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The "Karakoram Anomaly": indications based on observations, field data, models in Upper Hunza

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For decades, field evidence, in line with observations and experiences of the local population, seem to support the statement, that glaciers also in Gojal (Upper Hunza, Karakoram) follow the general trend of glacial decline: retreating glacier snouts, surface lowering of the terminal areas are the dominant indicators. But taking into consideration meteorological observations, runoff-data, remotely sensed snow and ice volumes, and modeled mass balances this picture has to be differentiated. The dominant processes in the ablation zone do not necessarily reflect processes of the whole glacial system. A number of investigations in the Central Karakoram result in an overall positive mass balance due to increased inputs at high elevated snow fields and accumulation areas. The proved or suggested gain is supposed to reflect increased winter precipitation, linked to westerly circulation patterns. These observations and their explanations are labeled as "Karakoram Anomaly", as they are up to now mainly documented for the 'Central Karakoram'.
Similar to some few glaciers in Baltistan (Baltoro) or at Nanga Parbat (Raikot), also Batura Glacier in the western Karakoram is comparably well observed and investigated by several research campaigns. And as most glaciers in Upper Hunza, also Batura has significantly lost volume in its ablation zone and flows with reduced speed. As a consequence, a number of irrigation channels, tapping melt water across side moraines, fell dry and had to be reconstructed repeatedly at lower levels, resulting in losses of irrigated fields at elevated terraces. This retreat and its consequences can clearly be documented in the field.
In contrast to these facts of glacial retreat, and considering the total snow and ice covered areas of the basin, mass-balance models with input from meteorological data series, run-off measurements at the glacier-outlet, as well as the analysis of repeat satellite data indicate, that (similar to other Karakoram glaciers) also Batura Glacier seem to have an overall positive mass balance. In other words, the significant loss of ice volume in the ablation zone must be over-compensated by gain of mass in the accumulation area. Increased snow-fall in winter, originating from westerly lows, is considered to be the dominant factor of this change in vertical water balance. Calculations, based on data from meteorological stations, as well as on SMR-modeling confirm a positive vertical precipitation lapse rate of ~ 65 mm/100m up to 5000 m.a.s.l. But in contrast to general assumptions, the volumetric analysis of multi-temporal satellite data does not support the gradient's reduction at higher altitudes. Yet, the calculated annual precipitation sum of > 3.000 mm (water equivalent) at ~ 7.000 m.a.s.l. has still to be confirmed. In addition, drifting snow and avalanches are important processes in modifying the vertical distribution of snow and ice, but their dynamics is difficult to be assessed.
In order to fully understand and to document the "Karakoram Anomaly" monitoring sites and representative glaciers have to be identified. And a combination of different methods has to be applied, ranging from ground based meteorological and run-off measurements, glaciological data collection, remote sensing and glacial modeling, to the inclusion of proxy-data and field evidence.

Keywords:
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