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The shredding of environmental signals by Australia's river systems studied using $^{26}Al/^{10}Be/^{14}C$ ratios in sediment

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Quantifying the dynamics of sediment routing systems is essential to understanding the mass fluxes associated with the processes acting across the landscape. Deciphering the latter, in turn, requires an understanding of how the erosional response of landscapes to climatic and tectonic forcings is buffered, modified, and even erased by the world's large rivers as sediments are transferred from source areas to depocentres. Due to its short half-life – 5730 years – in situ produced ^{14}C is sensitive to the sediment transit times characteristic to river systems and when used in combination with the longer lived isotopes, ^{14}C becomes a powerful tool for studying sediment transport from source to sink.

We estimated sediment transit times in Australia's largest river system, the Murray-Darling basin, by measuring downstream changes in cosmogenic $^{26}Al/^{10}Be/^{14}C$ ratios in modern river sediment. Results show that the sediments have experienced multiple episodes of burial and re-exposure, with cumulative lag times exceeding 1 Ma in the downstream reaches of the Murray and Darling rivers. Our study suggests that the transmission of environmental signals from Murray and Darling source-areas will potentially be out of sync – due to both the long cumulative residence times and the multiple episodes of burial and re-exposure – precluding any interpretations of source-area paleoclimate from these sediments. We further report $^{26}Al/^{10}Be$ ratios from river sediment along the East Australian continental margin that also deviate from steady-state values. Here we find a link between $^{26}Al/^{10}Be$ ratios and metrics of climate variability: the periodic stripping of vertically accreted floodplains by large floods means that deeper and potentially older material is periodically incorporated into the sediment mix transported by the modern river. The processes that control sediment reworking in East Australian coastal rivers are different to those operating in the Murray-Darling, but the outcomes are similar: environmental signals of climatic and tectonic forcing are altered and, in some instances, destroyed by the internal dynamics of the sediment routing system.

Taken together, our data suggest that sediment reworking and protracted sediment transit times may be the norm in Australian rivers as they may also be in other post-orogenic settings.