

Influence of snow and meteorological conditions on snow-avalanche deposit volumes and consequences for road-network vulnerability

Hippolyte KERN¹, V. Jomelli², Nicolas Eckert³, Delphine Grancher⁴, Michael Deschatres³, and Gilles Arnaud-Fassetta⁵

¹Université Paris 1 Panthéon-Sorbonne Laboratoire de Géographie Physique CNRS-UMR 8591 2 Rue Henri Dunant 94320 Thiais

²Aix-Marseille University CNRS IRD INRAE Collège de France UMR 34 CEREGE 13545 Aix-en-Provence

³UR ETNA Université Grenoble Alpes INRAE Centre de Grenoble 2 Rue de la Papeterie 38402 Saint-Martin-d'Hères

⁴Université Paris 1 Panthéon-Sorbonne Laboratoire de Géographie Physique CNRS-UMR 8591

⁵Université Paris Cité UMR 8586 PRODIG 8 rue Albert Einstein Case postale 7001 5 rue Thomas Mann 75205 Paris Cedex

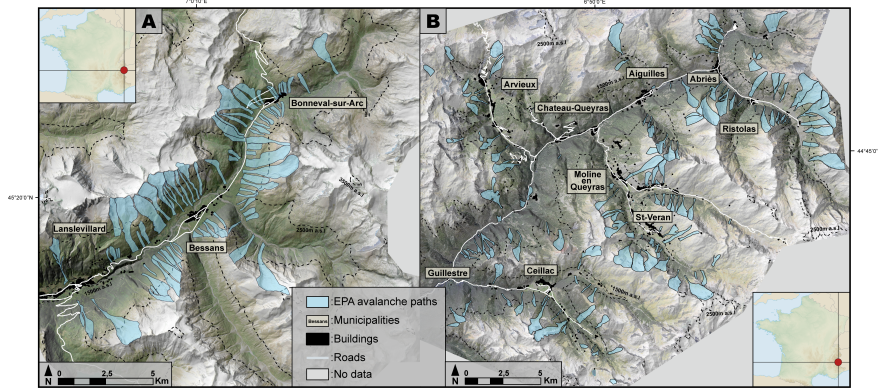
October 10, 2022

Abstract

Snow avalanches are a major component of the mountain cryosphere that frequently create a menace for the road network. Deposit characteristics determine the extent of damage and disruption to communication networks, but the factors controlling snow-deposit volumes remain largely unknown. This study investigates the influence of meteorological and snowpack conditions on snow-avalanche deposits and road-network vulnerability based on 1986 deposit volumes from 182 paths located in two regions of the French Alps between 2003 and 2017: Guil and Haute-Maurienne valleys. During the period, 195 avalanches impacted the road network in these areas, leading to major disruptions. In Haute-Maurienne, correlations between deposit volumes and meteorological and snowpack conditions are high in winter. However, the relationships differ with path elevation and orientation. Results do not show any significant relationship between volumes and meteorological or snowpack conditions for the spring season. Focusing on deposits that disturbed the road network, winter and spring reveal a distinct influence of meteorological and snow variables compared to the overall data set, with snowfall intensity as the predominant control variable of deposit volumes leading to road cuts. When the same analysis is conducted by considering Guil valley separately or by aggregating Haute-Maurienne with Guil valley area data, results do not show any significant relationship, highlighting the specific regional nature of relations between deposit volumes and meteorological and snowpack conditions.

