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Vegetation dynamics and land-cover change along a precipitation gradient in the tropical semi-arid high Andes

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Besides other factors like land use, soil, groundwater or temperature, precipitation is strongly influencing vegetation and land cover (LC). Various studies showed strong relations between annual precipitation and NDVI within semi-arid climates of monomodal annual precipitation. Inter- and intra-annual changes in precipitation are known to effect vegetation dynamics and may cause LC change. Quantifying inter- and intra-annual precipitation variability and its influence on vegetation and LC is thus important for a deeper understanding of ecosystem variability. It also forms the basis for predicting vegetation dynamics and LC changes from time series data of precipitation.
Our study investigates these effects in selected semi-arid regions of the tropical high Andes. Satellite-based remote sensing data offer a cost-effective possibility for retrieving information on vegetation dynamics and LC change. Data from the NDVI product MOD13Q1 (version 5) of the Moderate Resolution Spectrometer (MODIS) and the gridded 3h precipitation product (3B42 V6) from the Tropical Rain Measurement Mission (TRMM) were used in this study covering the period from 2000 to 2010. NDVI data have a spatial resolution of 250 m and a temporal resolution of 16 days, while TRMM data are available on a 0.25 degree geographic grid at three-hourly intervals.
First we applied a simple LC classification scheme using thresholds derived from NDVI based phenologic metrics over ten hydrological years. Then areas were delineated in which no LC change was detected (i.e. stable LC classes). Phenologic metrics of these areas were then aggregated by spatial averaging for each of the TRMM pixels analysed in our study. In a second step precipitation data was aggregated to precipitation sums for each 16-day MODIS NDVI interval.
Linear correlation analyses between annual precipitation and annual mean NDVI results in explained variances between $r^2 = 0.3$ and $r^2 = 0.7$ depending on LC class. It also became apparent that minimum annual NDVI is related to previous year precipitation up to $r^2 = 0.61$ indicating dependencies of vegetation dynamics on precipitation at an inter-annual time scale.

Keywords: vegetation dynamics, land cover change, NDVI, precipitation, MODIS, TRMM, tropical semi-arid high Andes