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Managing the Roussillon aquifer by preparing for saltwater intrusion in a semi-arid coastal region

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The Roussillon is a region in the south of France, bordering the Mediterranean Sea. The region is covered by an alluvial plain of about 800 km2 inland, which drains water from the eastern part of the Pyrenees. It is one of the driest regions of France with an average of 600 mm of rainfall per year over the last 20 years. It has recently suffered dry years, with a particularly low 250 mm of rainfall in 2023. The region's economy is mainly based on tourism and agriculture, both of which require water during spring and summer, which cannot be met by surface water alone and therefore relies heavily on the alluvial aquifer beneath it. This aquifer is composed of Quaternary sediments on top and thicker continental and marine Pliocene sediments below. The system has generally high permeability and has been well described by Dall'Alba (2023) using borehole data and innovative inverse methods based on multipoint statistics. If the aquifer was artesian before anthropic exploitation, the water level has dropped considerably in the last 50 years and is close to sea level near the coast. The water level oscillates during the year, with a low in summer caused by the drought period and, more importantly, by the annual distribution of pumping. This low in summer, especially in the coastal part where the aquifer water level goes below sea level, can cause irreversible saltwater intrusion, damaging the water quality. We therefore try to reproduce the observed seasonal oscillation using a Modflow model and various types of data: climatic, piezometric levels including continuous time series, boreholes, river water presence observatory, remote sensing, pumping tests. We show how important it is to understand the different boundary conditions of the aquifer to reproduce the seasonal trends, and how we can estimate the future behavior of the aquifer and better manage the resource by preventing saltwater intrusion.