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Geomorphic processes and the stability of surfaces in the central Atacama Desert (Chile) – comparing Sentinel-1 InSAR coherence time series and field evidence

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Recent analysis of spatio-temporal variations of Sentinel-1 InSAR coherences for the entire Atacama Desert have revealed that about 70% of the area show hardly any detectable surface change in an ENSO-affected time series between 2015 and 2018. This validates that geomorphic processes in the central Atacama are of remarkable slowness or even stagnant, as also suggested by the age of surfaces and landforms, i.e. the age of the landscape in general. Most of these surfaces in the central desert are characterized by rather smooth morphologies, which is a result of thick atmospherically derived salt and dust deposits masking the desert surface, supported by the presence of gypsum crusts and/or Biological Soil Crusts (BSCs). In contrast, geomorphic activity on recent time scales is typically linked to episodic Andean discharge or severe precipitation events, which can cause overland flow or flash flood activity even in the hyperarid core of the Atacama as recently shown by the 2015 rainfall event. Likewise, fog-related atmospheric moisture is assumed to provoke salt-driven shrink-swell processes, and episodic activity by slumping and/or seismicity may successively alter landforms in the central desert over longer time scales as well.

Based on Sentinel-1 InSAR coherence data, this contribution presents the spatial pattern of morphodynamic activity in the central Atacama Desert, which is paired with further independent variables achieved by remote sensing such as soil surface indices and geomorphometric parameters (e.g., using TanDEM-X WorldDEM^{TM}, DLR science grant), ultimately characterising the different types of desert surfaces. The satellite-based regional morphodynamic pattern is compared to on-site field evidence collected between 2016 and 2019, which suggests (limited) geomorphic activity rather than stability on late Pleistocene time scales at a variety of locations. Among these locations are flood-affected channel systems and alluvial fans, but also patterned ground structures, zebra stripes, slump- or creep-related slope deposits, or BSC-covered surfaces, which are assumed to support aeolian deposition. Except for the flooding activity, field sites with inferred late Pleistocene to Holocene activity seem to be located in the fog-affected zones of the Coastal Cordillera. Our study shows that the combination of field and remote sensing data may contribute to a better understanding of past and present – particularly rainfall-independent – geomorphic processes in the hyperarid Atacama.

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