
Low flows in a French Mediterranean and Alpine area: climatic and geological drivers

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Résumé

In the southeastern part of France, hydrological predictions based on the RCP8.5 climate change scenario indicate a 30 % decrease in annual low flow rates by 2070-2099 (Explore2 project). Like other alpine-mediterranean regions, the Alpes-Maritimes experienced severe hydrological droughts in 2022-23, with a significant period of water restrictions and shortages. This highlights the need for a better quantitative understanding of the trajectory of low flows. Our aim is to present the spatial and temporal variations of low streamflows in relation to climate and hydrogeological parameters. This study is based on an analysis of the data of 26 gauging stations across eleven catchments in the Alpes-Maritimes region. Six of these catchments are rain-dominated and characterised by karst, Triassic and alluvial formations and five are snow-dominated and characterised by crystalline bedrock, limestone and scree. The 95th percentile of specific daily streamflows (Q95 hereafter, in l/s/km²) from the French HydroPortail database was calculated as an indicator of low flows for the 1960-2023 period. Climatic parameters (e.g. precipitation and air temperature) provided by the daily gridded SAFRAN reanalysis (Vidal et al., 2010) were analysed for the catchments over the same period. Low streamflows range from 0 to 10.5 l/s/km² across the entire region. Snow-dominated catchments exhibit a median Q95 value that is five times higher than for rain-dominated catchments. This difference can be related to climate parameters, but also to both local hydrogeological characteristics and anthropogenic activities. Karst and Triassic geological formations may impact low streamflows quantity and quality. Anthropogenic activities, such as the withdrawal of drinking water, hydropower stations (source or sink) and wastewater treatment plants also have a significant impact on low flows spatial evolution. Finally, the 1960-2023 period exhibits a moderate downward trend in Q95 in snow-dominated catchments, whereas no decrease is observed in rain-dominated catchments. Despite a forecasted global downward evolution of low streamflows for all catchments by the end of the century, this study indicates that the recent effects of climate change are not equivalent in rain- and snow-dominated catchments. This provides a critical overview of the evolution of low flows in Alpine-Mediterranean catchments.

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Mots-Clés: Alpes, Maritimes, river low flows, statistical indicator Q95, rain, and snow, dominated catchments, karst, Trias