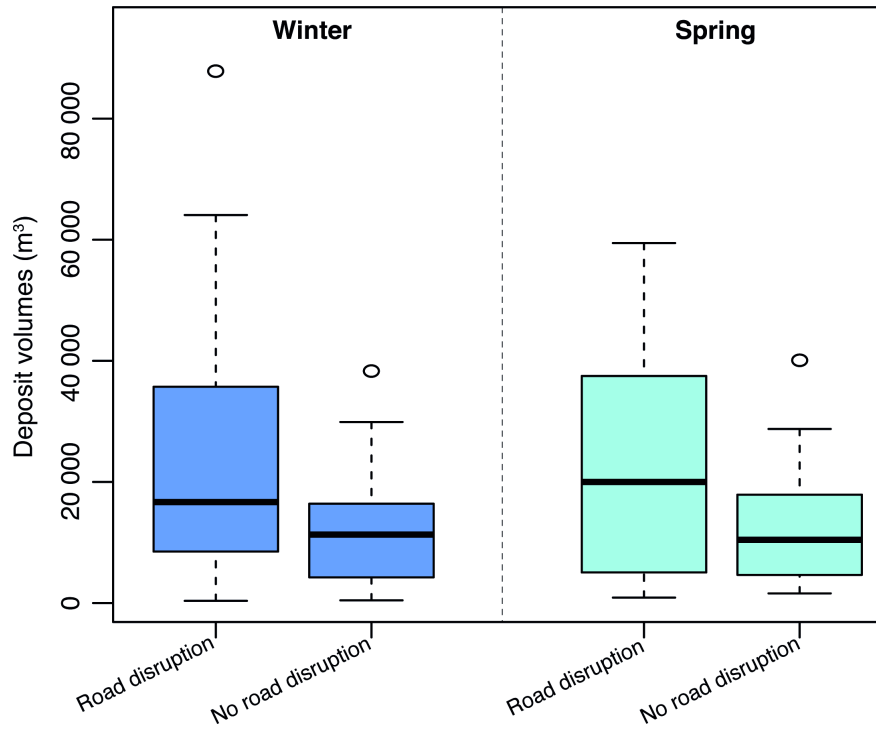
Hosted file

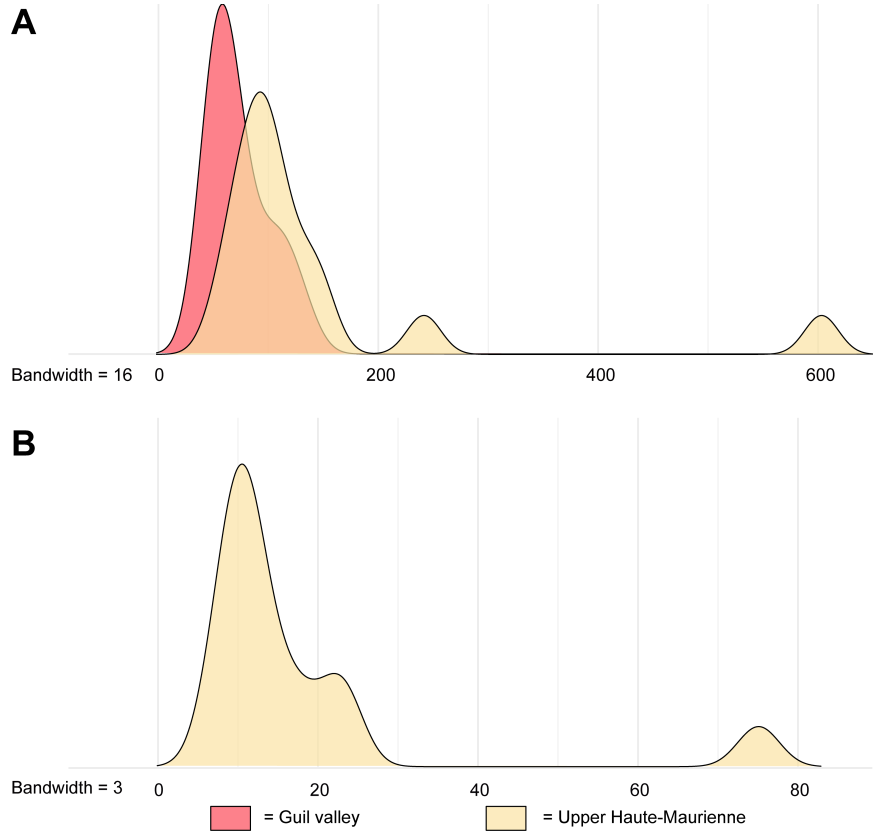
manuscript.docx available at <https://authorea.com/users/513723/articles/589795-influence-of-snow-and-meteorological-conditions-on-snow-avalanche-deposit-volumes-and-consequences-for-road-network-vulnerability>

