human failure rooted in how individuals perceive and process risk under conditions of uncertainty. Foundational work on heuristic cognition demonstrates that individuals rely

[1] Freeride: downhill alpine recreation in off-piste/backcountry terrain.
[2] Piste: marked trail for downhill alpine recreation. Pistes are controlled for avalanches whereas off-piste areas are not.
[3] Backcountry: areas not controlled for avalanches outside of resort boundaries.

on mental rules of thumb (McCammon, 2002) when making decisions in complex environments (Tversky & Kahneman, 1974). In avalanche terrain, these processes can systematically bias judgment, particularly in familiar or socially influenced settings (McCammon, 2002, 2004). Compounding this, avalanche decision-making occurs in what Hogarth, Lejarraga & Soyer (2015) term a *wicked learning environmen*t, where corrective feedback is infrequent and unreliable, limiting opportunities for individuals to calibrate their risk perception.

This places the study of avalanche incidents firmly within the domain of human geography, and more specifically within the growing body of scholarship concerned with how cognitive, social and cultural processes shape human behaviour in hazardous environments. Recent disciplinary reviews reflect this shift, noting a clear move away from geophysical explanations of avalanche incidents, towards more holistic frameworks that incorporate human, environmental and cultural variables (Hetland *et al*., 2025; Zgheib *et al*., 2020). This dissertation situates itself within this emerging discipline, contributing an empirical case study that is notably absent from existing literature.

1.1. Research Objectives

The existing body of human factor avalanche research has been developed almost exclusively within a North American context (e.g. McCammon, 2000, 2002, 2004; Atkins, 2000; Furman, Shooter & Schumann, 2010). This is a significant limitation and understanding why lies in the structural differences between North American and European resort environments. In North America, resort operators are responsible for avalanche mitigation across the entirety of their boundary, and access to uncontrolled backcountry terrain requires a deliberate decision to pass through clearly marked boundary gates, with explicit signage warning individuals they are entering potential avalanche terrain. This creates a well-defined threshold between controlled and uncontrolled environments. In the European Alps, no such obligation exists beyond marked pisted runs, meaning recreationists can move seamlessly from controlled to uncontrolled terrain with little or no formal demarcation. The boundary between "safe" and hazardous terrain is therefore structurally ambiguous in a way that has no direct North American equivalent. This has significant implications for how recreationists perceive and respond to avalanche risk, as the institutional cues that might prompt risk-awareness behaviours in North America are largely absent in European resorts.

Given that most human factor research has been conducted within a North American framework, its findings cannot be assumed to translate directly to a European Alpine context. This dissertation addresses that gap directly, focusing on the French Alps to pursue two research objectives, building a holistic account of the human geography of avalanche risk in one of the world's most heavily trafficked mountain environments.

Research Objectives:

1. **Determine the spatiotemporal patterns in avalanche fatalities in the French Alps between 1980 and 2023.**
   By analysing archival data, this study identifies temporal trends, spatial clustering, and the relative contribution of recreational activities leading to fatal outcomes across both controlled and uncontrolled terrain.

2. **Examine how risk perception, avalanche education, and heuristics shape recreational decision-making in uncontrolled terrain in the French Alps.**
   Drawing on an online survey of recreational off-piste/backcountry users and semi-structured expert interviews, this objective explores the behavioural and cognitive factors underlying engagement with avalanche hazard, and the extent to which formal education mediates risk-related decision-making.

In pursuing these objectives, this study employs a mixed-methods approach, integrating archival data analysis, online survey data, and semi-structured interviews. This methodological triangulation is particularly suited to a subject in which quantitative patterns in fatality data and quantitative/qualitative accounts of lived decision-making must be read together to produce a meaningful account of human behaviour in hazardous terrain.

1.2. Structural Overview

The following diagram outlines the structural overview of this dissertation, from the study's initial framing to its conclusion.

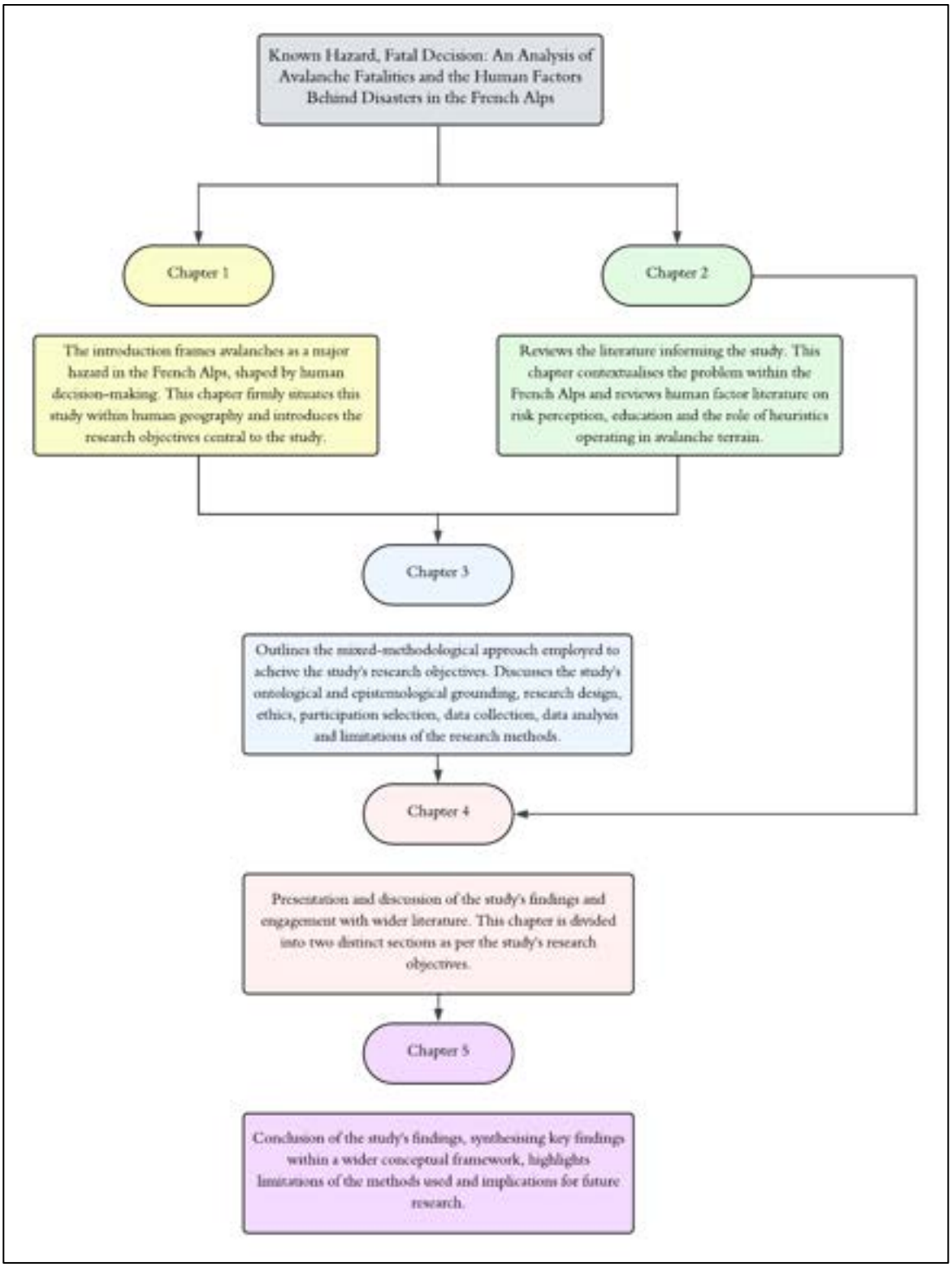

Figure 1. Structural Overview of Study

2. Literature Review

2.1. Context: Avalanche Hazard in the French Alps

Avalanches have long posed a threat to human societies in the European Alps, with early inhabitants interpreting their occurrence as divine punishment (Laternser & Pfister, 1997). This limited understanding of avalanche mechanics meant that, following destructive events, communities frequently rebuilt in the same vulnerable locations. Over time, however, this perception began to shift. The earliest documented attempts to reduce avalanche risk date back to the fourteenth century, when forestry protection was introduced above avalanche-endangered settlements (Techel *et al*., 2016). By the late nineteenth century, scientific investigations into snow physics had begun alongside the installation of permanent avalanche mitigation technologies (Höller, 2007; Laternser & Pfister, 1997). Avalanches were no longer regarded as supernatural phenomena but as measurable physical processes that could be mapped, monitored and mitigated.

The French Alps reached peak population during the nineteenth century, after which widespread outmigration resulted in a significant loss of local knowledge relating to avalanche hazards (De Crécy, 1980). Those who later repopulated the region were drawn largely by recreational opportunities, particularly skiing, yet lacked experiential familiarity with mountain hazards. Consequently, densely populated ski resorts developed in higher-altitude locations above older, more historically informed settlements (De Crécy, 1980). In December 1923, a week of catastrophic avalanche activity caused significant socioeconomic damage in the high valleys of the French Alps, resulting in fourteen fatalities and approximately one million francs in losses (Allix, 1924). Such events highlighted the growing responsibility of public authorities to regulate both permanent settlement and the rapid expansion of winter tourism (De Crécy, 1980).

During this period, scholarly attention largely reflected a focus on the physical properties of avalanches (e.g. Bravard, 1990; Valla 1990; Strazzeri & Manche, 1998; Schweizer & Lütschg, 2001). This emphasis is exemplified by the *Enquête Permanente sur les Avalanches* (EPA), the French national avalanche survey, which prioritised meteorological conditions and triggering mechanisms, while systematically excluding human factors from its analytical framework (Strazzeri & Manche, 1998). Contemporary literature increasingly recognises this as a critical omission. Recent reviews (e.g. Hetland *et al*., 2025; Zgheib *et al*., 2020) note a clear disciplinary shift from geophysical explanations toward more multi-dimensional frameworks that incorporate human, environmental and cultural variables. Building on this transition, this dissertation focuses on the human factors shaping avalanche hazard in the French Alps, aiming to deepen understanding of how decision-making processes influence the geography of avalanches in modern Alpine landscapes.

2.2. Risk Perception in Avalanche Terrain

Risk has been well established in broader decision-making literature as a critical component of how individuals make choices under uncertainty (Goldstein & Hogarth, 1997; Wu, Zhang & Gonzales, 2005). Kahneman & Tversky's (1979) Prospect Theory demonstrated that people do not evaluate risk objectively but relative to reference points, with losses weighted more heavily than equivalent gains. This asymmetry has profound implications for off-piste/backcountry decision-making: recreationists may systematically underweight the probability of avalanche release when their prior experience has been overwhelmingly positive, anchoring risk assessments to personal history rather than objective hazard indicators.

In the domain of outdoor recreation, Haegeli & Pröbstl-Haider (2016) argue that research into personal risk in extreme sports is increasingly important, as such knowledge can inform effective education programmes. Critically, this research illustrated that risk itself is not necessarily the primary motivator for participation in adventure sports, but rather a means of accessing intense experience, consistent with Breivik's (1995) characterisation of adventure sports as activities where participants accept the possibility of severe injury or death as an inherent condition of engagement. This has important implications for risk communication: if risk is understood as an acceptable cost of participation rather than a variable to be minimised, conventional safety messaging may fail to produce meaningful behavioural change.

In avalanche terrain specifically, risk perception is complicated by the binary and low-frequency nature of the hazard itself. Because avalanches are relatively rare events, not triggering a slide does not confirm that conditions were assessed accurately or that choices were appropriate – what Hogarth, Lejarraga & Soyer (2015) term a wicked learning environment, where feedback is unreliable and rarely corrective. This has a deeply distorting effect on experiential learning, as successful navigation of hazardous terrain may actively reinforce overconfident risk assessments rather than calibrating them. Risk propensity has been identified as a personality trait influencing decision-making in avalanche terrain, with McClung (2002) arguing that human components deserve formal integration into avalanche forecasting. This concern is compounded by the observation that individuals spending increasing leisure time in backcountry settings are progressively exposing themselves to hazard without necessarily developing commensurately accurate risk perception (Grímsdóttir & McClung, 2006). While avalanche bulletin information has been shown to be a critical component of recreational decision-making and risk assessment in North America (Furman, Shooter & Schumann, 2010), bulletins are only useful insofar as risk information is accurately understood and meaningfully acted upon during trip planning (Finn, 2020), suggesting that access to hazard information alone does not guarantee safety-oriented decision-making in the field.

The existing literature on risk perception in avalanche settings remains predominantly North American in focus. This dissertation extends these foundations into the French Alps, examining how risk perception and avalanche forecast engagement operate within a European institutional environment in which terrain boundaries are less clearly demarcated and formal risk communication may function differently.

2.3. The Impact of Avalanche Education

Avalanche education is widely regarded as a cornerstone of risk mitigation for backcountry/off-piste recreationists. Local and national organisations offer courses ranging from brief introductory sessions to intensive multi-day programmes, with the overarching goal of enabling recreationists to recognise hazardous terrain and travel more safely within it (Greene, Hendrikx & Johnson, 2022). Crucially, these programmes are best understood as short intervention programmes (SIPs), designed to disseminate knowledge and facilitate informed decision-making, rather than to eliminate the behaviour itself. This distinguishes them fundamentally from SIPs targeting risk behaviours such as recreational drug use, where abstinence is the intended outcome. Evidence consistently shows that fear-based tactics are not only ineffective but can actively backfire (e.g. Petrosino *et al*., 2000, 2005; West & O'Neal, 2004). Translated into an avalanche context, overly fear-based instruction risks generating overconfidence or misplaced excitement rather than calibrated risk awareness (Greene, Hendrikx & Johnson, 2022).

The empirical evidence for positive effects of avalanche education, while encouraging, requires careful interpretation. Birkeland, Greene & Logan (2017) argue that the increasing availability of avalanche information and education has contributed to a declining fatality rate over recent decades, though Greene, Hendrikx & Johnson (2022) caution that the quantitative data supporting this causal claim remains limited and the methodology contested. Nichols *et al*. (2018) found that formally uneducated recreationists were less likely to carry standard avalanche rescue equipment, suggesting a positive association between formal education and safety-oriented behaviour. Similarly, Mannberg *et al*. (2018) identified correlations between formal education and a lower propensity to recreate in higher-risk terrain, though the authors acknowledge that the mechanisms by which education translates into more conservative terrain choices remain poorly understood. The assumption that education straightforwardly produces more risk-averse recreationists is therefore empirically uncertain (Greene, Hendrikx & Johnson, 2022), and the possibility that SIPs produce insufficient behavioural change cannot be dismissed.

This dissertation aims to contribute to this literature by examining the relationship between formal avalanche education and safety-oriented decision-making. In doing so, it extends these predominantly

North American studies into a European context, where the structural ambiguity of backcountry terrain boundaries raises questions about how educational interventions translate into behaviour in the field.

2.4. Avalanche Decision-Making: The Role of Heuristics

A substantial body of research has identified human judgment, rather than a lack of technical information, as the primary driver of fatal avalanche accidents among off-piste/backcountry recreationists. Atkins (2000) argued that errors in judgement, skills, and knowledge represent the dominant causal factor in such accidents, and that decision-making errors are seldom attributable to information deficits but rather to how available information is cognitively processed under time-pressure, social influence, and physical fatigue. This was echoed by Fredston & Fesler (1994), who found that victims typically underestimate hazard or overestimate their own capabilities, making critical decisions based on personal desire rather than on the systematic integration of physical data. Notably, Fredston & Fesler (1994) also proposed that experienced recreationists are paradoxically prone to greater risk-taking through complacency, suggesting that expertise alone offers no immunity from poor judgment – a finding with significant implications for avalanche education policy.

The theoretical basis for understanding these patterns was established by Tversky & Kahneman (1974), whose foundational work demonstrated that individuals navigating uncertainty rely on cognitive shortcuts that, while often efficient, produce systematic and predictable errors. This framework was directly applied to avalanche terrain by McCammon (2002, 2004), who identified six key heuristic "traps" – familiarity, acceptance, consistency, expert halo, tracks/scarcity, social facilitation (FACETS) – that systematically increased hazard exposure independent of objective avalanche conditions. Crucially, McCammon (2002) found that avalanche training did not eliminate susceptibility to these biases, explaining why fatalities have persisted despite the growth of avalanche education programmes. Thaler & Sunstein's (2009) framework on choice environments further informed explanations behind why educated, experienced off-piste/backcountry recreationists persistently ignore environmental warning signs, framing such behaviour as the product of systemic cognitive error rather than individual negligence. However, the exclusively negative framing of intuitive decision-making has attracted scholarly challenge. Simon (1990), Gigerenzer (2007), and Dane & Pratt (2007) collectively argue that heuristic processing is not merely error-prone but is an adaptive, ecologically rational response to complex, time-pressured environments, with its reliability contingent on the depth and validity of a practitioner's domain expertise. The tension between heuristics as cognitive liability and heuristics as adaptive competence remains unresolved in avalanche literature. This represents an important theoretical axis along which this dissertation's findings on heuristic decision-making among recreationists can be interpreted.

The literature reviewed here is predominantly applied in a North American setting, reflecting the context in which the human factor concept was developed. This dissertation aims to build on this body of work within the context of the French Alps, where cultural norms around risk may shape decision-making processes in ways not fully captured by existing models.

