Geophysical Research Abstracts
Vol. 17, EGU2015-10007, 2015
EGU General Assembly 2015

Climate variability, precipitation trends, and impacts on surface processes in humid to arid climate transition zones of the NW Argentine Andes (24° S, 65° W)

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In the Andes of NW Argentina the distribution and amount of rainfall and associated surface processes are intimately correlated with pronounced topographic gradients and relief contrasts that intercept easterly moisture-bearing winds related to the South American Monsoon System. These conditions have led to a pronounced elevation-dependent distribution of rainfall, which involves areally limited transition zones between the humid eastern flanks of the orogen (eastern foreland and eastern flanks of the E Cordillera) and the arid orogen interior (Puna Plateau). At interannual scales rainfall patterns in this area can be modulated by different atmospheric disturbances, such as the South Atlantic Convergent Zone and the El Niño Southern Oscillation, resulting in drought or flooding events. During the last two decades, field observations document fluvial aggradation in many intermontane valleys along the eastern flanks of the orogen. This may be related to changing overall climatic conditions, impacting hillslope erosion processes at high elevation, but contemporaneously overwhelming the fluvial system and reducing transport capacity, leading to transient sediment storage.

We analyzed rainfall trends in the humid to arid climatic transition zone in the NW Argentine Andes over different time periods to characterize the spatiotemporal variability of rainfall patterns during the last five decades. We relied on both daily ground station (40 stations, 1956-2012) and three-hourly remote sensing rainfall data (3B42 V7 TRMM data, 1998-2014). Seasonal total anomalies analysis shows a complex rainfall pattern, reflected both in station data and remote sensing observations with clear positive (negative) statistically significant trends in the northern Puna Plateau and in the northern part of the foreland basin (southern part of the eastern foreland basin) of up to +20mm/yr (-20mm/yr). Quantile regression of three-hourly and daily data furthermore shows that, on average, intensified (diminished) extreme events (percentiles > 90th) almost completely account for the increase (decrease) in seasonal totals, while median rainfall values have been sustained at a constant level.

Our results suggest that climate transition zones in NW Argentine Andes have been subjected to the effects of pronounced climate variability over the last decades, primarily expressed as rainfall extreme events. In the context of regional fluvial aggradation and sediment transfer from semiarid hillslope environments to transient storage in intermontane basins we suggest that the intensity of changing rainfall extreme events may ultimately control the pronounced coupling between erosion and sedimentation in the intermontane basins of the southern central Andes.