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Combining ground based data, remote imagery and simple hydrological modeling to asses spring flows in an Italian meso-scale alpine watershed.

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A methodology is developed to estimate the daily flow discharge at snowmelt into a meso-scale alpine watershed in the Italian alps, the Serio river, featuring a 450 Km^2 drainage area and an average altitude of 1300 m a.s.l. A simple snowmelt model (SRM model), based on the degree day concept is used to determine snow melt in spring-time (roughly observed to start in the first days of April) and the related flow discharge. Using ten years of daily snow depth and air temperature measurements at several snow gauging stations in the area, the snow accumulation and melt dynamic in time is identified and the degree day factor properly assessed from the observed data, so as to provide correct tuning of the model. Using more than 200 sparse surveys made available from the Italian Association for Snow and Avalanches (AINEVA) and yielding snow density and temperature for both fresh and layered snow density, proper formulae are developed, providing the Snow Water Equivalent for both freshly fallen and consolidated snow as a function of the season, altitude and other morphologic and climatic variables. Satellite images are used to derive snow covered areas and depletion curves, required for water storage estimation and snowmelt volume assessment in the context of the SRM model. Data from a rain gage network and a simple lumped hydrological model (Nash model) are used to evaluate the storm generated runoff. A ten year daily flow discharge series is adopted to properly tune the model against the observed flows in spring time. Coupling the ground information, the satellite images and the hydrological model, the SRM model is correctly driven and can be used to provide reliable estimates of flow discharge during the snowmelt season.