3. Methodology

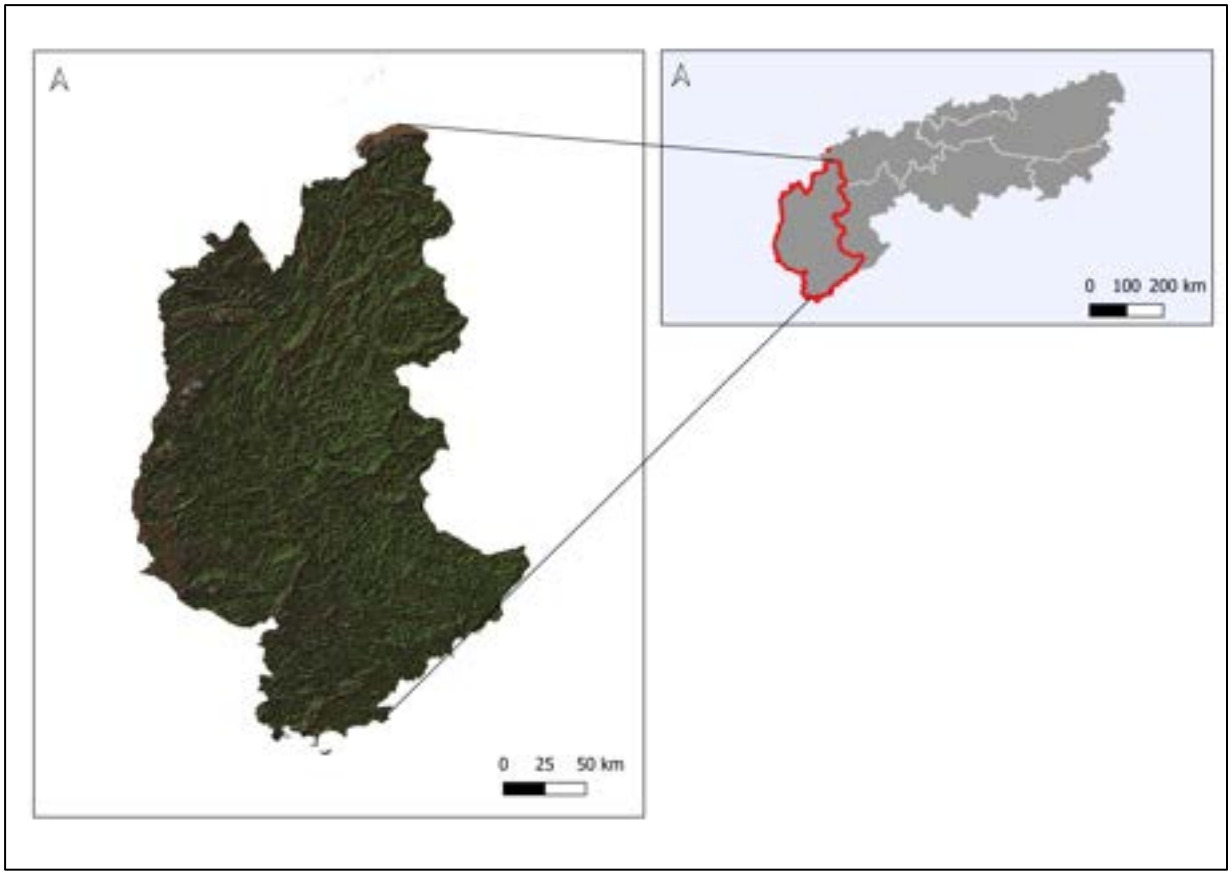

Figure 2. Map of the French Alps study area

Map of the French Alps, delineating the study area. Geographical data on country boundaries are sourced from Natural Earth data repository. The Alpine Convention boundary shapefile was sourced from the European Soil Data Centre (ESDAC). EuroDEM Elevation data derived from Mapsofeurope.org visualised using hillshade to contextualise the mountainous terrain of the study area. Map created by author using QGIS.

This study employs a mixed-methods approach, integrating quantitative and qualitative analyses of archival records, survey data and semi-structured expert interviews to build a holistic understanding of avalanche hazard in the French Alps. The objectives of this research are as follows:

> **RO1.** Determine the spatiotemporal patterns in avalanche fatalities in the French Alps between 1980 and 2023.
>
> **RO2.** Examine how risk perception, avalanche education, and heuristics shape recreational decision-making in uncontrolled terrain in the French Alps.

Avalanche archives provide an empirical foundation for examining historical and contemporary patterns of fatality statistics, essential to understanding the dynamics of risk activities (Hannam, 2002; Cope, 2025; Crowson, 2018; Valt & Pivot, 2013), directly addressing RO1. To explore the underlying

drivers of these spatiotemporal patterns, thereby addressing RO2, the study incorporates data on human factors associated with avalanche hazard. Quantitative and qualitative survey responses, alongside in-depth, interpretive insights from expert interviews (DeLyser, 2006; Winchester & Rofe, 2016), are used to address RO2. By combining quantitative and qualitative approaches, the study not only captures the extensive patterns in avalanche fatalities across the French Alps but also provides an intensive understanding of the processes and behaviours that shape these patterns (Harris, 2025; Warshawsky, 2014; Philip, 1998; Elwood, 2010).

3.1. Ontological and Epistemological Grounding

Ontology, the study of what exists, and epistemology, the study of how knowledge is constructed, form the foundation of how researchers approach studies (Snape & Spencer, 2003; Berryman, 2019; Al-Saadi, 2014). The qualitative methods used in this dissertation are grounded in relational ontology, which conceptualises reality as co-produced through relationships, interactions and processes rather than as a collection of fixed, independent entities (Sidorkin, 2002; Wildman, 2006), which, in the context of avalanche fatalities in the French Alps, recognises the dynamic relationship between human factors and avalanche hazard are deeply interconnected. The integration of the environmental and social dimensions of avalanche risk acknowledges that meaning, causality and consequence are constituted through human interaction with avalanche terrain, rather than residing in singular variables or actors.

Epistemologically, this study adopts a constructivist position. Constructivism regards knowledge as a human construction rather than objective truth (Cain, Grundy & Woodward, 2018; Kumar, 2006), thereby viewing avalanche fatalities as being shaped by how events are experienced, recorded, interpreted and communicated by individuals over time. Neither qualitative nor quantitative data are treated as objective reflections of reality; rather, they are understood as situated forms of knowledge produced under specific historical, institutional and social conditions. A constructivist epistemology allows for multiple interpretations of avalanche hazard to coexist, revealing potential differences in perspectives between recreationists, professionals and myself as the researcher, given my role in co-constructing meaning through analytical engagement of quantitative and qualitative data.

3.2. Research Design

The following methodologies are employed to achieve the research objectives central to this dissertation (Table 1).

Table 1. Table outlining the quantitative and qualitative methods used in the study, and the research objective each method addresses.

Method	Explanation	Research Objective
Archival Research	The publicly available ANENA *(Association Nationale pour l'Étude de la Neige et des Avalanches)* dataset was used to gather **quantitative** data on the patterns of avalanche incidents in the French Alps between 1980 and 2023, focusing particularly on the spatial shift in avalanche incidents from 'controlled' to 'uncontrolled' terrain, incidents involving recreational and non-recreational activities and the spatial clustering of fatalities.	RO1
Online Survey	Gather **quantitative and qualitative** insights into how risk perception, avalanche education, and heuristics shape recreational decision-making in uncontrolled, avalanche-prone terrain.	RO2
Semi-Structured Interviews	Interviews with avalanche experts such as off-piste guides and those employed in the avalanche education industry to gather deeper **qualitative** insights into the human factors interacting with avalanche hazard.	RO2

3.3. Participant Selection and Recruitment

Survey participants were selected based on the following criteria:

1. Take part in recreational activities in uncontrolled, avalanche-prone terrain in the European Alps.
2. Aged 18 or older.

Interview participants were selected based on the following criteria:

1. Professionals with expert knowledge on avalanche safety, education, guiding, and/or rescue in the European Alps.
2. Aged 18 or older.

While this research focuses on the French Alps, strictly recreating in the French Alps was not a specific requirement, thus calling for respondents across the European Alps to maximise participation. Given the Alpine Convention – an international sustainable development treaty for the European Alps – introduced cross-border cooperation on avalanche hazards in 1991 (Rudolf-Miklau *et al*., 2014), data gathered on human behaviour in avalanche terrain across the region was applicable for this study on the French Alps given cross-border similarities.

Recruitment for survey participants used a stratified and snowball sampling approach to ensure population requirements were met (Singh & Mangat, 1996; Naderifar, Goli & Ghaljaie, 2017), given the survey specifically called for individuals who recreate in uncontrolled terrain to capture the behaviours and perceptions of those who face avalanche risk directly. A range of channels and networks (i.e. Instagram, LinkedIn, Facebook, WhatsApp, European Alpine Clubs) were used to recruit participants who were encouraged to further distribute the survey with their own networks. Distribution of the survey was accompanied by a short article outlining the importance and purpose of the study distributed across various social networks by *The Freeride Republic,* a freeride community based in the French Alps who provide free in-person avalanche rescue practise sessions throughout the winter (Appendix-1)

Recruitment for expert-interviews involved reaching out to professionals who encounter avalanche risk on a regular basis. Mountain guides at *La Compagnie des Guides de Chamonix* (official guide company of Chamonix) were reached out to via email requesting guides to take part in the research. Emails were also sent to various individuals employed within the avalanche safety/education industry (see Appendix-2 for example email). Emails consisted of a participant information sheet outlining the relevant information prior to conducting the interview, a consent form which each participant needed to tick and sign, as well as a set of open-ended questions to structure the interview around. Interview participants were given the choice to remain fully identifiable within the research or to be pseudonymised to protect personal identity (Gibbs, 2018; Brear, 2018). Two participants who opted for pseudonymity consented to being attributed to their company and referred to as the following (Table 2).

Table 2. Table of interview participants and role in the mountains.

Interview Participant	**Role**
Dominique (Dom) Perret	Legendary freerider and co-founder of international avalanche education platform *WEMountain*, which prides itself on its holistic and preventative approach to avalanche safety.
Guide 1	Guide for *La Compagnie des Guides de Chamonix*
Guide 2	Guide for *La Compagnie des Guides de Chamonix*
Federico Arletti	Guide for *La Compagnie des Guides de Chamonix*
Rob Stewart	PR director for *Ski Press* and *Mountain Press*. Represents *Henry's Avalanche Talk:* a team of off-piste professionals who help individuals make better informed decisions, develop avalanche awareness and provide off-piste and touring insights.

3.4. Ethical Considerations and Positionality

This research abides by the ethics, risk assessment, and local health and safety rules, codes, and procedures associated with conducting an undergraduate dissertation in the School of Geography and Sustainable Development at the University of St Andrews. A full UTREC proposal requesting

permission to carry out both the survey and expert interviews was granted approval (Appendix-3). Participation in the survey and interview was entirely voluntary, with informed consent obtained electronically before respondents proceeded. For survey participants, no personally identifying information was required, rendering their data entirely anonymous and participants were able to withdraw at any point before submission. Interview participants were given the opportunity to choose whether their data remain fully identifiable within the research or be pseudonymised, as well as the choice to withdraw their data at any time without reason before dissertation submission. Data were stored securely in line with GDPR guidelines and used solely for academic purposes.

As a researcher with personal experience in uncontrolled winter mountain environments, I recognise my positionality and interest in avalanche risk and off-piste/backcountry recreation may shape the framing and interpretation of the research. To mitigate potential response and non-response bias, the survey was designed using established literature on decision-making in avalanche-prone terrain, and questions were structured neutrally to avoid leading questions (Parfitt, 2005). Throughout the analysis, reflexive consideration was given to how my positionality and familiarity with the subject matter may influence interpretation (Gurr, 2024).

3.5. Data Collection

The survey was conducted via Qualtrics. It contained 33 questions and took approximately 5-10 minutes to complete. Of the 33 questions, only one was open-ended given that, despite their greater potential to yield in-depth responses (McGuirk & O'Neill, 2016), the aim of the survey was to maximise representation and generate valuable numerical data for statistical analysis in service of RO2. Closed-ended questions were thus prioritised to minimise non-response and survey dropout before completion (Roventine, 2024; Lynn, 2017). The survey questions were structured around academic literature on the human factors behind avalanche risk, including Ian McCammon's (2002, 2004) work on *Heuristic Traps*, as well as the first expert interviews providing insights into additional questions. The survey was rigorously reviewed through pilot testing with a sub-sample of the target population prior to distribution to ensure the survey achieved my aims; twice with avalanche experts to assess appropriateness for the audience, and once with a non-expert backcountry recreational participant to ensure legibility, coherence and seamlessness (McGuirk & O'Neill, 2016). The survey questions were structured around the following sections (Table 3).

Table 3. Survey question sections. See Appendix-4 for full list of survey questions.

A	Background Information
B	Terrain Use
C	Training, Equipment and Preparedness
D	Group Behaviour and Decision-Making
E	Risk Perception
F	Information and Technology Use
G	Technology and Social Media
H	Decision Influences
I	Experience and Final Reflection

Semi-structured interviews were guided by open-ended questions which participants received prior to the interview taking place. The semi-structured format allows for a guided but flexible conversation, enabling participants to emphasise what they consider most significant while maintaining alignment with the pre-prepared questions (Kitchin & Tate, 2000; Longhurst, 2003; Ayres, 2008). Each interview lasted approximately 60 minutes and were conducted online via Microsoft Teams given their inherent flexibility and cost-efficiency, particularly in accommodating international participants based in alpine areas (Oliffe *et al*., 2021; Wakelin, McAra-Couper & Fleming, 2024). Interviews were structured around the following thematic areas (Table 4).

Table 4. Interview question sections. See Appendix-5 for full lists of interview questions.

A	Human Factors in Avalanche Decision-Making
B	Education, Communication and Behaviour
C	Risk Culture in Off-Piste and Backcountry Recreation

3.6. Data Analysis

Archives

France's ANENA data repository provides records of avalanche incidents from 1980 to 2023, forming the basis of this study and the primary means of meeting RO1. Raw incident data for each decade were extracted and analysed to reveal spatiotemporal patterns in avalanche fatalities over this period. Although earlier French avalanche records exist (dating back to winter 1969-70), these are limited to written notes and press clippings and are not available in a structured, downloadable format through ANENA's public database (ANENA, n.d.). As this research focuses specifically on the French Alps, only data from the relevant alpine departments were included in the analysis (Table 5).

Table 5. Table outlining the departments representing the study area.

Department names and codes included in study (French Alps)	Mountain ranges excluded from study (France)
• Savoie (73) • Haute-Savoie (74) • Isère (38) • Drôme (26) • Hautes-Alpes (05) • Alpes-de-Hautes-Provence (04) • Alpes-Maritimes (06)	• Vosges • Pyrenees • Jura • Corsica • Massif Central

Survey

The Qualtrics software provides tools for data analysis; together, the crosstabulation and chi-squared outputs contribute directly to answering RO2. The crosstabulation tool was used to analyse correlations between variables which were selected based on the study's research objectives and recurring themes outlined by interview participants. Chi-squared statistical testing was applied to test between two variables at 95% confidence level. Each test produced a p-value to determine statistical significance, indicating certain crosstabulations were likely to be meaningful rather than coincidental (Harris, 2016; Clifford, Cope & Gillespie, 2023).

Interviews

Interviews were recorded, transcribed and manually coded thematically to identify patterns, recurring themes and attach meaning to such themes (Riger & Sigurvinsdottir, 2016). Unlike quantitative survey and archival analysis, the main purpose of the interviews was to gain deeper qualitative insights into what experts deemed most important (Longhurst, 2003; Ayres, 2008) regarding the interaction between human factors and avalanche hazard, hence the semi-structured format, directly addressing RO2.

3.7. Limitations

Archives

Between 1980 and 1999, only fatal avalanches were recorded in France (ANENA, n.d.). To maintain a continuous database, non-fatal avalanche incidents were excluded from analysis. The most recent available data at the time of data collection and analysis was winter 2022-23, therefore avalanche patterns for the French Alps do not align with the survey and interview data collection conducted in the winter of 2025-26. Despite this, data on spatiotemporal patterns across the French Alps remain relevant to meet RO1.

Survey

As outlined by researchers who used surveys to assess human interaction with avalanche hazard (e.g. Furman Shooter & Schumann, 2010; Hetland *et al*., 2025), responses to questions regarding avalanche

risk approach, decision-making and behaviours in the field were hypothetical, thereby eliciting answers based on what individuals *think* they would do or based on past scenarios rather than real-time decision-making. Consequently, results may not accurately capture the emotional, social, and environmental pressures operating in avalanche terrain. Additionally, participants may alter answers due to a need to preserve a positive self-image or a lack of self-awareness (Alicke & Sedikides, 2009). Given the total number of respondents was 156, results likely underestimate the true impact of human factors in avalanche situations. Nevertheless, the survey provided valuable insights to address RO2.

Interviews

Limitations arose regarding language. Four of the five interview participants did not speak English as their first language, meaning there were certain topics or vocabulary that weren't easily translatable. To overcome this, interview participants were invited to discuss certain themes in French to maintain the conversational nature of the semi-structured format. Despite that, these were rare occasions and, when needed, Microsoft Teams' in-built transcriber automatically translated segments into English.

4. Results and Discussion

This chapter presents and discusses the key findings of the study. The results and discussion are structured in two parts, aligning with the research objectives this study seeks to achieve. The first part determines the spatiotemporal patterns of avalanche incidents in the French Alps; the second examines the human factors that interact with recreational decision-making in uncontrolled, avalanche-prone terrain.

4.1. Part One: Determine the Spatiotemporal Patterns in Avalanche Fatalities in the French Alps Between 1980 and 2023

4.1.1 Archival Data Analysis

Between 1980 and 2023, ANENA recorded 1937 avalanche incidents in the French Alps, 804 of which were fatal, yielding a total death toll of 1163. Notably, the proportion of naturally triggered avalanches more than halved after 2010, falling from a mean of 16.5% (1980-2010), to 7.5% (2010-2023). Males accounted for 72.4% of recorded victims; females for 12.4%, with sex unreported in 15.2% of incidents.

Table 6. Avalanche fatality summary statistics in the French Alps for 43 years (1980-2023). The annual mean death toll, range (minimum to maximum), proportion of fatalities in uncontrolled terrain, proportion of fatalities during recreational activities, and proportion of human-triggered avalanche fatalities are shown.

