

## **Putting humans in the loop: Using crowdsourced snow information to inform water management**

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The unprecedented availability of user generated data on the Web due to the advent of online services, social networks, and crowdsourcing, is opening new opportunities for enhancing real-time monitoring and modeling of environmental systems based on data that are public, low-cost, and spatio-temporally dense, possibly contributing to our ability of making better decisions.

In this work, we contribute a novel crowdsourcing procedure for computing virtual snow indexes from public web images, either produced by users or generated by touristic webcams, which is based on a complex architecture designed for automatically crawling content from multiple web data sources. The procedure retains only geo-tagged images containing a mountain skyline, identifies the visible peaks in each image using a public online digital terrain model, and classifies the mountain image pixels as snow or no-snow. This operation yields a snow mask per image, from which it is possible to extract time series of virtual snow indexes representing a proxy of the snow covered area.

The value of the obtained virtual snow indexes is estimated in a real world water management problem. We consider the snow-dominated catchment of Lake Como, a regulated lake in Northern Italy, where snowmelt represents the most important contribution to seasonal lake storage, and we used the virtual snow indexes for informing the daily operation of the lake's dam. Numerical results show that such information is effective in extending the anticipation capacity of the lake operations, ultimately improving the system performance.