Geophysical Research Abstracts
Vol. 21, EGU2019-15029, 2019
EGU General Assembly 2019

Biotic effects on river sediment dynamics mediated through grain size distribution in the Chilean Coastal Cordillera

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Sediment dynamics in river catchments are governed by tectonics, climate and biota. They act directly on the transport process by controlling topography and sediment transport capacity (runoff) and indirectly by controlling the flux and grain size distribution (GSD) of sediments supplied from hillslopes to the fluvial system. Since climate is the main driver for biotic activity, both effects are strongly coupled, and often difficult to disentangle. However, while climate forcing shows a clear trajectory towards increased erosion with increasing humidity, the effect of vegetation is more ambiguous. On short timescales vegetation reduces hillslope erosion and sediment supply from hillslopes by stabilizing soils and trapping sediments. On longer timescales an increased sediment residence time and enhanced biochemical weathering of material in the soils enhances the production fine grained material and hence strongly alters the GSD of material delivered to the fluvial transport system. We state that the influence of vegetation on the grain size distribution of sediments supplied to the river system is a key factor in the biotic control on sediment dynamics, since it exerts a strong control on the transport mechanics and morphodynamics in the river system which in turn control incision and deposition and hence landscape evolution.

To investigate vegetation induced shifts in GSD, we collected grain size samples of hillslope and channel sediments in four granitic mountainous river catchments located along the strong bioclimatic gradient of the Chilean Coastal Cordillera, ranging from the arid, non-vegetated Atacama desert in the north (26°S) to the humid and densely vegetated Cordillera Nahuelbuta in the south (38°S).

78 volumetric bulk samples were taken with grain sizes ranging from clay (d = 0.3μm) to boulders (d >300mm). By sampling hillslope and fluvial sediments from the hilltop to the channel outlet we track the effect of vegetation on the spatial variability of GSDs along the sediment transport path.

Results show that hillslope sediments in humid areas contain higher fraction of fines compared to the arid areas, while channel sediments in contrast are much coarser. Uniform GSDs in the arid catchments reflect nonselective and thus transport-limited conditions in the river channels. In contrast, in humid catchments GSDs show strong differences between fine hillslope sediment and coarse channel deposits, indicating size selective and supply-limited transport conditions in catchment with higher vegetation coverage.