Data	Mean	Min-Max	Uncontrolled (%)	Recreational (%)	Human-Triggered (%)
ANENA	26.4	10–52	94.3	95.4	87

4.1.2 Recreational Activities and Uncontrolled Terrain

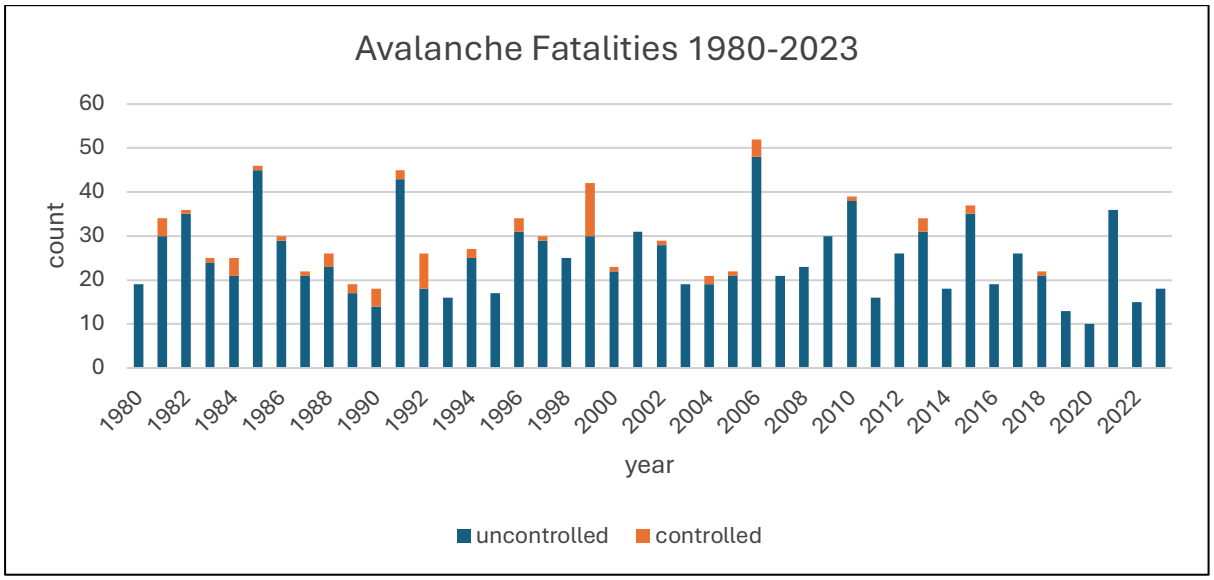

Figure 3a. Avalanche Fatalities in Uncontrolled vs. Controlled Terrain

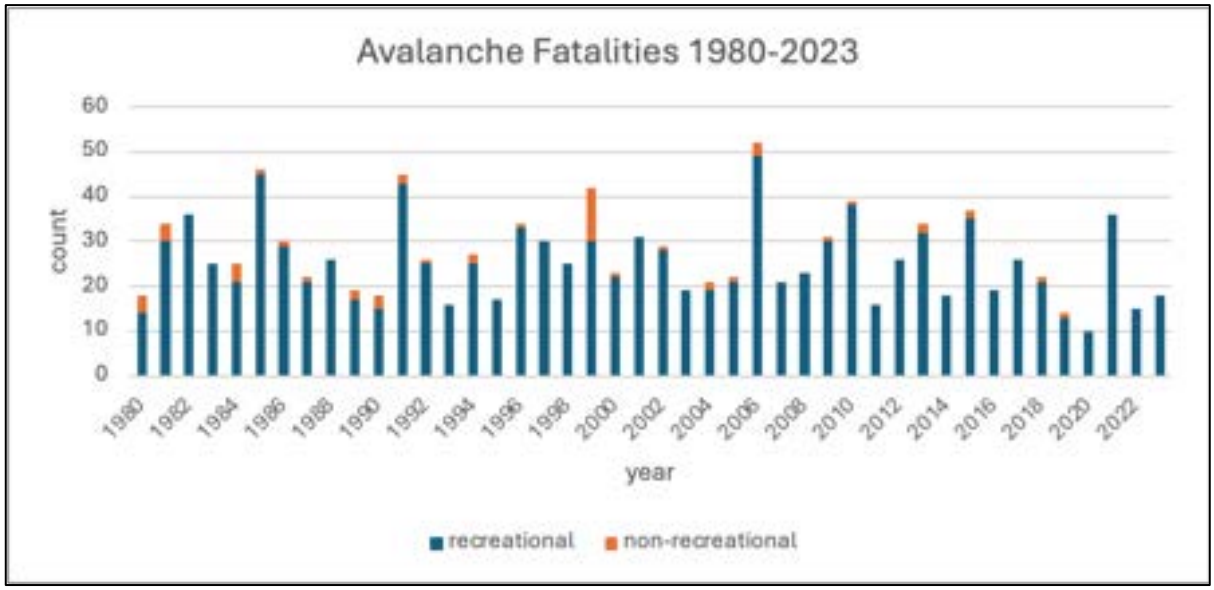

Figure 3b. Recreational vs. Non-Recreational Avalanche Fatalities

Avalanche fatality numbers in the 43 years between 1980 and 2023 in controlled vs. uncontrolled terrain (Fig.3a) and by recreational vs. non-recreational activities (Fig.3b). Avalanche fatalities defined as 'controlled' were those which occurred in areas managed for avalanche risk (i.e. settlements, mines, on-piste, transport routes, buildings). Those defined as 'uncontrolled' were those occurring in areas *not* managed for avalanche risk (i.e. off-piste, backcountry). Non-recreational avalanche fatalities were determined through the following categories: preventative triggering, search and rescue (SAR), settlements, transport routes and damage to infrastructure. Data sourced from ANENA data repository.

Avalanche fatalities in uncontrolled terrain (n=1097) overwhelmingly exceed those in controlled areas (n=66) for the study period, with controlled terrain recording zero fatalities since 2019. Uncontrolled terrain fatalities exhibit clear interannual variability, with peaks in 1985, 1991 and 2006. Excluding these spike years, the mean annual death toll was 23.4. After the first peak in 1985 (n=45), the number of avalanche fatalities in uncontrolled terrain declined (*mean*=20.8, 1986-1990), perhaps reflecting technological improvements, such as the analogue avalanche transceiver which extended transmission

range in 1986, significantly improving companion search and rescue (SAR) capabilities (Gasser, 2020). The 1990s represent a decade with particularly high fatality rates, with most annual death tolls sitting in the mid-to-upper twenties, likely reflecting sustained growth in winter recreation. Despite this variability, no clear long-term trend is apparent across the full period. However, the most recent years (2019-2023, *mean*=18.6) are among the lowest on record, potentially indicating improvements in avalanche forecasting, avalanche education and rescue technologies, though further investigation is required to confirm this.

A near-identical pattern is observed in Figure 3b, with recreational-related fatalities (*n*=1109) exceeding non-recreational ones (*n*=54). The sole exception – a peak in controlled and non-recreational fatalities in 1999 – is attributable to the Montroc disaster (Chamonix). This winter saw an abnormal volume of snowfall across the European Alps, leading to an avalanche that channelled 100,000 tonnes of snow and debris into the village, killing twelve (Techel *et al*., 2016; The Avalanche Review, 2003; Rapin and Ancey, 2000; Eckert & Giacona, 2023). The near-perfect alignment between recreational and uncontrolled terrain fatalities confirms that off-piste/backcountry recreational exposure are the dominant drivers of avalanche mortality, with controlled, non-recreational terrain fatalities almost exclusively representing exceptional, catastrophic incidents rather than regular, systemic events.

These findings are consistent with broader trends identified across the European Alps by Techel *et al*. (2016), who document a significant post-1970 decline in controlled terrain fatalities, alongside a corresponding boom in uncontrolled terrain deaths between the 1960s and 1980s, driven by ski area expansion and winter tourism. As publicly available avalanche records for the French Alps begin only in the winter of 1980-81, this analysis captures the tail end of that expansion rather than its onset, which may explain the absence of a pronounced long-term trend. Nevertheless, while these figures may reflect the success of mitigation strategies in controlled areas, further examination into the human factors behind avalanche deaths is required to understand fatality numbers in the French Alps.

4.1.3 Recreational Activity Breakdown

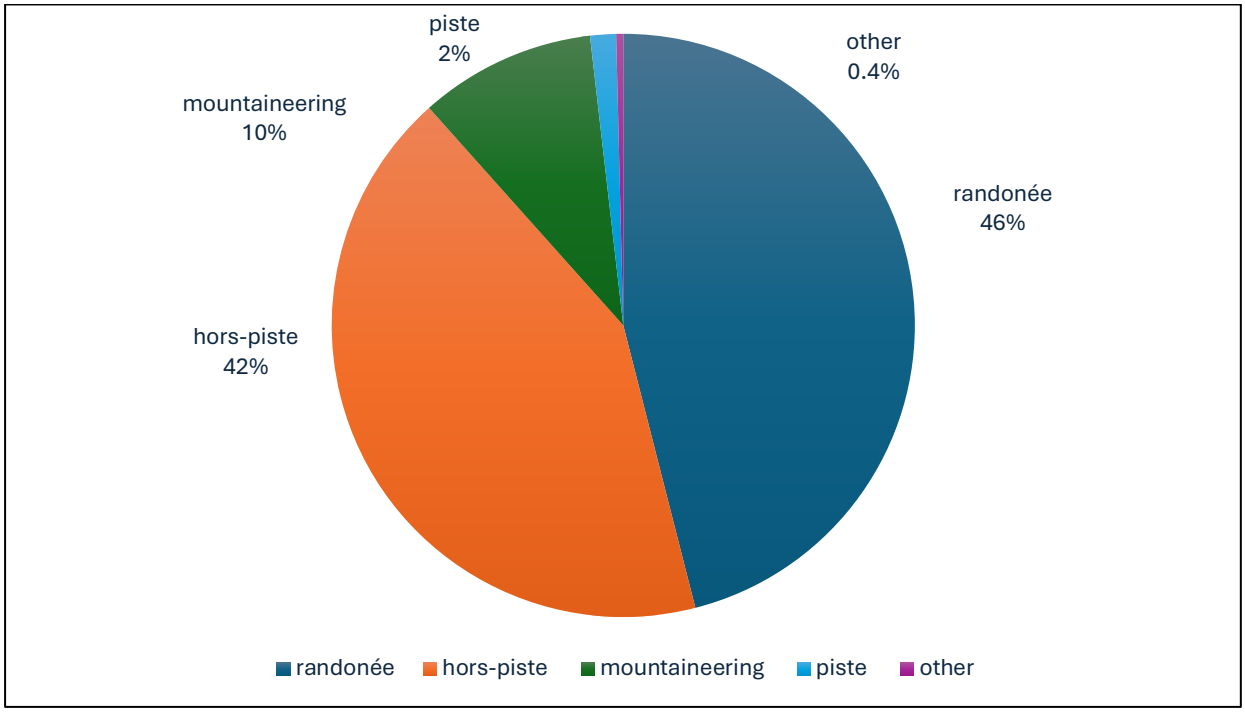

Figure 4. Fatal Avalanches by Recreational Activity

Fatal avalanche incidents by recreational activity in the French Alps (1980-2023). Only avalanches that resulted in at least one fatality were included in graph.

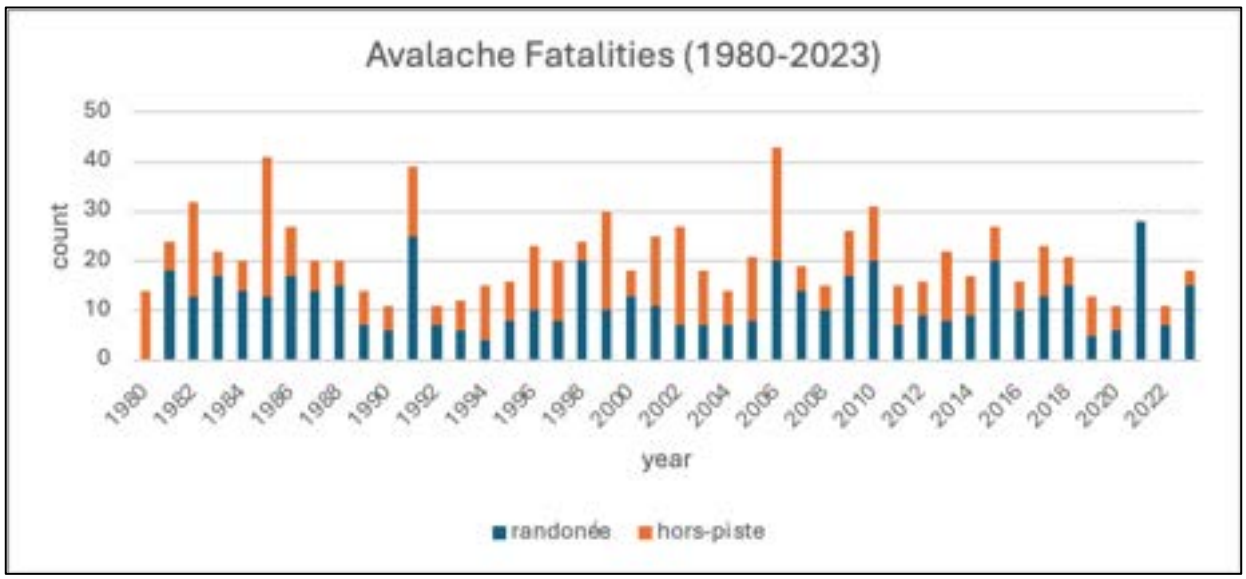

Figure 5. Avalanche Fatalities Caused by Randonnée and Hors-Piste Activities

Recreational avalanche fatalities broken into two subcategories: ‘randonnée’ (self-propelled backcountry recreation) and ‘hors-piste’ (recreation outside of open pistes accessible by resort-powered lifts) recreational activities (1980-2023).

Randonnée (self-propelled backcountry) and hors-piste (lift-accessible off-piste) activities together account for 88% of recreational avalanche fatalities (Fig.4). Figure 5 reveals a notable shift in their relative contributions over time. Off-piste deaths dominated from 1980 through the mid-1990s, driving both the 1985 and 2006 peaks, but have been on a gradual decline thereafter, potentially reflecting improved awareness among resort users and more cautious off-piste risk management, as although French resorts bear no legal obligation to control avalanche hazards beyond marked pistes, resorts assume recreationists without specialist knowledge of avalanche risk will venture into these zones, therefore take extra precaution (Pistehors.com, 2013).

From around 2005-2010, randonnée fatalities became a near-equal or greater share of total deaths. From 2014 onwards, randonnée clearly dominates, with no equivalent decline to that observed in off-piste deaths. This divergence raises questions concerning whether avalanche safety education has kept pace with the rapid growth in self-propelled activities like touring[4], for which interview participants noted a particular surge during the COVID-19 pandemic when resort closures led to an increased reliance on self-propelled alpine access, including among less experienced users. This observation corresponds with the pronounced peak in randonnée fatalities in 2021, for which all recreational avalanche fatalities fell within this category (ANENA, 2023).

This pattern aligns with research on lift-access backcountry (LABC) users in Montana, USA, who occupy an intermediate space between resort and self-propelled backcountry terrain, often termed as "sidecountry" terrain. Sykes *et al*. (2018) found that LABC users carried rescue equipment less frequently, exhibited lower avalanche hazard awareness, and, as GPS data showed, were more likely to select higher-risk terrain due to a false perception that proximity to resort boundaries implies safety compared to formally trained backcountry recreationists. While geographically distinct, these findings suggest that increasing randonnée fatalities in the French Alps may partly reflect a diversifying user base with varying levels of experience and risk literacy, reinforcing the importance of targeted avalanche education at the resort-to-backcountry transition.

[4] Touring: combination of self-propelled uphill ascent and downhill travel in backcountry terrain.

4.1.4. Chamonix: A Regional Fatality Hotspot

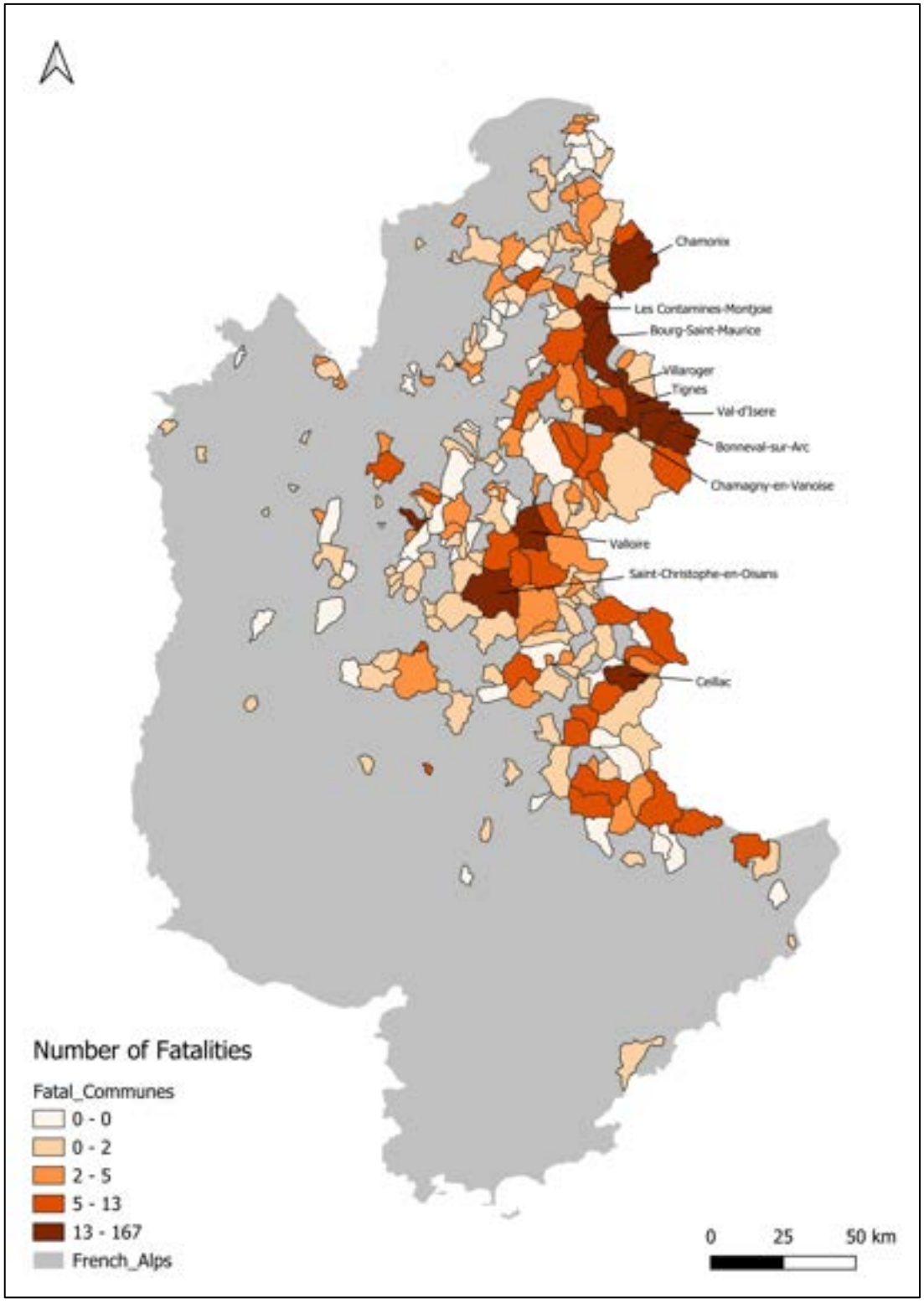

Figure 6. Avalanche Fatality Concentration per Commune in the French Alps

Map of communes included in ANENA's avalanche data repository across the French Alps. Number of fatalities sourced from ANENA's database. France shapefile was sourced from the European Soil Data Centre (ESDAC) clipped to the Natural Earth data repository for country boundaries. Commune boundaries sourced from Institut National de l'Information Géographique et Forestière (IGN). Choropleth map created using Jenks natural breaks classification method. Map created by author using QGIS.

Of the 268 Alpine communes included in the ANENA dataset, 213 (79%) recorded at least one fatality between 1980 and 2023, with a mean of 4.3 deaths per commune. Chamonix is a clear outlier, accounting for 14% of all fatalities (n=167), followed by Val d'Isère (n=65) and Tignes (n=47). The eleven highest-fatality communes (labelled, Fig.6) collectively account for 42.5% of deaths. This spatial clustering among communes characterised by high tourism intensity and freeride culture suggests fatalities are not randomly distributed, consistent with Pfeier, Höller & Zeileis (2018), who identified a correlation between avalanche fatality concentration and tourism in Austria.

