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Coupling distributed modelling and multi-scale snow remote sensing information: understanding processes and flow prediction in mountainous ungauged watersheds

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Mountainous regions are highly dependent on the snow regime from both the ecosystem and water resource management approaches; however, there is a general lack of weather and flow monitoring in their higher areas, and this poses a constrain for water flow prediction and water resource assessment downstream. They generally constitute also suitable locations for small hydropower plants, but this energy source is subrogated to the environmental flow requirements, which are not easy to establish under un-gauged conditions. The gap in discharge monitoring over these regions is usually related to the access difficulties and makes it crucial both an adequate understanding of the local hydrological processes, and their interaction, and the use of alternative data sources for a satisfactory modelling and further assessment. The combination of distributed physically-based hydrological modelling, which can also benefit from previous application in similar areas, and the fusion of different remotely sensed information associated to the snow presence in these areas provides not only a sound alternative to gauging but also a chance to gain insight in the non-linearity of hydrological processes and assess adaptation planning options.

This study presents this approach applied to the reconstruction of discharge series in different un-gauged small mountainous catchments located in the head area of the Guadalfeo River Basin, in Sierra Nevada (southern Spain), in a region ranging from 1000 to 3479 m a.s.l. that faces the Mediterranean Sea in a 40-km distance. For this, the hydrological modelling of the river flows by WiMMed (Wathershed Integrated Model for Mediterranean regions, www.uco.es/dfh/), a physically-based distributed model operational for the entire basin from downstream calibration, was performed over each catchment. The snow evolution, the major driver on the flow signature in this area, was traced by means of three remote sensing sources: MODIS and Landsat TM satellites, and terrestrial pictures from two control points in the area. Coupling modelling and snow distributed data resulted in daily river flow series at each catchment, and a first step towards an operational system to assess impacts associated to future changes in the snow regime.

The fusion of these data sources was key in the tuning of the model from the snow map series with both high time and spatial resolution, but this also help to further validate the strengths and weaknesses of the snow and river flow modelling and hence what additional efforts are still needed in these snow regions from an operational point of view.

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