



Alluvial fan morphodynamics along the coastal Atacama Desert – geomorphometric, geologic, and climatic perspectives

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The narrow coastal plain between 20.5°S and 25.5°S in Northern Chile is characterized by Late Quaternary alluvial fans emerging from the prominent Coastal Cordillera to the Pacific Ocean. Especially towards the south, coastal alluvial fans (CAF) become the dominant geomorphological feature. They are much younger than the interior alluvial fans of the hyperarid Atacama Desert and are, in comparison, highly active. However, only few regional studies on the past and recent morphodynamics of the CAF have been conducted so that the dependency of their dynamics on climatic, lithologic, and tectonic controls is as yet not well understood.

Following a low precipitation gradient from S to N, controls on the CAF morphometry are deciphered in this study. For this purpose, a spatial statistical analysis of the relations between the morphometry of ~150 CAF and the morphometric and geologic properties of the corresponding catchments was conducted. Morphometric analyses were based on digital elevation models with 12.5 m and ~30 m resolution (TanDEM-X WorldDEMTM and ALOS World 3D, respectively). Regional geological data in scales between 1:100,000 and 1:250,000 were compiled and evaluated according to dominant lithologies of the catchments.

Spatial assessment of sediment connectivity in the catchments enabled the subdivision of larger catchments in upstream zones reaching deeper in the Coastal Cordillera and downstream zones extending only over the steep flank of Coastal Cordillera. In contrast to the upstream regions, the downstream parts predominantly contribute to the supply and transport of sediment. Stronger correlations between CAF and catchment morphometrics are evident when only the downstream zones are considered instead of the entire catchments. The results are interpreted along the N-S-gradient based on extreme precipitation values derived from the Regional Climate Model WRF for the Atacama Desert.

In conclusion, spatial analysis of CAF-catchment-relationships and precipitation patterns show a dominant role of climatic influences on the Late Quaternary CAF morphodynamics. Our results corroborate a contrasting landscape development between the coastal Atacama and the inland desert core due to the different precipitation sources and corresponding frequencies. Strong limitation of sediment supply and transport to the western flank of the Coastal Cordillera indicates that precipitation events originating mainly from extratropical winter storms scarcely affect the inner mountain range. Furthermore, CAF morphometry mirrors the decreasing influence of such events towards the north.

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