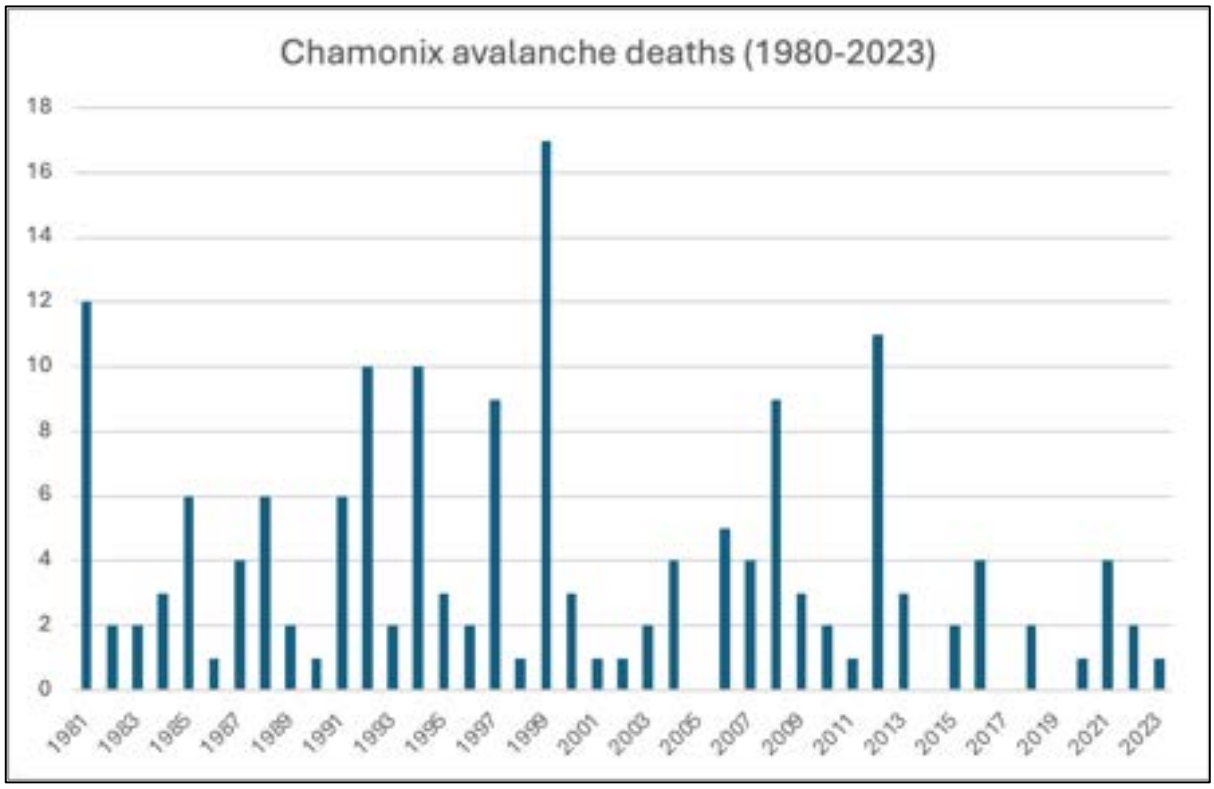

Figure 7. Avalanche Fatalities in Chamonix (1980-2023)

Despite Chamonix's disproportionate death toll, Figure 7 reveals an overall declining trend in fatalities across the study period, notwithstanding spikes in 1981 (n=12), 1999 (n=17, Montroc incident) and 2012 (n=11). Interview participants – three Chamonix-based mountain guides – attributed the high death toll to the valley's long-established freeride culture, rooted in the extreme skiing movement of the 1980s, for which Chamonix provided the backdrop for dozens of extreme skiing films (Germain, 2021), attracting a wave of individuals motivated by pushing limits.

Figure 8. Interview participant describing Chamonix's freeride culture

"[Chamonix] is a magnet for crazy people in every field" – ***Guide 2***

The above quote suggests the sheer exposure to avalanche-prone terrain by freeriders seeking to push their limits is one of the reasons behind the statistics presented. All three guides, however, cautioned against attributing fatality patterns solely to cultural factors, emphasising the importance of physical terrain, as illustrated in Figure 9.

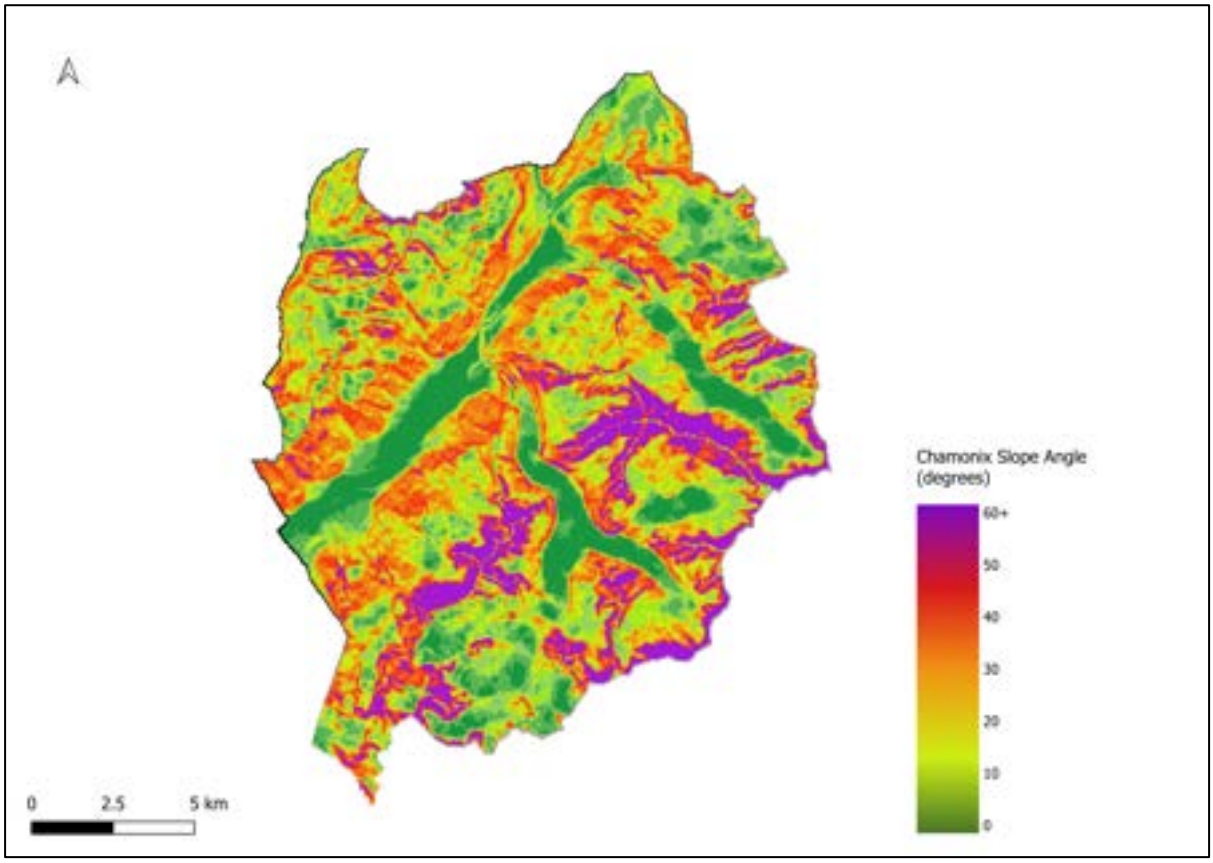

Figure 9. Slope Angle Map of Chamonix, France

Map of slope angles across Chamonix. Elevation data derived from EuroDEM was used to visualise slope angle. Chamonix boundary shapefile was created by author. Map created by author using QGIS.

A large proportion of Chamonix's slopes exceed 30º, the threshold commonly associated with optimal avalanche initiation (Schaerer & McClung, 2006), with guides noting difficulty in finding any freeride terrain below this angle. Critically, much of this steep, uncontrolled terrain remains lift-accessible, lowering the barrier to entry for recreationists across all experience levels. The guides nonetheless observed that the volume of people accessing avalanche-prone terrain in recent years appears disproportionately high relative to incident rates, tentatively suggesting local mitigation efforts may be having a positive effect.

4.2. Part Two: Examine How Risk Perception, Avalanche Education, and Heuristics Shape Recreational Decision-Making in Uncontrolled Terrain in the French Alps

4.2.1. Survey Demographics

A total of 156 participants completed the Qualtrics survey. Gender identity was not recorded as it was not considered analytically relevant to the study's objectives (Weber *et al.*, 2021). Key survey demographics are summarised in Table 7.

Table 7. Survey demographics. The table provides information on the age, geographic distribution, recreational activities, role, experience, terrain usage and training of respondents (see Appendix-6 for full results).

Age	Age ranged from 18-65+. Largest group: 18-24 (30%).
Geographic Distribution	80% of respondents recreate in the French Alps (Fig.10). Respondents recreating exclusively outside the European Alps (*n*=3) were excluded from analysis.
Recreational Activities	77% off-piste; 48% randonnée (self-propelled touring). Non-off-piste/backcountry respondents excluded.
Role	40% of respondents best described their role in the mountains as a recreational participant (e.g. on holiday). 40% were regular recreational users (e.g. seasonnaire).
Experience	55% of respondents report 50+ weeks of winter mountain experience (weeks used as measure over years to capture exposure frequency).
Terrain Usage	All three unpatrolled terrain types represented: edge of piste (85%), sidecountry (80%), backcountry (61%).
Avalanche Training	58% completed a formal avalanche safety course.

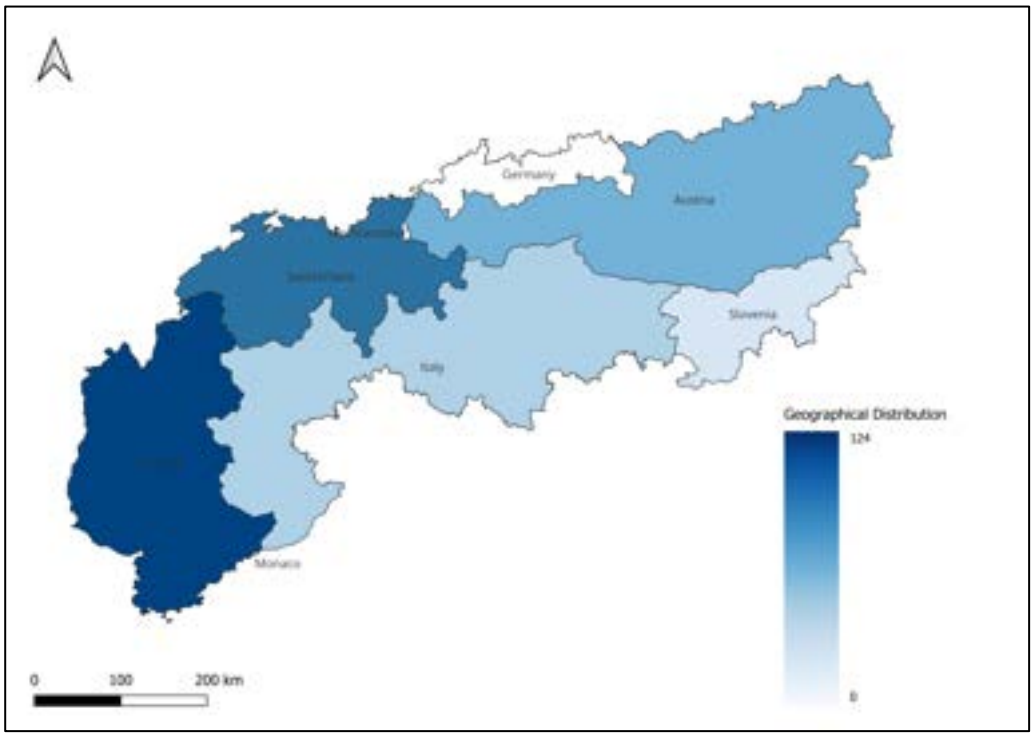

Figure 10. Geographical Distribution of Respondents across European Alps

Map showing geographical distribution of survey respondents across the European Alps. The Alpine Convention boundary shapefile was sourced from the European Soil Data Centre (ESDAC) clipped to Natural Earth data for country boundaries. Map created by author using QGIS.

4.2.2. Risk Perception and the Avalanche Bulletin: Interpreting Fatality Patterns in the French Alps

Avalanche bulletins play a crucial role in communicating avalanche hazard information to off-piste/backcountry recreationists. Météo-France publishes a daily *Estimation du Risque d'Avalanche* (avalanche risk estimation) between early November and early June across 36 fixed massifs in the French Alps, the Pyrenees and Corsica, providing a regional forecast of avalanche danger based on snowpack, meteorological conditions and snow/avalanche observations (Dufour *et al.*, 2024). The avalanche bulletin follows the European Avalanche Danger Scale (Fig.11) introduced by the European Avalanche Warning Services (EAWS) in 1993 which categorises danger on a five-level scale based on the likelihood and potential size of avalanches. Avalanche bulletins employ a pyramidal structure to maximise comprehension across experience levels, progressing from "entry-level" visual cues (signal words, colour-coding, icons), to more technical snowpack and terrain information. (Statham *et al.*, 2006 2010; St. Clair, 2019).

Figure 11. European Avalanche Danger Scale

European Avalanche Danger Scale. The table includes level out of five, associated icon, snow cover stability/compactness and trigger probability. Source: Snowsafe (2026)

Despite the widespread availability of avalanche bulletins, fatality patterns reveal persistent misinterpretations of avalanche danger. Of the 578 avalanche fatalities with a recorded danger level between 1993 and 2023, the majority (54%) occurred at Level 3-Considerable, the fewest fatalities at Level 1-Low or Level 5-Extreme, the latter skewed due to the 1999 Montroc incident (Fig.12).

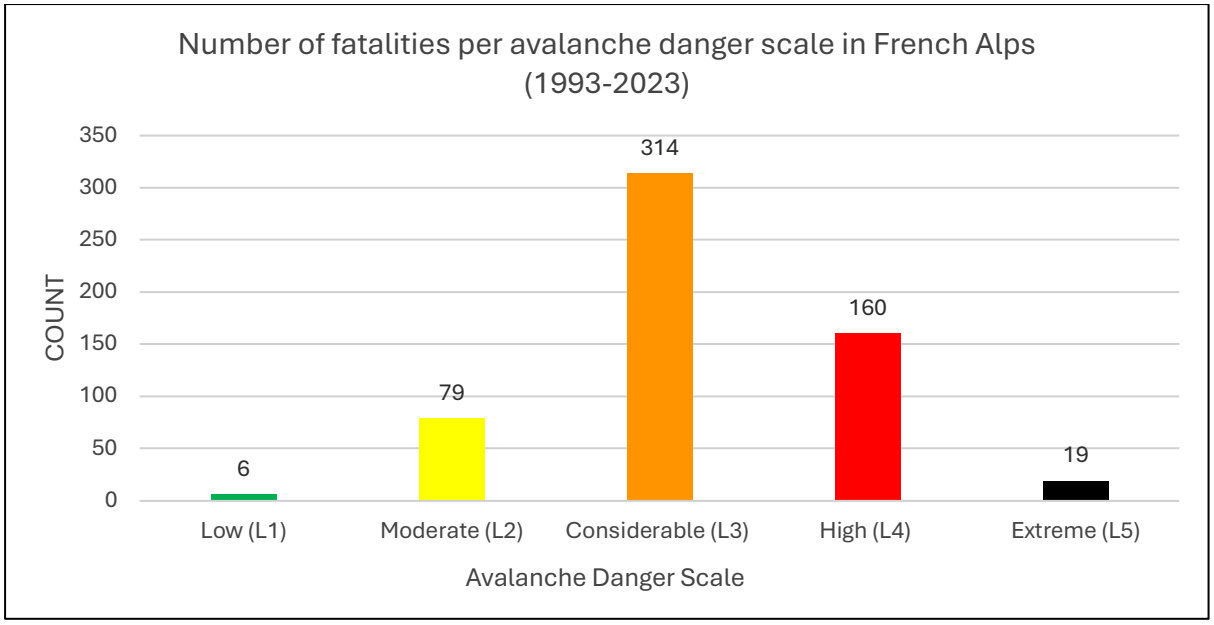

Figure 12. Avalanche Fatalities per Danger Level in the French Alps

Total number of avalanche fatalities according to the avalanche bulletin danger level at the time of death for 30 years from 1993-2023 (ANENA) after EAWS introduced the European Avalanche Danger Scale in 1993.

This distribution reflects a recurring paradox: most fatalities tend to occur at "intermediate" rather than extreme danger levels. Comparable patterns are documented in Tyrol, Austria, where the majority of avalanche-related helicopter and SAR operations occurred at Level 2-Moderate or 3-Considerable, due to a higher participation rate in backcountry recreation compared to on "high" risk days (Strapazzon *et al.*, 2021). Two cognitive mechanisms explain this. First, avalanche danger does not progress linearly and rises disproportionately, as illustrated in Figure 13. This means the upper range of Level 3-Considerable can closely resemble Level 4-High conditions despite the numerical distancing perhaps suggesting otherwise. Second, the positioning of Level 3-Considerable at the midpoint of a five-level scale creates a perceptual bias towards "average" danger (Schniewind, 2023). In fact, the EAWS (2022) designates Level 2-Moderate as the most frequent and thus "average" condition, with Level 3-Considerable being issued approximately one-third of the time, Level 4-High around 2% of the time and Level 5-Extreme being reserved for rare, catastrophic conditions. Interview data supports the interpretation that danger levels function as behavioural thresholds rather than objective hazard assessments, with recreationists often treating a drop from Level 4-High to Level 3-Considerable as a transition to acceptable terrain despite the potential for extremely critical consequences.

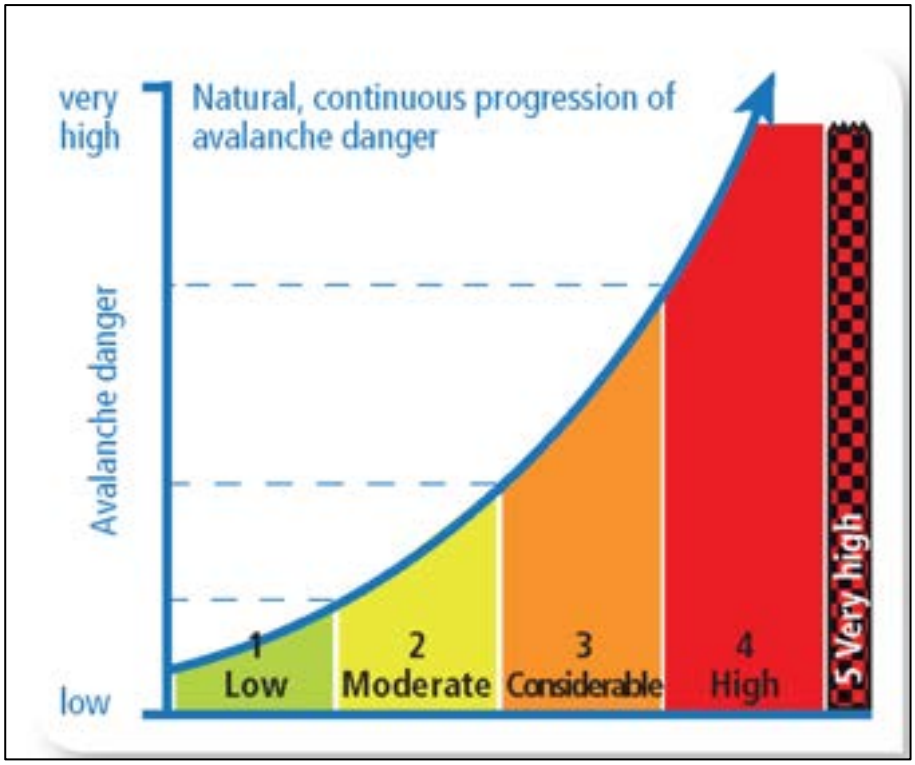

Figure 13. Natural Non-Linear Progression of Avalanche Danger

European Avalanche Danger Scale. Blue line (natural, continuous progression of avalanche danger) increases non-linearly. Source: EAWS (2022).

