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Quantifying the geomorphic impacts and sediment transport of a lake break-out lahar, Mt. Ruapehu, New Zealand.

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Pre- and post- LiDAR surveys analysed from the 2007 Mt. Ruapehu Crater Lake breakout lahar display the net impact a lahar has on the landscape and provides a proxy for the net sediment entrained and transported. Between 22-40 km from source, the lahar was carrying its maximum sediment load of 3x106 m3, a quantity that remained stable for this stretch of river indicating a volumetric bulking of ∼2.5 times its initial starting volume. Despite maintaining a stable total quantity of sediment along this river stretch, a complex interplay of erosion and deposition continued, effectively exchanging and recycling sediment between the flow and its substrate. Controls on this exchange appear to relate to channel sinuosity, depth, width, roughness and local slope. The resulting lahar deposits comprise several discrete units that differ in grainsize, texture, thickness and distribution depending on local channel conditions and time-variant flow rheology. The dynamic flow data show a rapidly rising watery bow-wave ahead of the lahar, which emplaced bedded, moderately-sorted medium sands on middle- to high-level banks. High flow velocity and turbulence promoted erosion in near-channel sites. Overlying massive, reversely graded, very poorly-sorted sandy gravels were deposited by the highly sediment-charged main lahar body. Decrease in stage height and retreat of the concentrated flow back into the channel ceased deposition on the upper banks and initiated near-channel accumulation of thick, normally graded gravelly units at channel bends and a thin coarse sandy layer along straight sections. The final depositional stage was marked by bedded, moderately- to poorly-sorted sandy deposits in near-channel sites and initially on middle slopes, with pulses in the waning flow producing alternating layers of coarse and medium sands. The step-wise drop in flow stage resulted in simultaneous erosion of the previously deposited sediments and successive cutting of terraces. The model of deposition provides a useful indicator of the net sedimentological response of the lahar as well as the ability to quantify sediment movement and sedimentation rates. Furthermore, when combined with stage height data and flow velocities the geomorphic analysis also provides an ideal platform for comparing theoretical calculations of dynamic flow parameters, such as bed shear stress, to real world examples to explain the resulting patterns of erosion and deposition. Understanding and quantifying sediment entrainment (erosion) can now be incorporated into flow simulations to provide better forecasts of the hazards expected for these types of events.