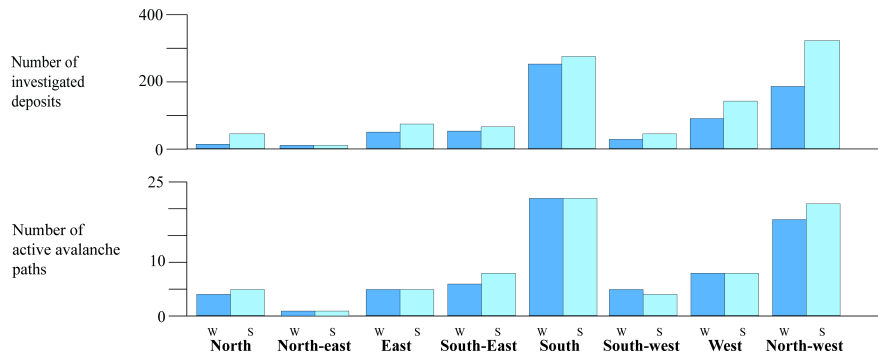
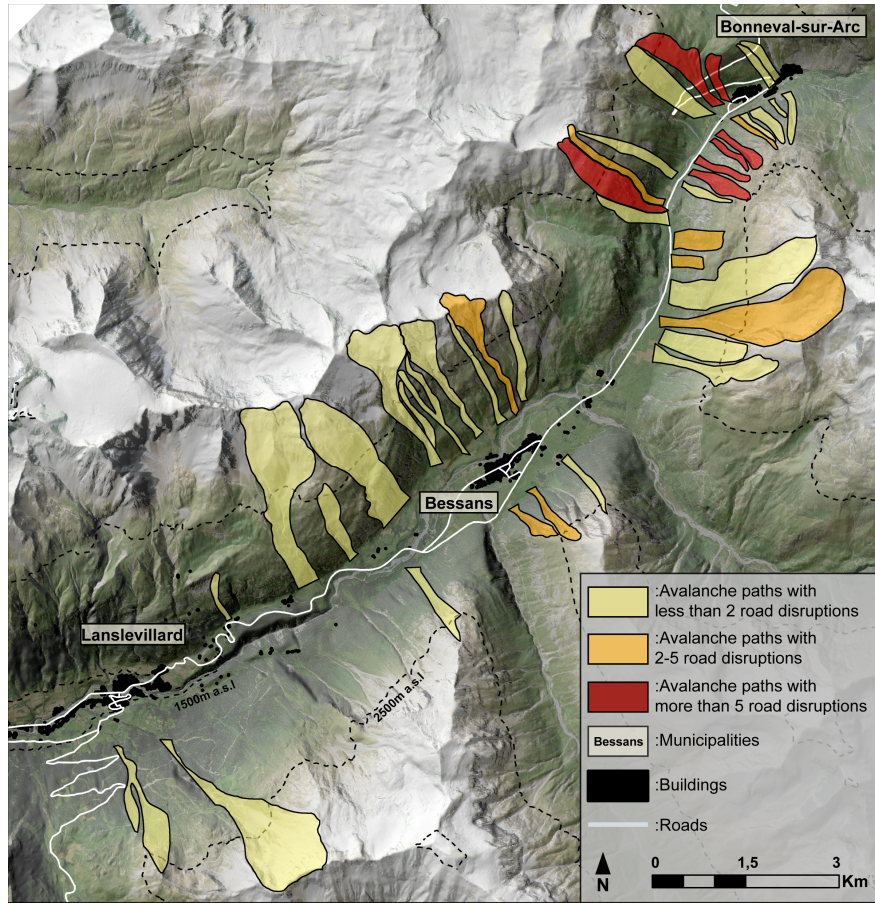