A further interpretive issue, raised by interview participant Dom, concerns the spatial mismatch between bulletin scale and individual-level decision-making.

Figure 14. Interview participant discussing the avalanche bulletin.

'The avalanche bulletin is a net meant to catch whales, not shrimp. We skiers, we're shrimp' – ***Dom***

This quote stresses the importance of understanding that the avalanche bulletin, while a helpful indication of avalanche danger on a given day, needs to be interpreted as such: a regional *estimation* of avalanche danger. Avalanche forecasts cover a minimum of 100km^2 (Schweizer *et al.*, 2020) encompassing multiple valleys, elevation bands, slope aspects and varying climatic influences that were traditionally designed to inform public safety across settlements and infrastructure rather than individual slope assessment (Oelboeck, 2026). The bulletin therefore represents a regional hazard assessment, not a slope-specific safety guarantee, and should be interpreted accordingly.

4.2.3. Risk Perception and The Misinterpretation of Avalanche Information

Survey results indicate that 74% of respondents always consult the avalanche bulletin before entering avalanche-prone terrain (Appendix-7), suggesting a high level of awareness of its importance. However, Guide 1 observed that many recreationists engage only with the "entry-level" components of the report,

typically the danger level, altitude band and slope aspect, often overlooking more detailed snowpack and terrain information that is critical for accurate hazard assessment. This superficial engagement with avalanche bulletin content may explain the gap between the high consultation rate among survey respondents and poor risk perception outcomes identified in fatality statistics and broader literature.

Interviewees consistently framed avalanche risk as the product of hazard and consequence, meaning the presence of danger does not diminish following risk assessment; rather, the decision to recreate in avalanche terrain involves the conscious acceptance of residual risk. Unlike other natural hazards, exposure to avalanche risk when recreating in uncontrolled terrain is entirely voluntary and often routine for regular backcountry users (Haegeli, Gunn, & Haider 2012), demanding a continuous, self-directed process of risk management (St. Clair, 2019).

A key theme that emerged from the interviews was the role of complacency in shaping risk perception. Avalanche decision-making occurs in a wicked learning environment, where corrective feedback for poor decision-making is rarely provided (Hogarth, Lejarraga & Soyer, 2015), and when provided, i.e. when an avalanche is triggered, can be fatal, making risk perception particularly challenging in avalanche-prone terrain (Mannberg *et al*., 2018). Interview participants noted this lack of feedback can produce complacency.

Figure 15. Interview participants discussing lack of feedback in avalanche terrain.

'You could be in a resort where the risk is three out of five for a long time without really seeing any avalanche activity. This does not mean that it is safe' – ***Rob***

'People think "nothing happened last time, so it's safe today"' – ***Guide 2***

The above quotes allude to the fact that because most backcountry travel does not result in an avalanche, recreationists may develop a false sense of security, reinforcing heuristic thinking and complacency, especially in familiar terrain. These findings align with broader literature on the difficulties of communicating avalanche risk effectively; while bulletins provide a coherent and scientifically grounded summary of complex snowpack conditions (Lanzanasto *et al*., 2018), their interpretation at the individual level is mediated by experience, motivation and risk tolerance (St. Clair, 2019). As one interviewee's rhetorical remark (Fig.16) suggested, the subjective trade-off between perceived reward and perceived danger is central to how recreationists navigate avalanche terrain.

Figure 16. Interview participant questioning risk appetites.

'What is the point of this risk? To make a few more turns on soft snow? To ski a steeper couloir? To get the social media shot?' – ***Federico***

4.2.4. Rescue Equipment ≠ Safety Equipment.

A further dimension of risk perception concerns the behavioural effects of avalanche rescue equipment. Survey data revealed a statistically significant relationship between self-reported risk acceptance and avalanche airbag use (p=0.04, Appendix-8). Participants who never wore an avalanche airbag were substantially more likely to avoid avalanche terrain wherever possible or opt for low-risk options (77.1%). In contrast, respondents who always wore an airbag reported markedly higher risk tolerance, with 40.9% accepting moderate to very high levels of risk. This pattern suggests the possession of rescue equipment may contribute to a risk compensation effect, whereby individuals adjust their behaviour in response to perceived improvements in safety. While avalanche airbags are highly effective in reducing the likelihood of complete burial, studies have shown that, when equipped with airbags, thrill-seeking backcountry users exhibit elevated risk-taking (Haegeli, Rupf & Karlen, 2019). Survey respondents support this interpretation, with 65% agreeing/strongly agreeing that modern avalanche rescue technology make people more willing to take risks (Appendix-9).

A key conceptual problem identified across interviews is the language used to describe this equipment. Items such as transceivers, shovels and probes[5] are widely marketed and thus perceived – including in academic literature (e.g. Greene, Hendrikx & Johnson, 2022; Nichols *et al*., 2018; Pearlly *et al*., 2015; Van Tilburg, 2012, 2021) – as "safety equipment" despite their function being strictly limited to post-burial SAR.

Figure 17. Interview participants discussing the misconceptions of what constitutes as "safety" equipment.

'If you are in a car and you wear a seatbelt, will you have an accident because you did/did not wear a seatbelt? It's the same with avalanche rescue gear' – ***Guide 1***

"Your only safety tool is your brain" – ***Dom***

The above quotes highlight these technologies do not *prevent* avalanches. This framing, which conflates prevention with rescue, fosters a false sense of security, potentially increasing willingness to enter hazardous terrain. The practical consequences of this mischaracterisation are reflected in survey data. While almost all respondents own or rent a transceiver (93%), shovel (93%) and probe (89%) (Appendix-10) almost half the respondents (41%) report a lack of confidence in using rescue equipment effectively (Appendix-11). While 59% noted being confident/very confident, the gap between ownership (or rent) and operational competence is significant: high equipment ownership does not imply rescue readiness. This reinforces the argument that "safety" and "rescue" are not interchangeable,

[5] TSP (transceiver, shovel and probe) are essential, non-negotiables when it comes to avalanche equipment used to locate and extract buried individuals.

and that over-reliance on equipment may obscure the primary objective of avalanche risk management: considerate decision-making that avoids the need for rescue in the first place.

Overall, these results highlight the complexities associated with avalanche risk perception. Although the avalanche bulletin provides a consistent and scientifically grounded hazard assessment, its interpretation remains mediated by human behaviour, complacency and perceived enhanced safety. Consequently, improving avalanche safety depends on strengthening education and communication strategies that address how individuals interpret and act upon risk information in avalanche terrain.

4.2.5 Avalanche Education: Is Knowledge Alone Sufficient?

The purpose of avalanche education courses is not to discourage backcountry use, but to develop informed decision-making under appropriate conditions (Greene, Hendrikx & Johnson, 2022). Avalanche decision-making frameworks generally fall into two categories: analytical approaches, which require the systematic assessment and weighing of contributory risk factors to avalanche formation, and probabilistic approaches, which relies on basic rules-of-thumb, notably slope angle and the avalanche danger scale, to predict the likelihood of avalanche occurrence (Schweizer, Mitterer & Reuter, 2024). While analytical approaches were traditionally thought to be reserved for "experts" (Atkins & McCammon, 2004), recent qualitative research (e.g. Landrø, Engeset & Pfuhl, 2022) suggests that amateur recreationists can recognise key avalanche risk factors similarly to experts, yet the ability to apply a taught decision-making framework with sufficient precision and consistency improves with formal training and accumulated experience (Balent *et al*., 2018; Landrø, Engeset & Pfuhl, 2022).

The survey results support this, showing statistically significant differences between formally trained (58%) and untrained (42%) respondents across safety-oriented behaviours, contributing to Nichols *et al*.'s (2018) findings which revealed a positive correlation between formal avalanche education and the adoption of safety-oriented behaviours. A highly significant relationship was identified between participants who had completed a formal avalanche safety course and the frequency of practising avalanche rescue skills (p=1.23e^{-11}, Appendix-12). Among trained participants, 57.5% reported practising rescue skills at least once per year, while 63.2% of untrained individuals reported never practising at all. A similarly significant relationship exists regarding respondents' self-reported confidence in the use of rescue equipment (p=1.31e^{-11}, Appendix-13), with 77.6% of trained participants reporting confidence/high confidence, compared to just 28.6% of those without training. Remarkably, 71.4% of untrained respondents reported no/low confidence – a striking gap given that equipment ownership (or rent) is near-universal across both groups.

Avalanche education allows individuals to acquire knowledge that may lead to improvements in risk perception, increased confidence and safer decision-making (Greene, Hendrikx & Johnson, 2022). However, interview participants and existing literature converge on the view that knowledge alone is insufficient, particularly in a wicked learning environment, where the absence of corrective feedback reduces individuals' ability to learn effectively from experience (Hogarth, Lejarraga & Soyer, 2015). Notably, 54% of respondents who had experienced a "near-miss" related to avalanches reported becoming more cautious in avalanche-prone terrain thereafter (Appendix-14), suggesting that direct negative feedback, rare as it is in a wicked learning environment, remains among the most effective catalysts for behavioural change according to guides.

Figure 18. Interview participant discussing importance of knowledge application.

'The only thing more important than knowledge is the ability to apply the knowledge itself' – ***Rob***

The above quote is consistent with Kolb's (1984) theory of experiential learning, where knowledge is built through the interaction of experience, perception, cognition and behaviour. In avalanche contexts, this is often derived from repeated exposure to varied conditions and continuous reflection on decision-making processes. Repeated practise thus emerges as a critical factor in bridging this gap. While transceiver use, for example, is relatively straightforward, interviewees stressed that time-critical, physically strenuous skills such as strategic shovelling are rarely practised to a sufficient standard, despite shovelling efficiency being directly linked to survival probability through reduced extrication time (Van Tilburg *et al*., 2023). Survey data supports this concern (Fig.19).

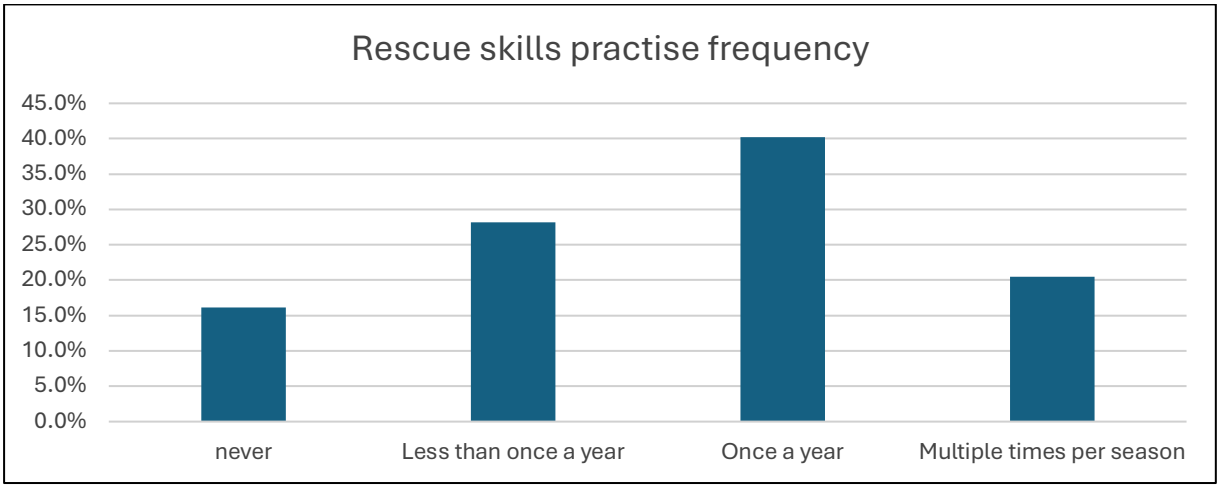

Figure 19. Frequency of Rescue Skills Practise among Survey Participants

Graph demonstrating how often participants who engage in off-piste/backcountry activities living in mountain regions over the winter season practise avalanche rescue skills. Recreational participants (i.e. respondents who best described their role in the mountains as being on holiday) were omitted from these results.

Figure 19 demonstrates that while 40.2% of participants living in mountainous regions over the course of the winter practise avalanche rescue skills once a year, a concerning proportion (44.3%) either never practise or practise skills less than once a year. Effective avalanche response requires regular, repeated practise, ideally multiple times per season, yet this is only embedded in the behaviour of 20.5% of respondents.

Avalanche education thus plays a vital role in developing competence and confidence when supported by ongoing practice and experiential learning. Possessing knowledge or equipment without the ability to deploy either under high-consequence conditions represents a critical gap in avalanche safety.

4.2.6. The Role of Heuristics

Introduced by Ian McCammon (2002), avalanche heuristics are simplified decision-making strategies that allow individuals to make rapid decisions under conditions of uncertainty which form a key component in avalanche education curricula (Furman, Shooter & Schumann, 2010; Isaak 2016). While intuition-based decision-making can be efficient due to the automatisation of decisions, reducing cognitive burden (Gigerenzer, 2007; Simon, 1990; Dane & Pratt, 2007), in avalanche terrain, where decisions are loaded, complex and time-pressured, such shortcuts frequently produce systematic biases, leading to heuristic "traps", that increase exposure to avalanche hazard (McCammon, 2002). McCammon's (2002) six heuristic traps (FACETS) empirically linked to avalanche accidents were investigated in the survey. Familiarity and expert halo emerged as the most influential, followed by scarcity and consistency. Social facilitation and acceptance exerted comparatively little self-reported influence (Fig.20).

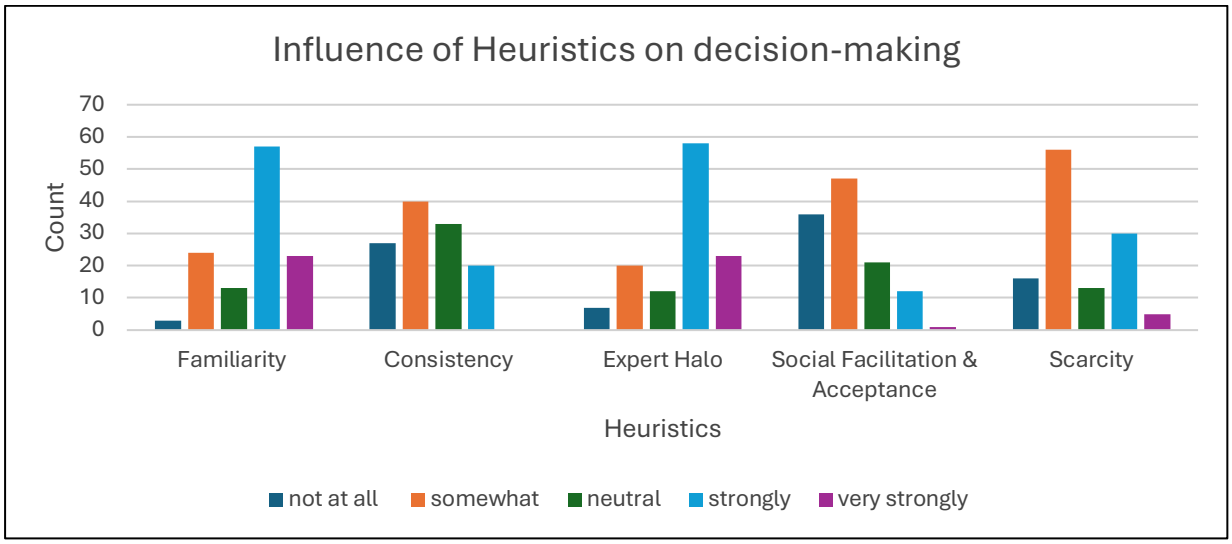

Figure 20. Influence of Heuristics on Decision-Making among Survey Participants

Survey results demonstrating how strongly each heuristic influences respondents' decision-making to recreate on a slope in avalanche-prone terrain. Social facilitation and acceptance were considered as one field in this survey.

Familiarity

> *'The familiarity heuristic relies on our past actions to guide our behaviour in familiar settings'* (McCammon, 2004:3).

Over half the respondents (54%) described themselves as being familiar or very familiar with the uncontrolled terrain they typically recreate in (Appendix-15), with 66% reporting that familiarity strongly or very strongly influences their willingness to recreate on a given slope (Appendix-16). This supports McCammon's (2002) finding that 69% of US avalanche incidents occurred on familiar terrain, with the tendency among recreationists to think: what is the need for going through the same time-consuming risk assessment only to arrive at what is usually the same conclusion?

Figure 21. Interview participant grouping familiarity with complacency.

'Nothing happens <u>most</u> of the time' – ***Rob***

As the above quote illustrates, repeated travel without incident creates deceptive reinforcement of "safe" outcomes – a direct function of the wicked learning environment (Hogarth, Lejarraga & Soyer, 2015) – where the perceived redundancy of systematic risk assessment increases with familiarity, and initial caution diminishes as exposure to a slope accumulates.

Expert Halo

The expert halo heuristic, evident in group decision-making dynamics, refers to the deference of one's judgement to

> *'An informal leader who, for various reasons, ends up making critical decisions for the party'* (McCammon, 2004:4).

Leadership may be based on knowledge and experience or simply being older, a technically better freerider, or a more assertive individual. 67% of survey respondents strongly/very strongly associated the presence of a leader with their likelihood of recreating in avalanche terrain (Appendix-17), supporting McCammon's (2002) finding that accidents were more likely when groups abdicated judgement to a leader. This is particularly concerning given 35% of respondents reported group members without avalanche training, with a further 13% unsure of their group's competency (Appendix-18). Figure 22 portrays the relationship between decision-making role and self-reported confidence, for which a statistically significant relationship exists (p=0.002, Appendix-19): those who led decisions reported substantially higher confidence, while those deferring to others reported lower confidence. Interview results and literature outline a common problem with this: cohesive groups tend

to make decisions without critically vetting them, therefore abdication of power by followers is often based on the perceived competency of the leader, as opposed to their directive leadership style and knowledge of avalanche safety (Furman, Shooter & Schumann, 2010).

Guides additionally noted that hiring a professional guide is frequently perceived as a transfer of responsibility rather than a supplement to individual judgement. Concern was also raised regarding the sufficiency of avalanche training for French ski instructors, who are currently required to complete only two weeks of avalanche training before being authorised to take clients off-piste – a threshold that may cultivate misplaced trust in perceived expertise (McCammon, 2002).

