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Full length Article

The recent deglaciation of Kolahoi valley in Kashmir Himalaya, India in response to the changing climate

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ABSTRACT

In the present study, the retreat of Kolahoi glacier was mapped from the satellite observations and historical maps supplemented by the extensive field observations to understand the recent deglaciation of the Kolahoi valley, Kashmir Himalaya, India. The glacier has retreated by 2.85 km during the last 157 years from 1857 to 2014 with an average retreat of about 18.2 m year^{-1}; however, the glacier snout has shown higher recession during the last decade. The geomorphological evidence reveals glaciation of the Kolahoi valley during the Quaternary. These evidences include glacial till at Pahalgam and Aru besides terminal and lateral moraines at Lidderwat, Satlanjan and Kolahoi Gunj in the Kolahoi valley. The glacier has shrunk by 2.81 km^2 during the last 51 years (1962–2013) losing an ice volume of 0.30 km^3. The observed glacier changes were correlated with the climate data from PMIP3-CMIP5 models. The temperatures are predicted to increase almost ten times more than that observed during the Last Glacial Maximum (LGM). The future temperature is predicted to rise between 0.18 °C and 0.61 °C per decade under RCP 2.6 and RCP 8.5 respectively. The projected rise in the temperature, if realized, will have an adverse effect on the glaciers and would, in all likelihood, adversely affect the water availability for various sectors in the region.

1. Introduction

The indicators of climate change are very evident over Himalaya (Beniston, 2003; Kang et al., 2010; Romshoo et al., 2011; Wang and Chen, 2014) and these changes have exacerbated glacier recession (Akhtar et al., 2008; Immerzeel et al., 2010; Romshoo et al., 2015). It, therefore, becomes imperative to understand the magnitude of the climatic changes and how these changes influence the cryospheric and hydrological processes in the region. Recent studies have demonstrated that the glacier cover in the Kashmir Himalaya, India is declining at an increasing rate compared to other parts of the Hindu Kush Himalaya (HKH) (Kääb et al., 2012; Murtaza and Romshoo, 2016). Hence, it is very obvious that the Himalaya may lose the glacier cover in response to the climate change which will have serious impacts on the regional hydrology (Barnett et al., 2005; Cogley, 2011; Nepal et al., 2014). However, some studies suggest that Himalayan glaciers, especially in the Karakorum region, are stable (Bahuguna et al., 2014; Ganjoo and Koul, 2013; Raina, 2009). The past glaciological, climatological and hydrological studies in the Himalaya have focused, on spatio-temporal changes in glacial extents (Frey et al., 2012; Kääb et al., 2014), mass balance (Berthier et al., 2007; Brahmbhatt et al., 2012), snow cover dynamics (Hall, 2012; Rittger et al., 2013), hydrological modelling (Naz et al., 2014; Nepal et al., 2014), climate change impacts (Hock, 2014; Sorg et al., 2012) and anthropogenic activities (Ginot et al., 2014; Kaspari et al., 2014; Ming et al., 2009). Despite the vulnerability of Kashmir Himalayan glaciers to the environmental changes, very few glaciological studies have been carried out to understand the glacier recession in the region.

Mapping the glacio-geomorphological features is vital for assessing the historical glacier extents, fluctuations and glacial controls on landscape development in montane systems (Barnard et al., 2004; Hughes et al., 2005; Kamp et al., 2004; Owen et al., 2006). These features provide valuable information about the past glacial extents (Owen et al., 2002; Zawiska et al., 2015). Earlier efforts to map glaciogeomorphology in the Himalayan region were mostly restricted to small-scale field surveys that include the notable studies of Dainelli (1924–1935), Norin (1925), Klute (1930), Trinkler (1930), De Terra and Paterson (1939) and Holmes and Street-Perrott (1989). Most of the glaciological studies carried out so far in Kashmir Himalaya are restricted to mapping and understanding the short term dynamics of glaciers (Bolch et al. 2012; Romshoo et al., 2015) with a little emphasis on glacial geo-

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