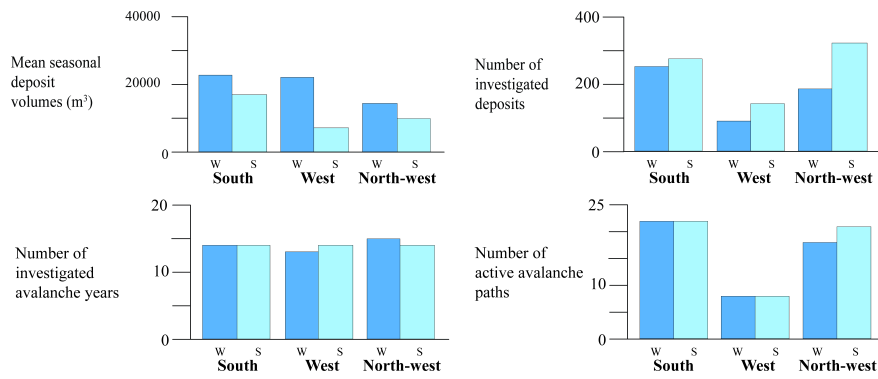
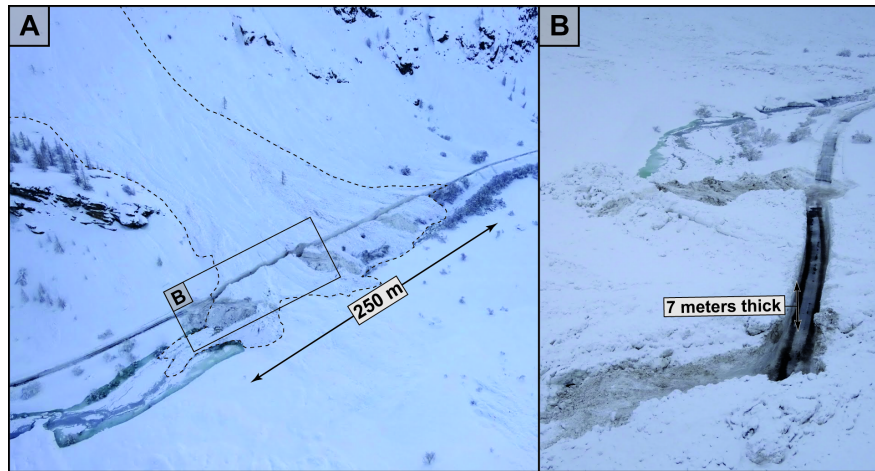
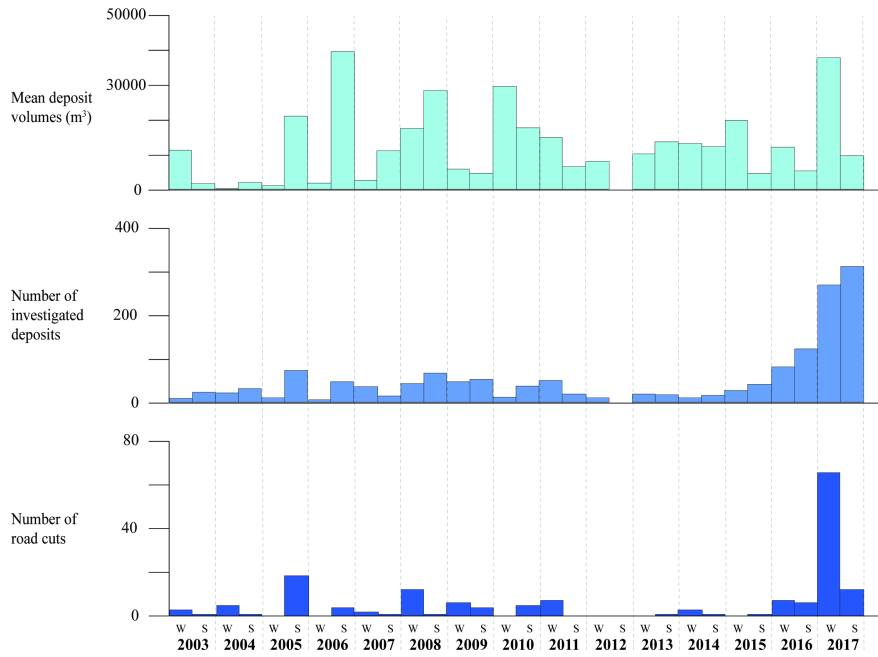
$$\bar{X}_{\omega}^t = \omega_{HM}^t X_{HM}^t + \omega_{GV}^t X_{GV}^t$$