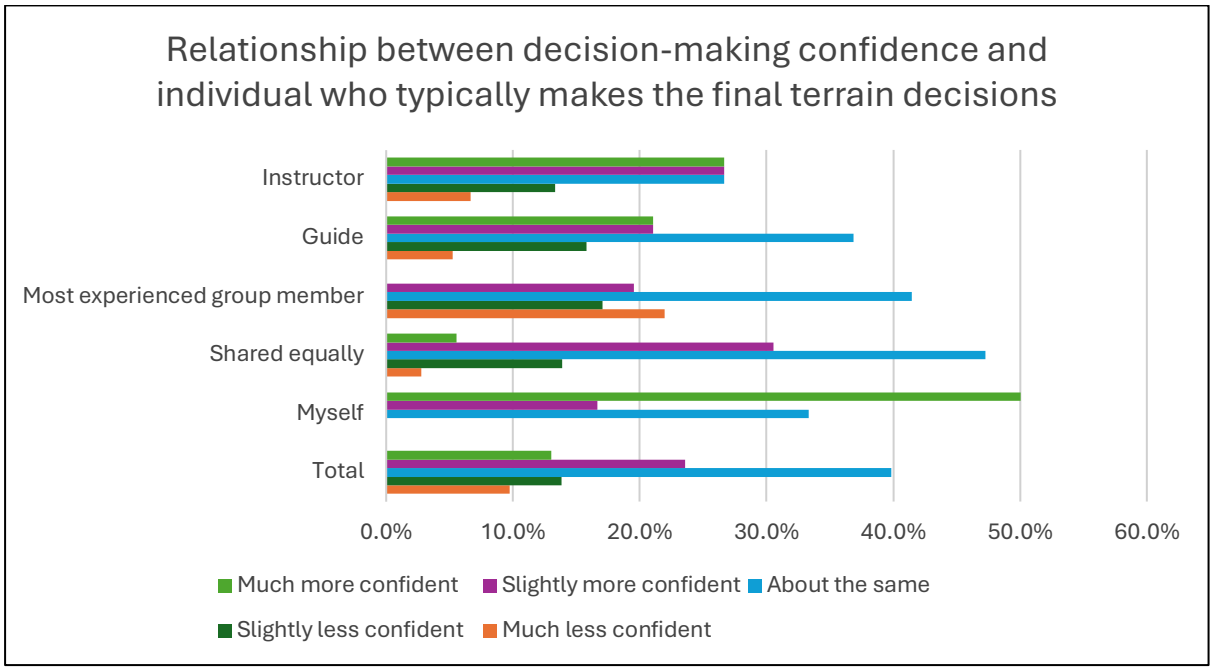

Figure 22. Self-Reported Decision-Making Confidence vs. Individual Who Makes Group Decisions among Survey Participants

Survey participants were asked to describe their confidence in decision-making compared to other group members and to declare who usually leads decision-making for the group. Guides and Instructors were specifically asked to select 'Guide' or 'Instructor' if they wanted to refer to themselves.

Scarcity

> *'The tendency to value resources or opportunities in proportion to the chance you may lose them, especially to a competitor'* (Cialdini, 2001, in McCammon, 2004:6)

Survey results indicate that the allure of fresh tracks somewhat influenced 47% of respondents and strongly influenced a further 25% (Appendix-20), consistent with reward-seeking behaviour described by Furman, Shooter & Schumann (2010). Interview insights supported this, linking scarcity closely to

social facilitation – the observation of others on a slope, signalling both opportunity and competition – and the intrinsic value placed on "fresh tracks".

Consistency

> *'Once we have made an initial decision about something, subsequent decisions are much easier if we simply maintain consistency with that first decision'* (McCammon, 2004:3)

34% of respondents reported that commitment to a planned objective, somewhat influenced their decision-making, with a further 17% reporting strong influences (Appendix-21). While interviewees acknowledged the psychological difficulty of abandoning a goal, they also emphasised the importance of reframing the abandonment or adaptation of original plans as a "victory" rather than failure – a cognitive strategy consistent with behavioural theory, where strong prior intentions can override updated risk assessments and increase hazard exposure (Furman, Shooter & Schumann, 2010).

Social Facilitation and Acceptance

> *'Social facilitation is a decisional heuristic where the presence of other people enhances or attenuates risk-taking by a subject, depending on the subject's confidence in their risk-taking skills'* (McCammon, 2004:5).

> *'The acceptance heuristic is the tendency to engage in activities that we think will get us noticed by or accepted by people we like or respect, or by people we want to like or respect us'* (McCammon, 2004:4).

While McCammon's (2004) study revealed gender played a role (essentially, men wanting to impress women), subsequent studies (e.g. Furman, Shooter & Schumann, 2010) reveal the acceptance heuristic applies regardless of gender. As such, my study focused solely on the willingness of risk-taking in the presence of others, combining these two heuristics. Survey results reveal only 12% of respondents felt group pressure strongly influenced their decisions in avalanche terrain, with 30% reporting no influence whatsoever (Appendix-22). These self-reported figures are notably low relative to both interview data and existing literature, with experts like Tremper (2008) characterising social facilitation as one of the primary drivers of avalanche incidents. This discrepancy may reflect limited self-awareness of social influence, itself consistent with heuristic-driven cognition, where individuals are often unable to identify these biases shaping their decisions.

Figure 23. Interview participant describing influence of social facilitation and acceptance heuristics in Chamonix.

'To be accepted, you need to do something difficult or crazy which is a big thing between 15-30-year-olds' – ***Federico***

The above quote highlights the cultural dimensions of risk-taking, especially in locations such as Chamonix. Here, the pursuit of status and peer recognition actively encourages entry into more hazardous terrain – reinforcing the argument that social influence operates below the threshold of conscious awareness.

4.2.7. Social Media: An Emerging Heuristic Trap?

When McCammon first introduced his findings on heuristic traps in 2002, Facebook was more than two years from its initial launch, however, social media has emerged as a significant amplifier of the acceptance and social facilitation heuristics, extending their effects beyond immediate group dynamics into a broader, virtual social environment (Tremper, 2008; Isaak, 2016). While 67% of survey respondents reported that social media does not influence their terrain choices (Appendix-23), 34% identified it as a primary motivation for carrying a camera in off-piste/backcountry terrain (Appendix-24). However, interview data suggests this to be a discrepancy, likely reflecting the same disconnect between perceived and actual behavioural influence, perhaps due to the online nature of the survey which captured hypothetical rather than real-time decision-making in avalanche terrain, a limitation in this research.

Figure 24. Interview participant noting how the presence of cameras alters behaviour.

'If you get a camera stuck in front of you, you're going to do things that you may not have done without that camera being in front of you' – ***Rob***

The above quote suggests individuals may be unaware of this supposed "enhanced" risk-taking, in which individuals risk their physical well-being to maintain social identity (Beames & Pike, 2008). Guides consistently observed the presence of cameras altering behaviour. In fact, on Level 4-High days, a significant proportion of individuals were observed in uncontrolled terrain using helmet cameras, prioritising "the best shot" over safe decision-making. This aligns with Isaak's (2016) concept of 'invisible pressure', where social media expands one's audience from a physically nearby group (McCammon, 2004) to a virtual global platform accessible from a portable smartphone. What was once a desire to impress surrounding peers now extends to maintaining an online identity – what Tremper

(2008) terms *Kodak Courage*, amplified in the digital age, reinforcing risk-taking behaviours. Although statistical analysis did not show a significant relationship between age and social media influence, younger participants (18-24) were more likely to acknowledge its impact (Appendix-25), supporting the idea that this generation of "digital natives" may be more susceptible (Isaak, 2016). Despite this, the presence of social media motivations across all adult age groups (excluding 65+) suggests this may not be an exclusively youth-driven phenomenon. Rather, it reflects a broader cultural shift in which documentation and performance have been embedded in backcountry recreation.

Importantly, as Tremper (2013) notes, social media is not solely negative. Interviewees highlighted its positive role in real-time information sharing, particularly via WhatsApp networks among guides exchanging field observations, and its potential to raise avalanche awareness through exposure to avalanche incident footage. Nevertheless, its integration into decision-making contexts warrants greater attention in both research and avalanche education curricula as a contemporary extension of established heuristic traps.

4.2.8. No Singular Heuristic Takes Precedent

A consistent theme across interviews was that no single heuristic operates in isolation. Avalanche incidents typically result from a culmination of "mistakes", where multiple heuristics interact simultaneously. For example, a familiar slope (familiarity) with existing fresh tracks (social facilitation/scarcity), approached with a confident leader (expert halo) toward a pre-set objective (consistency), creates a compounding effect that significantly elevates risk exposure. This reinforces the need to view heuristic decision-making as a dynamic, multi-factor process rather than a series of discrete influence. The notion that no singular heuristic takes precedent, but rather that risk emerges from their interaction, speaks to the broader theoretical debate in avalanche research between heuristics as cognitive liability and heuristics as adaptive competence. The compounding, self-reinforcing nature of the traps investigated in this study aligns more closely with the former, suggesting that in high-consequence terrain, the very mental shortcuts that ordinarily support efficient decision-making become vectors for systematic error.

5. Conclusion

Every winter, off-piste/backcountry recreationists are exposed to terrain where snowpack instability and human decision-making collide. That collision is rarely random. The 1,163 avalanche fatalities recorded in the French Alps between 1980 and 2023 are not simply the product of an unforgiving physical environment; they are, overwhelmingly, the product of human behaviour. This dissertation set out to understand why, and to do so within a geographical context that existing scholarship left largely unexplored.

Two objectives drove the inquiry. The first was to determine the spatiotemporal patterns in avalanche fatalities across the French Alps between 1980 and 2023. The second was to examine how risk perception, avalanche education and heuristic decision-making interact with avalanche hazard in uncontrolled terrain. To address both, the study employed a mixed-methods approach, integrating 43 years of ANENA archival data, an online survey of 156 recreational off-piste/backcountry users, and five semi-structured expert interviews with guides and avalanche education professionals based primarily in the French Alps.

What emerges from the evidence is a picture of systematic, predictable failure. Spatially, avalanche fatalities are not randomly distributed: 94.3% occurred in uncontrolled terrain, 95.4% involved recreational activities, and Chamonix alone accounted for 14% of all deaths over this period – a spatial concentration explained by the convergence of extreme freeride culture, optimal avalanche slope angles, and unrestricted lift-accessible exposure to avalanche-prone terrain. Temporally, a striking shift is underway: while off-piste fatalities have gradually declined since 2006, randonnée-related deaths have shown no equivalent reduction, rising to dominate recreational fatalities from 2014 onwards. The evidence indicates that avalanche education has not kept pace with the rapid and COVID-accelerated growth of self-propelled backcountry activity, particularly among less experienced users transitioning from resort-to-backcountry environments.

The human factors findings are where this study's conceptual contribution becomes most explicit. Kahneman & Tversky's (1979) Prospect Theory anticipates that individuals anchor risk assessments to prior experience rather than objective conditions, and this study finds precisely that dynamic operating in the French Alps: 54% of fatalities occurred at Level 3-Considerable, a danger level routinely misinterpreted as "average" due to its position in the middle of a five-point scale and to histories of uneventful exposure. Equipment compounds rather than corrects this problem: the conflation of rescue equipment with "safety equipment" fosters risk compensation, with those consistently wearing avalanche airbags demonstrating greater willingness to accept elevated risk exposure. This is the precise wicked learning environment that Hogarth, Lejarraga & Soyer (2015) describe: survival is

systematically misread as validation, foreclosing the corrective feedback that accurate risk calibration requires. This study extends and geographically relocates McCammon's (2002, 2004) FACETS framework. Familiarity and expert halo emerged as the dominant heuristic influences among survey respondents, largely consistent with McCammon's North American findings, yet the French Alpine context introduces a structural dimension absent from that literature: the institutional ambiguity of terrain boundaries means the cognitive triggers that might prompt risk-awareness in a clearly demarcated North American resort are largely absent here, making heuristic susceptibility more, not less, likely. Social media, meanwhile, represents a growing extension of the acceptance and social facilitation heuristics that McCammon could not have anticipated in 2002, amplifying Tremper's (2008) concept of *Kodak Courage* from an immediate group dynamic into a digitally global performance pressure.

The education findings complicate rather than confirm the optimistic strand of the SIP literature. While formal training correlates significantly with safety-oriented behaviours such as rescue skills practice and resultant equipment-use confidence, it does not resolve the core problem: knowledge and its application in real terrain, under social and emotional pressure, remain demonstrably disconnected. This supports Gigerenzer's (2007) contention that heuristic reasoning is not simply error, it is the default cognitive mode under time pressure, implying that interventions targeting knowledge acquisition alone are structurally insufficient. Heuristic decision-making in avalanche terrain may therefore be better understood as cognitive liability rather than adaptive competence when decisions compound under pressure. What the evidence indicates is that effective avalanche education must engage with *how* decisions are made, not only *what* information is available.

Limitations remain. Survey responses captured hypothetical rather than real-time behaviour, likely underestimating the emotional and social pressures operating in the field; archival data ends in 2022-23, leaving recent seasons unexamined; and the interview sample, while expert, is small. Based on the study's limitations and findings, future research could pursue longitudinal tracking of randonnée users across experience levels, examine whether the institutional differences between North American and European terrain access produce measurable differences in heuristic susceptibility, and investigate whether decision-focused rather than knowledge-focused education programmes produce more durable behavioural change.

Avalanche fatalities in uncontrolled terrain persist not because recreationists lack information, but because of the architecture of human cognition – under pressure, in familiar terrain, within social groups, and increasingly before a global online audience – conspires against the application of what they know. Addressing this requires more than just targeted avalanche education, it demands a deeper reckoning with why people decide as they do when the stakes are highest, and the European Alps,

with its unique cultural, institutional, and geographic character, offer terrain for that reckoning that scholarship has only just begun to map.

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Appendices

Appendix 1: *Freeride Republic* Article for Survey Distribution

Article link:
freeride-republic.com/learn-article/avalanche-deaths-arent-just-about-snow/

(Full article on pages 61-62)

AVALANCHE DEATHS AREN'T JUST ABOUT SNOW

University of St Andrews

School of Geography & Sustainable Development

Academic Research on Avalanche Risk

Avalanche Deaths Aren't Just About Snow – **They're About Us**

France, Spain, Italy, Andorra, Austria, Slovakia, Slovenia. 10 avalanche deaths across these seven Alpine countries already in the 25/26 season.

This article forms part of ongoing academic research at the University of St Andrews examining both the human and physical factors behind avalanche risk and decision-making in the European Alps.

Every winter, the same question gets asked: *What was the snowpack doing?* But maybe it's time we start asking a harder one: **what were we doing?**

Despite decades of progress in forecasting, equipment and mitigation, avalanche fatalities continue to occur, particularly in uncontrolled, unpatrolled backcountry terrain. Recent research shows that while deaths in settlements and transport corridors have dropped dramatically, up to 97% of avalanche fatalities now occur in the backcountry. Not because the mountains are new but because *our relationship with them has changed.*

Avalanche Deaths Aren't Just About Snow – They're About Us

More Access. Same Mistakes.

Backcountry skiing, splitboarding, freeride touring – access has never been easier. Lifts go higher, gear gets lighter, information travels faster. Yet the patterns behind avalanche incidents remain stubbornly familiar.

Why? Because avalanches are not just physical events. They are **human events.**

Research increasingly points to **human factors** as the primary driver behind avalanche fatalities: heuristic traps, hornlhorby, social pressure, goal fixation, and the quiet confidence that creeps in when terrain looks safe – or did it just feel safe last time?

Tracks don't mean stability. Blue skies don't mean safety. Experience doesn't mean immunity. And yet, avalanche education still leans heavily toward snow science, terrain traps, and weather cues – essential tools, yes – but often at the expense of the behavioural patterns that lead us into trouble.

A Changing Risk Landscape

Climate variability adds another layer of complexity. Warmer temperatures, shifting precipitation patterns, and lower snow data at lower elevations are reshaping avalanche conditions across the Alps. Snowpacks are becoming more variable, less predictable, and harder to "read" using old rules.

At the same time, more people are heading into the backcountry, often with mixed experience levels, strong visual influences from social media, and growing confidence in technology.

The result? **New risk profiles but old decision-making habits.**

JOURNEY LEVEL: ALL

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HOW TO PERFORM A BASIC FREERIDE RISK ASSESSMENT

Why This Research Matters, Now

Avalanche fatalities are declining overall, but we still don't fully understand why nor do we understand the year-on-year variability regarding these statistics. That makes this moment critical. There is a narrow window to learn what's working, what isn't, and how education, communication, and self-assessment need to evolve.

Understanding how people perceive risk, how they make decisions in familiar terrain, and how group dynamics influence behaviour could help reduce preventable deaths, not through fear, but through better awareness.

Add Your Voice

If you recreate in avalanche terrain – whether you ski, snowboard, tour or guide – your experience matters.

This anonymous survey supports academic research at the University of St Andrews into the human factors behind avalanche risk in the European Alps. It takes just a few minutes and contributes to improving how we talk about, teach, and manage risk in the mountains.

Take The Survey Here

Because the next step in avalanche safety isn't just understanding the snow. It's understanding ourselves.

Appendix 2: Email Reaching out to Interview Participants

The below message is an example of an email sent to *La Compagnie des Guides de Chamonix* requesting interview participants.

Hello!
My name is Ani, and I am a student at the University of St Andrews in Scotland. I am currently working on my undergraduate dissertation, which focuses on avalanche risk in the Alps. My working title is:

Avalanche Risk in the French Alps: Exploring the Spatial Shift in Fatalities and the Impact of Human Behaviour.

I would be very interested in interviewing one of your guides to gain insights into how they manage risk in the field and the challenges they may encounter when working with clients. As Chamonix is the commune with the highest number of avalanche-related fatalities in the French Alps, I was keen to reach out to you in the hope of gaining a local perspective on avalanche risk and the behaviours of backcountry users in the Chamonix area.

If any of your guides are open to participating, I will send over a brief consent form for them to review and complete. This ensures I have your permission to include insights from our conversation in my dissertation and confirms your comfort with discussing avalanche-related topics. I can also send over a draft of questions for you to look over to get an idea of what I will ask in the interview.

I have a participant information sheet outlining the purpose of the study and how contributions will be used as an interview participant, however I am unable to attach it to this request form. If this is of interest, please let me know and I will send over the relevant documents. I am happy to answer any questions you may have.

Many thanks in advance,
Ani

Appendix 3: Ethical Approval

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School of Geography and Sustainable Development Ethics Committee

4 November 2025

Dear Anastasia Wong

Thank you for submitting an Ethics Application Form application for review by the Geography and Sustainable Development ethics committee. The committee reviewed this application and accompanying documents on 4 November 2025. The outcome of this review is given below:

Project Title Avalanche Risk in the Alps: Exploring the Spatial Shift in Fatalities, Human Behaviour, and the Influence of Climate.
Researcher(s) Anastasia Wong
Supervisor(s)
Application Ref 0845 - GSD-0845-1166-2025
Decision Date 4 November 2025 **Decision Expiry Date** 4 November 2030
Review Outcome Favourable opinion
Specific Conditions *(optional)* None
Ethics committee comments *(optional)*

The following supporting documents are acknowledged:

Document Type	File Name	Date	Version
PIS Document	participant-information-sheet	03/11/2025	3.0
Participant Consent Document	consent form_surveys	31/10/2025	2.0
Participant Consent Document	consent form_interviews	03/11/2025	5.0

Favourable opinions

A favourable opinion is conditional upon any conditions set by the committee, if any, as described in the 'Specific conditions' section above.

