Geophysical Research Abstracts
Vol. 16, EGU2014-11450, 2014
EGU General Assembly 2014

Sediment accumulation and net storage determined by field observation and numerical modelling for an extensive tropical floodplain: Beni River, Bolivian Llanos

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Lowland floodplains in subsiding basins form major depocentres responsible for the storage and cycling of large quantities of fine sediment and associated nutrients and contaminants. Obtaining reliable estimates of sediment storage in such environments is problematic due to the high degree of spatial and temporal variability exhibited by overbank sediment accumulation rates, combined with the logistical difficulties inherent in sampling locations far away from the channel. Further complexity is added by the high channel mobility, which recycles sediment and reconfigures the relationships between channel and floodplain morphology, sediment transport and overbank sedimentation. Estimates of floodplain accretion can be derived using a range of numerical sedimentation models of varying complexity. However, data required for model calibration are rarely available for the vast floodplains associated with tropical rivers. We present results from a study of channel-floodplain sediment exchange fluxes on the Rio Beni, a highly dynamic, tropical sand-bed tributary of the Amazon in northern Bolivia. The Beni transports high concentrations of suspended sediment, generated in the river's Andean headwaters, and disperses this material across an extensive floodplain wetland that experiences annual inundation over an area of up to 40000 km^2. We utilise estimates of overbank sedimentation rates over the past century derived from ^{210}Pb analysis of floodplain sediment cores collected along a 375 km length of channel, including sampling a range of channel-floodplain configurations within the channel belt and on the distal floodplain (up to 60 km from the channel). These data are used to investigate spatial and temporal variations in rates of floodplain sediment accumulation for a range of grain sizes. Specifically, we examine relationships between sedimentation rate and distance from the channel, and characterise within channel belt variability in sedimentation linked to patterns of channel migration and associated levee reworking. Field data are used to inform a hydrodynamically-driven model of overbank sedimentation and to derive uncertainty-bounded estimates of total floodplain sediment accumulation. Sediment exchange due to planform channel mobility is quantified using a numerical model of meander migration, calibrated using analysis of remote sensing imagery to determine rates and geometry of channel migration. Our combined data and model analysis allows the construction of a mean annual sediment budget for the Beni, which suggests channel-sediment exchange fluxes in the order of 100 Mt a^{-1}, equivalent to 10% of the sediment load of the mainstem Amazon.