Multi-temporal study of BELVEDERE glacier for hydrologic hazard monitoring and water resource estimation using UAV: tests and first results

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Nowadays, expected effects of climate change at local, regional and global scales endanger hydrologic budgets of Alpine regions. An example is the massive shrinkage of mountain glaciers, with the consequent problem of water resources reduction for civil population and ecosystems. Therefore, it is very important to monitor glaciers' evolution, in order to allow an estimation of glaciers' reduction and possible effects on the hydrologic cycle. In 2015, a research team called DREAM (Drone Technology for Water Resources and hydrologic hazards Monitoring) has been created within the framework of "Alta Scuola Politecnica", joint initiative between Politecnico di Milano and Politecnico di Torino (Italy), and composed by 15 people among students, research associates and professors belonging to the two universities. The goal of the research team is to investigate new technologies and tools, including Unmanned Aerial Vehicle (UAVs), for monitoring natural hazard and evaluating water resources at different scales. In particular, in this first step, the DREAM team has selected as test site the eastern slopes of Monte Rosa and its long glacier tongue (Belvedere glacier). This area of Monte Rosa massif has an altitude range between 2000 m up to 4500 m ASL, while the glacier tongue has an extension greater than 3 km 2. Usually, glacier thickness and area evolution are monitored using, e.g., time-consuming field activities based on point stratigraphy and mass balances, or radar sounding, which do not allow to obtain a continuous-time, detailed and accurate information about surface and volume evolution at fine spatial resolutions. In this framework, we have used a fixed-wing UAV (eBee sensesly) to acquire RGB images, in order to generate a dense DSM (DDSM) and an orthophoto of the glacier, with a high resolution (4-6 cm). In this way, we aim at analyzing the variations of glacier volume in time. The acquisition was carried out with two different campaigns of measurement in October 2015. Eight flights were realized, covering about 2.7 km2; the images have been georeferenced through a series of ground control points, installed on the glacier and on surrounding moraines, which were measured with GNSS positioning (RTK or static). The images (> 1200) have been elaborated with different photogrammetric software, such as Agisoft PhotoScan, APS, LPS, Pix4D, in order to investigate the ratio quality of the product/ time consumption, with respect to hydrological purposes. The DSM obtained has been compared with other DSMs realized in the past years, making a multi-temporal analysis, and estimating the volumes' variations and trends of the glacier. Here, the activities will be described, including the field campaigns, data processing, and the first results obtained.