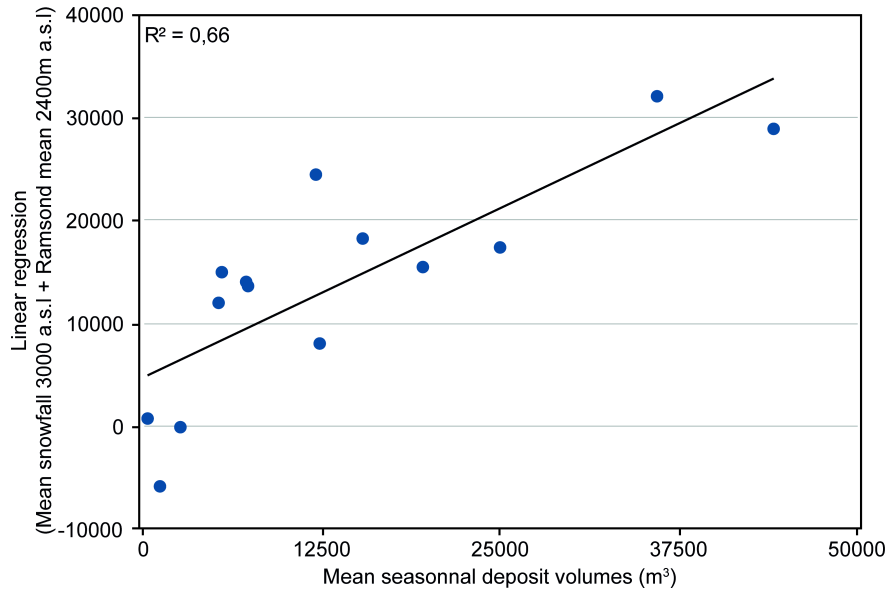
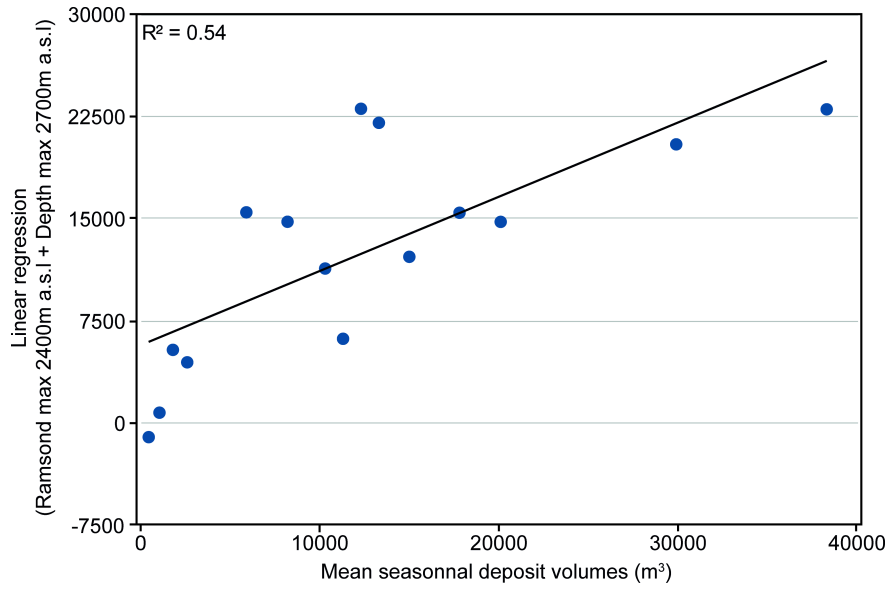
$$\text{with } \begin{cases} \omega_{HM}^t = \frac{N_{HM}^t}{N_{HM}^t + N_{GV}^t} \\ \omega_{GV}^t = \frac{N_{GV}^t}{N_{HM}^t + N_{GV}^t} = 1 - \omega_{HM}^t \end{cases}$$











Hosted file

Table 1.docx available at <https://authorea.com/users/513723/articles/589795-influence-of-snow-and-meteorological-conditions-on-snow-avalanche-deposit-volumes-and-consequences-for-road-network-vulnerability>

Hosted file

Table 2.docx available at <https://authorea.com/users/513723/articles/589795-influence-of-snow-and-meteorological-conditions-on-snow-avalanche-deposit-volumes-and-consequences-for-road-network-vulnerability>

Hosted file

Table 3.docx available at <https://authorea.com/users/513723/articles/589795-influence-of-snow-and-meteorological-conditions-on-snow-avalanche-deposit-volumes-and-consequences-for-road-network-vulnerability>

Hosted file

Table 4.docx available at <https://authorea.com/users/513723/articles/589795-influence-of-snow-and-meteorological-conditions-on-snow-avalanche-deposit-volumes-and-consequences-for-road-network-vulnerability>

Hosted file

Table 5.docx available at <https://authorea.com/users/513723/articles/589795-influence-of-snow-and-meteorological-conditions-on-snow-avalanche-deposit-volumes-and-consequences-for-road-network-vulnerability>