A favourable opinion is valid for 5 years from the decision date, see the expiry date above.

If you wish for this opinion to apply to any subsequent changes made to the project, you must first submit an amendment request to the ethics committee, using the University's ethics amendment application form. Changes made to the research without the submission of such a request will invalidate this favourable opinion.

Ethics opinions must be renewed every 5 years by submission of a new application. If only a short extension is required, for example to finish writing up, you can request a discretionary extension of up to 6 months from the ethics committee.

You must report any serious adverse events, or significant changes not covered by this approval, related to this study immediately to the ethics committee.

A favourable opinion is given on the condition that:

- you abide by any specific conditions set by the ethics committee
- you conduct your research in line with:
  - the details provided in your ethical application.
  - relevant University policies and procedures, including the Principles of Good Research Conduct.
  - the conditions of any funding associated with your work.
  - any local legal or ethical requirements.
- all applicable approvals, permissions, or documents are obtained before research commences.

A favourable opinion by a University ethics committee does not confer any kind of approval for the research, be it governance, legal or otherwise. However, a favourable opinion is necessary for the research to proceed.

You should retain this approval letter with your study paperwork and ensure you insert a copy into the back of your dissertation before submission.

Yours sincerely,

Geography and Sustainable Development

Appendix 4: Qualtrics Survey Questions

The Qualtrics Survey on Avalanche Safety and Decision-Making in the Mountains included participant information, informed consent and consent tick box sections which participants were asked to read and consent to before taking part in the survey. Every question was multiple choice except question 33 which was open-ended (marked with *). Insights from the open-ended question was not included in the results/discussion section, instead prioritising quantitative numerical trends and statistical significance though close-ended questions.

SURVEY QUESTIONS
(A) Background Information
1. What is your age group?
2. Where do you most often take part in winter mountain activities? (Select all that apply)
3. Which winter mountain activities do you take part in? (Select all that apply)
4. Which best describes your role in the mountains?
5. Approximately how many weeks of winter mountain experience do you have in total?
(B) Terrain Use
6. Do you take part in off-piste or backcountry recreation? (If **No**, please skip to end of survey)
7. Which of the following unpatrolled terrain types do you recreate in? (terrain not controlled for avalanches) (Select all that apply)
8. How familiar are you with the off-piste terrain you usually recreate in?
(C) Training, Equipment and Preparedness
9. Have you completed a formal avalanche safety training course?
10. How often do you practise avalanche rescue skills (e.g. use of transceiver, probe, shovel)?
11. Which of the following avalanche rescue items do you own or rent? (Select all that apply)
12. How confident are you in using your avalanche rescue equipment?
(D) Group Behaviour and Decision-Making
13. What is your typical group size in avalanche terrain?
14. Is everyone in your group trained in avalanche rescue?
15. Who usually makes the final decision about terrain choice in your group? (If you are a guide/instructor wanting to refer to yourself, please select 'Guide' or 'Instructor')
16. Have you ever felt uncomfortable questioning a decision made by a more experienced group member?
(E) Risk Perception
17. How would you typically describe your approach to managing risk in avalanche-prone terrain?
18. Compared to others in your group, how confident are you in your avalanche decision-making?
(F) Information and Technology Use
19. Do you consult the avalanche bulletin/report before entering avalanche-prone terrain?
20. Which source do you rely on most when making decisions in avalanche terrain?
21. Do you wear an avalanche airbag when recreating in avalanche-prone terrain?
22. Do you think modern avalanche rescue equipment and technology make people more willing to take risks?
(G) Technology and Social Media
23. When recreating in avalanche-prone terrain, how often do you carry or use a camera? (including phone, GoPro, drone, or similar)
24. What are your primary reasons for filming or taking photos while recreating in avalanche-prone terrain? (Select all that apply)
25. How much does social media content (e.g. videos, photos, posts) influence your choice of terrain or objectives in avalanche-prone areas?
(H) Decision Influences

26. How strongly does seeing fresh tracks on the slope influence your decision to ski or travel on a slope?
27. How strongly does being familiar with the terrain influence your decision to ski or travel on a slope?
28. How strongly does wanting to stick to a planned objective influence your decision to ski or travel on a slope?
29. How strongly does presence of a guide or experiences leader influence your decision to ski or travel on a slope?
30. How strongly does pressure from the rest of the group influence your decision to ski or travel on a slope?
(I) Experience and Final Reflection
31. Have you ever experienced a near-miss related to avalanches?
32. If you answered yes to the previous question, how did this affect your behaviour?
*33. In your own words, what do you think most commonly leads people to make unsafe decisions in avalanche terrain?

Appendix 5: Semi-Structured Interview Questions

DOMINIQUE PERRET
(A) Human Factors in Avalanche Decision-Making
1. Walk me through your risk assessment when committing to a slope? What are the things you look at before setting out to access a particular slope? What do you assess when you are actually there?
2. Have you ever reached a slope or objective having made appropriate risk assessment then decided it would be a better idea to turn around? And if so, why?
3. In your opinion, what are the biggest human factors contributing to avalanches? Are these heuristic traps? You know many freeriders and backcountry skiers, do they fall into these traps?
(B) Education, Communication and Behaviour
4. When it came to teaching others, you mentioned you needed specialists like doctors and snow scientists to validate it – could you elaborate on this? Is this in reference to teaching others about avalanche safety? General mountain safety? Was this because you were not certain your methods for risk assessment were completely reliable?
5. In your interview with Mathieu Ros Medina, you mention you have 'made your peace with death'. How, if at all, does this influence your decision-making when approaching freeride terrain?
6. Could you tell me a little bit about the Mountaineering Human Factor tool that you developed? What sort of things does the self-assessment include? Would you say this has had any success thus far? How do you see its application in the future of freeride risk assessment?
(C) Risk Culture in Backcountry Recreation
7. You offer a fresh perspective on avalanche assessment, stating in a quote that 'avalanche bulletins are nets meant to catch whales while we skiers are shrimp', indicating individual skiers are merely an afterthought regarding avalanche safety. In what ways would you suggest improvement of avalanche bulletins and safety at the individual level?

CHAMONIX GUIDES
(A) Human Factors in Avalanche Decision-Making
1. Can you briefly describe your background as a mountain guide in Chamonix and the type of terrain and clients you most often work with?
2. How has your understanding of avalanche risk evolved over the course of your guiding career?
3. In your experience, what are the most common ways people *misjudge* avalanche risk in the Chamonix area?
4. Are there particular heuristics or "mental shortcuts" you see clients rely on when assessing safety (for example, familiarity with terrain, previous tracks, or confidence in weather)?

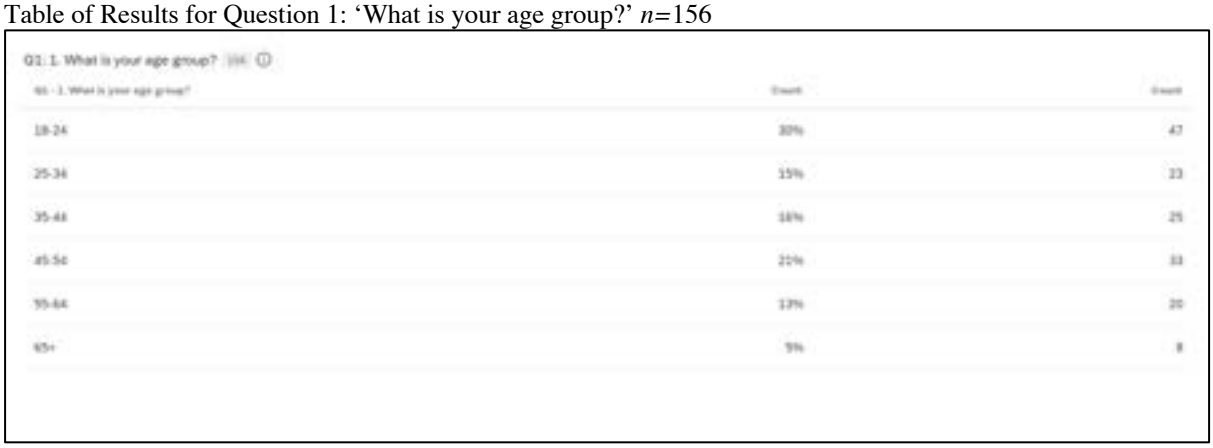
5. How often do you encounter the belief that ‘nothing happened last time, so it’s safe today’, and how do you manage that mindset?
6. What is the most common type of client that you encounter – i.e. are they on holiday and want to experience the backcountry for the first time? Are they avalanche-trained?
7. How do group dynamics, e.g. peer pressure and expectations affect decision-making in avalanche terrain?
8. Have you noticed differences in risk awareness between locals, seasonnaires, and visiting skiers or snowboarders? If so, what are they?
9. How do you personally assess and manage avalanche risk on a guiding day? i.e. what checks do you carry out in preparation for a day spent in avalanche-prone terrain?
10. Have you ever had to change or abandon a plan due primarily to human factors (e.g. too tired, not enough energy) rather than snow or weather conditions?
11. Can you recall a situation where a small human decision or oversight could have led to serious consequences?
(B) Education, Communication and Behaviour
12. How do you communicate risk to clients who may have very different levels of experience or risk tolerance?
13. What methods do you find most effective for encouraging clients to respect avalanche risk without causing fear or resistance?
14. In your view, what aspects of avalanche education are currently well addressed and what aspects are still lacking?
(C) Risk Culture in Backcountry Recreation
15. Why do you think Chamonix has such a high number of avalanche-related fatalities compared to other areas in the French Alps?
16. How do accessibility, lift systems, and steep terrain influence risk-taking behaviour here?
17. Do you think the culture of extreme skiing and mountaineering in Chamonix affects how people perceive acceptable risk?
18. Have you observed changes in avalanche patterns, snowpack stability, or user behaviour in recent years?
19. Looking ahead, what do you think needs to change (e.g. culturally or educationally) to reduce avalanche incidents in the Alps without removing our freedom in using the backcountry?
20. Do you think there is a chance that continued irresponsible use of the backcountry/off-piste skiing could lead to laws against backcountry-usage?
21. If there was one key message about avalanche risk and human behaviour you wish more backcountry users understood, what would it be?

ROB STEWART
(A) Human Factors in Avalanche Decision-Making
1. In your opinion, what are the most common psychological or behavioural factors that lead people to underestimate avalanche risk?
2. How do you think social dynamics – such as group pressure, leadership roles, or desire for achievement – influence avalanche decision-making in the backcountry?
3. Many avalanche accidents occur even when people have training. Why do you think there is often a gap between knowledge and real-world decision-making?
(B) Education, Communication and Behaviour
4. From your experience working with Henry’s Avalanche Talk and avalanche education more broadly, what do you see as the biggest challenges in helping recreational mountain users understand avalanche risk?
5. How do you think avalanche education has changed over the last decade, particularly with the growth of backcountry recreation and ski touring?
6. Based on your experience with avalanche talks and educational outreach, what communication strategies seem most effective in changing behaviour rather than just increasing knowledge?

7. Looking ahead, what improvements or innovations do you think are needed in avalanche education to better reduce accidents, particularly among newer backcountry users?
(C) Risk Culture in Off-Piste and Backcountry Recreation
8. Do you think experience in the mountains always leads to safer decision-making, or can it sometimes increase risk-taking? Why?
9. To what extent do you think social media and online mountain culture are influencing how people perceive avalanche risk or acceptable levels of danger?

Appendix 6: Survey Demographics

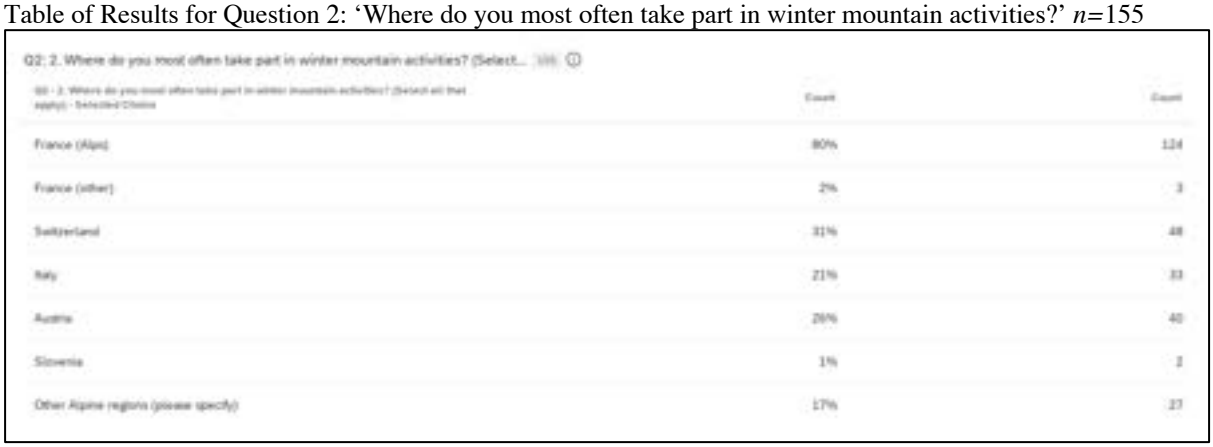
Table of Results for Question 1: 'What is your age group?' *n*=156



Q1: 1. What is your age group?

18-24	30%	47
25-34	15%	23
35-44	16%	25
45-54	21%	33
55-64	13%	20
65+	5%	8

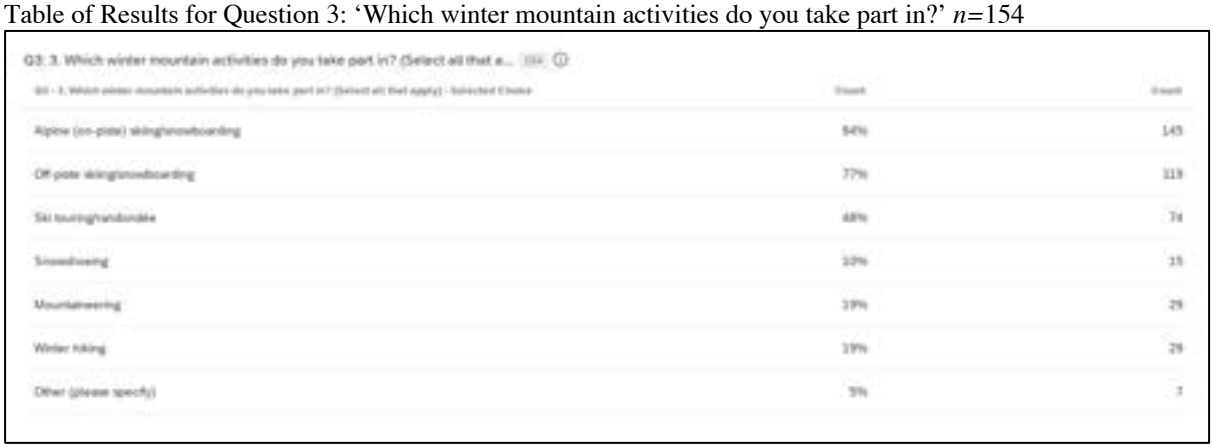
Table of Results for Question 2: 'Where do you most often take part in winter mountain activities?' *n*=155



Q2: 2. Where do you most often take part in winter mountain activities? (Select...

France (Alps)	80%	124
France (other)	2%	3
Switzerland	31%	48
Italy	21%	33
Austria	26%	40
Slovenia	1%	2
Other Alpine regions (please specify)	17%	27

Table of Results for Question 3: 'Which winter mountain activities do you take part in?' *n*=154



Q3: 3. Which winter mountain activities do you take part in? (Select all that a...

Alpine (on-piste) skiing/snowboarding	94%	145
Off-piste skiing/snowboarding	77%	119
Ski touring/randonnée	48%	74
Snowshoeing	10%	15
Mountaineering	19%	29
Winter hiking	19%	29
Other (please specify)	5%	7

Table of Results for Question 4: 'Which best describes your role in the mountains?' *n*=154

Q4: 4. Which best describes your role in the mountains? 154

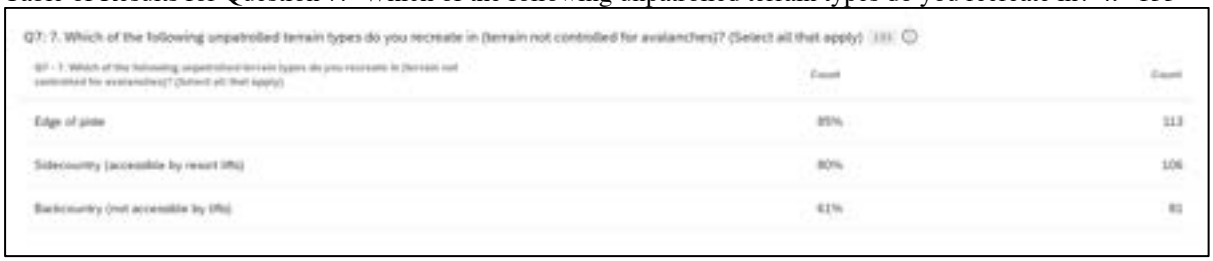
Recreational participant (e.g. on holiday)	40%	61
Regular recreational user (e.g. seasonnaire)	40%	61
Instructor	8%	13
Mountain guide	3%	5
Other (please specify)	9%	14

Table of Results for Question 5: Approximately how many weeks of winter mountain experience do you have in total?' *n*=155

Q5: 5. Approximately how many weeks of winter mountain experience do you have in total? 155

1-10	10%	15
11-20	10%	16
21-30	13%	20
31-40	8%	12
41-50	4%	6
More than 50	55%	86

Table of Results for Question 7: 'Which of the following unpatrolled terrain types do you recreate in?' *n*=133



Q7: 7. Which of the following unpatrolled terrain types do you recreate in (terrain not controlled for avalanches)? (Select all that apply) 133

Edge of piste	85%	113
Sidecountry (accessible by resort lifts)	80%	106
Backcountry (not accessible by lifts)	61%	81

Table of Results for Question 9: 'Have you completed a formal avalanche training course?' *n=139*

Q9: 9. Have you completed a formal avalanche safety training course? 139

Yes	58%	80
No	42%	59

Appendix 7: Avalanche Bulletin Results

Table of Results for Question 19: 'Do you consult the avalanche bulletin/report before entering avalanche-prone terrain?' *n=122*

Q22: 19. Do you consult the avalanche bulletin/report before entering avalanche-prone terrain? 122

Always	74%	90
Often	14%	17
Sometimes	10%	12
Never	2%	3

Appendix 8: Self-Reported Risk Against Use of Avalanche Airbag Crosstabulation

Crosstabulation results for use of avalanche airbag when recreating in avalanche terrain against self-reported approach to managing risk in avalanche-prone terrain.

