Introduction

As virtual water towers, glaciers have been a crucial source for Andean societies and livelihoods. Peru’s mainly remote living population in the Central Andes has to cope with a strong seasonal variation of precipitations and river runoff interannually superimposed by ENSO impacts. Consequently, direct glacier and lake water runoff constitute a vital continuous water supply and represent a regulating buffer mitigating human vulnerability to climatic-hydrological variability. This natural system is likely to deteriorate, triggered by accelerated glacier retreat and climatic changes. This nourishes concerns about a sustainable water supply in the Cordillera Blanca (CB) area and even more so in the arid coastal reaches of the lower Santa watershed while Ancash’s population, irrigation-intensive agriculture and hydropower demand increase. Here we present a comprehensive review of the actual situation and perspectives for water resources management in the Peruvian Andes.

Impacts in water supply: accelerated glacier retreat

With 459 km² glacier area at present the CB (Figure 1) represents the largest glacialized mountain range of the tropics worldwide. Especially as the second half of the 1970s, it has been strongly affected by massive ice loss with around 34% glacier area decline from 1970 to 2010 (ANA, 2010; Rabatel et al., 2013; Figure 2). More frequent ENSO events in the last decades and the abrupt Pacific climate shift with a positive PDO phase and higher SST since 1976 could explain this accelerated retreat (Rabatel et al., 2013; Vullié et al., 2008).

Main characteristics of the Santa river basin

The 12,200 km² wide Santa basin receives about 675 mm/year precipitation (34 station average), characterized by high seasonality. Consequently, river flow has a high-level in the wet season (November-April: ~206 m³/s) and low-level runoff in the dry season (May-October: ~62 m³/s). Glacial melt water contributes with 10-20% in the wet and up to 40% in the dry season (Mark et al., 2005).

First evidences of a crossed ‘peak water’

This constant water supply for human consumption especially during the months of less precipitation is already decreasing. First evidences corroborate a crossed ‘peak water’ in 6 glaciological subcatchments of the Santa river (Figure 3) where on prior enhanced river runoff will decrease and level out towards a new still unknown minimum with higher discharge variability. This contradicts the general consensus of a subsequent future discharge decline within a few decades. Future annual water stream (Figure 3, Phase 4) will be much lower than today with a dry season discharge decrease of up to 30% (Borera et al., 2012; Bury et al., 2013).

Increasing water demand: agriculture

Agriculture accounts for 80% of the total water consumed in Peru. ChaVíMoChic, an emblematic project situated on the dry Pacific coast (Santa effluent), is host to 74,000 ha export crops including 60,000 ha Recent expansion efforts (Phase III, Figure 1) stand in stark contrast and will even trigger the declining river runoff especially during dry season (cf. Carey et al., 2013).

Increasing water use: new hydropower schemes

Hydropower, with 53% (5.3%) of whole power capacity nationwide (Santa catchment) the energy pillar of Peru’s economy, might also be heavily affected by diminishing water resources. The Cañon del Pato central in the lower Santa river requires a minimum water discharge of 72 m³/s at full capacity (263 MW). High runoff seasonality and the current water resources decrease and increase of discharge variability contain a strong conflict potential with high economic and social impacts (cf. Vergara et al., 2007). Peru’s energy demand is increasing by 7.5%/year (MINEM, 2013). Present and future hydropower schemes will need to take into account a lower river discharge.

Conclusions

The CB area and Santa basin have raised considerable scientific interest but still represent an in-situ hydro-climatic and glacier data scarce region. Climate change impacts are already altering natural water supply while human water demand with needs for a year-round constant minimum discharge is increasing.

More comprehensive studies are imperative in order to quantify and capture the complexity and links between natural water supply and different water users. The use of biased-corrected satellite data is imperative in order to close data gaps in the remote and poorly gauged CB area. More transdisciplinary efforts considering physical and social key variables must be made to develop adaptation strategies to a rapidly changing water balance in the Santa basin. Acknowledgements

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References