		Q24: 21. Do you wear an avalanche airbag when recreating in				
		Total	Always	Often	Somtimes	Never
Q19: 17. How would you typically describe your approach to managing risk in avalanche-prone terrain?	I avoid avalanche terrain whenever possible	12.3%	0.0%	12.5%	7.1%	17.1%
	I am cautious and generally choose low-risk options	56.6%	59.1%	37.5%	57.1%	60.0%
	I am comfortable managing moderate risk	24.6%	18.2%	43.8%	35.7%	20.0%
	I am willing to accept higher levels of risk	5.7%	18.2%	6.3%	0.0%	2.9%
	I am comfortable accepting very high levels of risk	0.8%	4.5%	0.0%	0.0%	0.0%
	Overall Stat Test of Percentages	0.038518517417863066				

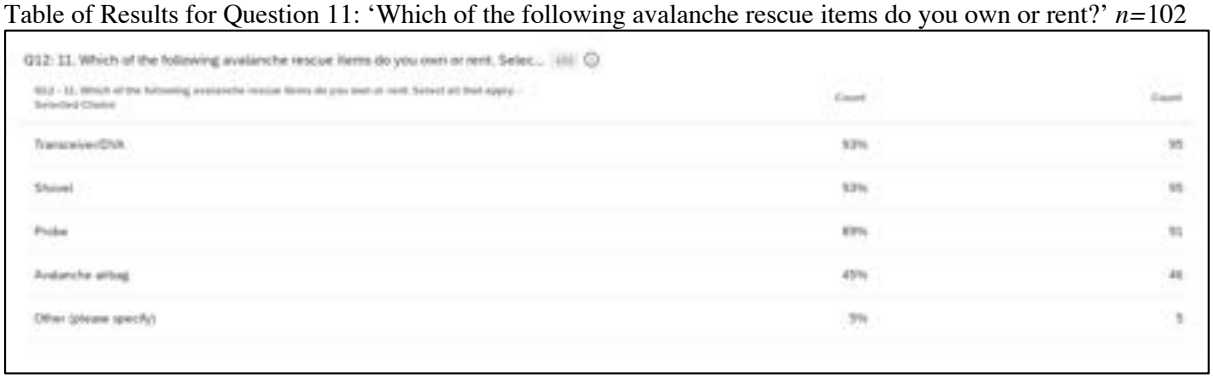
Appendix 9: Rescue Equipment and Risk Tolerance Results

Table of Results for Question 22: 'Do you think modern avalanche rescue equipment and technology make people more willing to take risks?' *n*=125

Q25: 22. Do you think modern avalanche rescue equipment and technology make people more willing to take risks? 125		
Q25 - 22. Do you think modern avalanche rescue equipment and technology make people more willing to take risks?	Count	Count
Strongly disagree	2%	3
Disagree	5%	6
Neutral	28%	35
Agree	51%	64
Strongly agree	14%	17

Appendix 10: Use of Rescue Equipment Results

Table of Results for Question 11: 'Which of the following avalanche rescue items do you own or rent?' *n*=102



Q12: 11. Which of the following avalanche rescue items do you own or rent. Selec... 102		
Q12 - 11. Which of the following avalanche rescue items do you own or rent. Select all that apply - Selected Choice	Count	Count
Transceiver/DVA	93%	95
Shovel	93%	95
Probe	89%	91
Avalanche airbag	45%	46
Other (please specify)	5%	5

Appendix 11: Self-Reported Confidence in Use of Rescue Equipment Results

Table of Results for Question 12: 'How confident are you in using your avalanche rescue equipment?' *n=129*

Q13: 12. How confident are you in using your avalanche rescue equipment?

Not confident	19%	24
Slightly confident	22%	29
Confident	38%	49
Very confident	21%	27

Appendix 12: Crosstabulation between Course Completion and Skills Practise

Crosstabulation Results for frequency of avalanche rescue skills practise against completion of a formal avalanche training course.

		Q9: 9. Have you completed a formal		
		Total	Yes	No
Q10: 10. How often do you practise avalanche rescue skills (e.g. use of transceiver, probe, shovel)?	Never	29.9%	6.3%	63.2%
	Less than once a year	25.5%	36.3%	10.5%
	Once a year	31.4%	37.5%	22.8%
	Multiple times per season	13.1%	20.0%	3.5%
	Overall Stat Test of Percentages	1.2265463547923247e-11		

Appendix 13: Crosstabulation between Course Completion and Rescue Skills Confidence

Crosstabulation Results for self-reported confidence in use of avalanche rescue equipment against completion of a formal avalanche training course.

		Q9: 9. Have you completed a formal		
		Total	Yes	No
Q13: 12. How confident are you in using your avalanche rescue equipment?	Not confident	18.6%	0.0%	49.0%
	Slightly confident	22.5%	22.5%	22.4%
	Confident	38.0%	46.3%	24.5%
	Very confident	20.9%	31.3%	4.1%
	Overall Stat Test of Percentages	1.3077218093081904e-11		

Appendix 14: Behaviour Change after Avalanche "Near Miss" Results

Table of Results for Question 32: 'If answered yes to the previous question, how did this affect your behaviour?' *n*=48. Previous question asked whether respondents had experienced a "near miss" related to avalanches for which 38% answered yes *n*=121

Q34: 31. Have you ever experienced a near-miss related to avalanches?

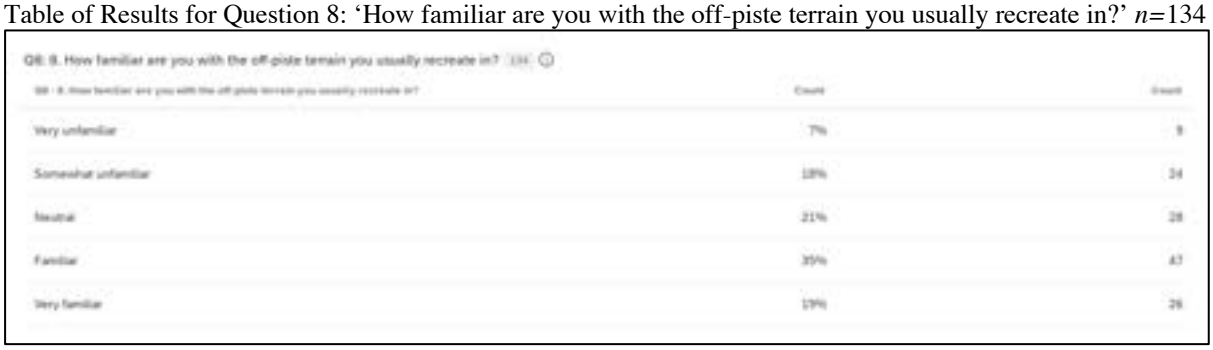
Yes	38%	46
No	57%	69
Unsure	5%	6

Q35: 32. If you answered yes to the previous question, how did this affect your behaviour?

Became more cautious	54%	26
No significant change	40%	19
Became more confident	6%	3

Appendix 15: Terrain Familiarity Results

Table of Results for Question 8: 'How familiar are you with the off-piste terrain you usually recreate in?' *n*=134



Q8: 8. How familiar are you with the off-piste terrain you usually recreate in?

Very unfamiliar	7%	9
Somewhat unfamiliar	18%	24
Neutral	21%	28
Familiar	35%	47
Very familiar	19%	26

Appendix 16: Familiarity Heuristic Decision-Making Results

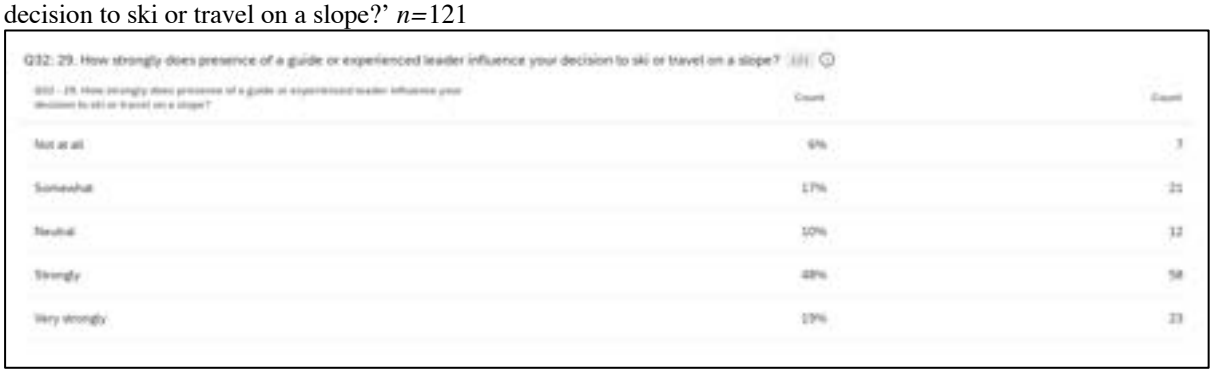
Table of Results for Question 27: 'How strongly does being familiar with the terrain influence your decision to ski or travel on a slope?' *n*=121

Q30: 27. How strongly does being familiar with the terrain influence your decision to ski or travel on a slope?

Not at all	2%	3
Somewhat	21%	25
Neutral	11%	13
Strongly	47%	57
Very strongly	19%	23

Appendix 17: Expert Halo Heuristic Decision-Making Results

Table of Results for Question 29: 'How strongly does presence of a guide or experienced leader influence your decision to ski or travel on a slope?' *n*=121

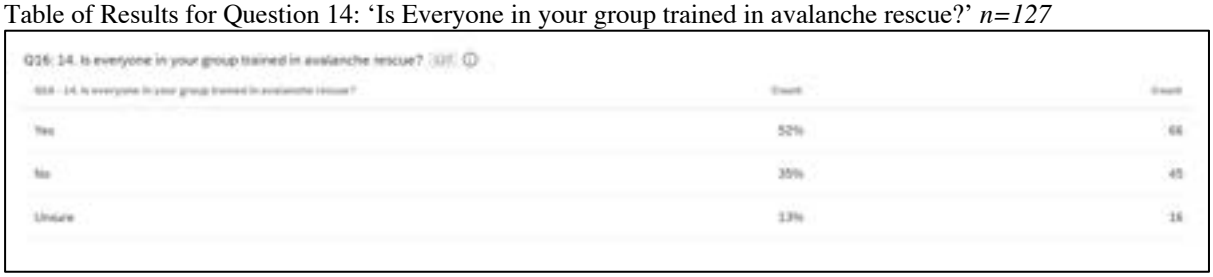


Q32: 29. How strongly does presence of a guide or experienced leader influence your decision to ski or travel on a slope? (121)

	Count	Count
Not at all	6%	7
Somewhat	17%	21
Neutral	10%	12
Strongly	48%	58
Very strongly	19%	23

Appendix 18: Group Members Avalanche Training Results

Table of Results for Question 14: 'Is Everyone in your group trained in avalanche rescue?' *n=127*

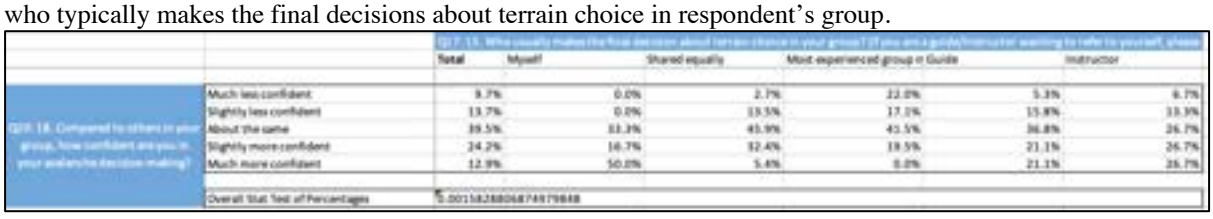


Q16: 14. Is everyone in your group trained in avalanche rescue? (127)

	Count	Count
Yes	52%	66
No	35%	45
Unsure	13%	16

Appendix 19: Crosstabulation between Decision-Making Confidence and Individual who Makes Final Terrain Choices.

Crosstabulation Results between decision-making confidence compared to others in the group and individual who typically makes the final decisions about terrain choice in respondent's group.



		Total	Myself	Shared equally	Most experienced group member or Guide	Instructor	
Q19: 18. Compared to others in your group, how confident are you in your avalanche decision making?	Much less confident	9.7%	0.0%	2.7%	22.0%	5.3%	6.7%
	Slightly less confident	13.7%	0.0%	13.5%	17.1%	15.8%	13.3%
	About the same	39.5%	33.3%	45.9%	41.5%	36.8%	26.7%
	Slightly more confident	24.2%	16.7%	32.4%	19.5%	21.1%	26.7%
	Much more confident	12.9%	50.0%	5.4%	0.0%	21.1%	26.7%
	Overall Stat Test of Percentages	5.001582880687497984E					

Appendix 20: Scarcity Heuristic Decision-Making Results

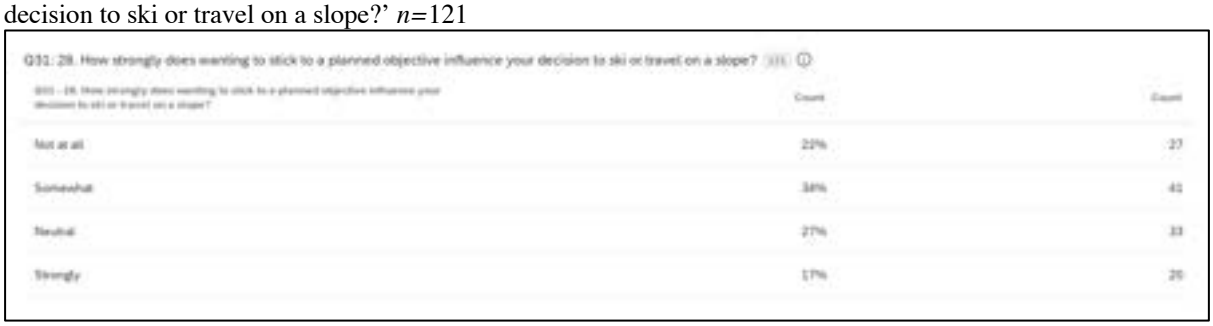
Table of Results for Question 26: 'How strongly does seeing fresh tracks on the slope influence your decision to ski or travel on a slope?' *n*=121

Q29: 26. How strongly does seeing fresh tracks on the slope influence your decision to ski or travel on a slope? (121)

	Count	Count
Not at all	13%	16
Somewhat	47%	57
Neutral	11%	13
Strongly	25%	30
Very strongly	4%	5

Appendix 21: Consistency Heuristic Decision-Making Results

Table of Results for Question 28: 'How strongly does wanting to stick to a planned objective influence your decision to ski or travel on a slope?' *n*=121



Q31: 28. How strongly does wanting to stick to a planned objective influence your decision to ski or travel on a slope?

	Count	Count
Not at all	22%	27
Somewhat	34%	41
Neutral	27%	33
Strongly	17%	20

Appendix 22: Social Facilitation and Acceptance Heuristic Decision-Making Results

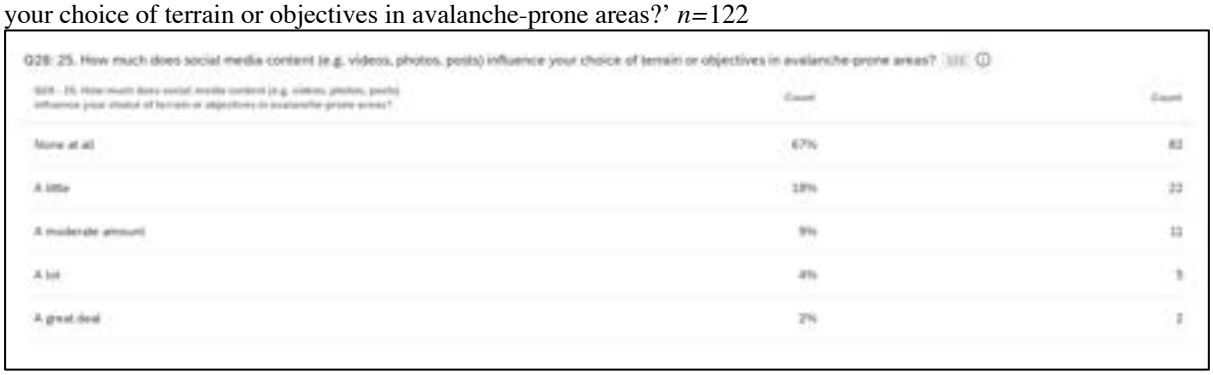
Table of Results for Question 30: 'How strongly does pressure from the rest of the group influence your decision to ski or travel on a slope?' *n*=121

Q33: 30. How strongly does pressure from the rest of the group influence your decision to ski or travel on a slope?

	Count	Count
Not at all	30%	36
Somewhat	40%	48
Neutral	17%	21
Strongly	12%	15
Very strongly	1%	1

Appendix 23: Social Media Influence Results

Table of Results for Question 25: 'How much does social media content (e.g. videos, photos, posts) influence your choice of terrain or objectives in avalanche-prone areas?' *n*=122



Q28: 25. How much does social media content (e.g. videos, photos, posts) influence your choice of terrain or objectives in avalanche-prone areas?

	Count	Count
None at all	67%	82
A little	18%	22
A moderate amount	9%	11
A lot	4%	5
A great deal	2%	2

Appendix 24: Motivations for Camera Use Results

Table of Results for Question 24: 'What is your primary reason for filming or taking photos while recreating in avalanche-prone terrain?' n=119

Q27: 24. What is your primary reason for filming or taking photos while recreati... 119

Personal memories	76%	90
Social media sharing	34%	40
Professional or sponsored content	10%	12
Route or condition documentation	14%	17
Not applicable/I do not film or take photos	16%	19
Other (please specify)	3%	3

Appendix 25: Crosstabulation between Social Media Influence and Age

Crosstabulation Results for social media content influencing terrain or objective choice and age of respondents. There was no statistically significant relationship between these variables.

		Q1: 1. What is your age group?						
		Total	18-24	25-34	35-44	45-54	55-64	65+
Q28: 25. How much does social media content (e.g. videos, photos, posts) influence your choice of terrain or objectives in avalanche-prone areas?	None at all	67.2%	50.0%	75.0%	65.0%	79.2%	68.4%	100.0%
	A little	18.0%	23.5%	15.0%	30.0%	4.2%	21.1%	0.0%
	A moderate amount	9.0%	11.8%	5.0%	5.0%	12.5%	10.5%	0.0%
	A lot	4.1%	8.8%	5.0%	0.0%	4.2%	0.0%	0.0%
	A great deal	1.6%	5.9%	0.0%	0.0%	0.0%	0.0%	0.0%
	Overall Stat Test of Percentages	0.488367109383529 7						