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Radiocarbon and geochemical constraints on shallow groundwater recharge in a large arid zone river, Cooper Creek, SW Queensland, Australia

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In the arid and semi-arid internally drained Lake Eyre Basin of central Australia, large mud dominated anabranching river systems transport monsoon derived floodwaters into the centre of the continent during the summer months, and subsequently spend much of the year under low to no flow conditions. Cooper Creek has the largest catchment in this basin, and in south west Queensland has a wide (20-60km) floodplain and multiple channel system. Enlarged channel segments, known as waterholes or billabongs, can retain water throughout much of the dry season, and their mud base can often be scoured during floods into the underlying sandy alluvium where the shallow groundwater table exists ~3-5m below the base of the waterholes. Little is known of the groundwater recharge mechanisms in this ecologically important and hydrologically unregulated river system, thus a number of piezometer transects were construct across the floodplain between two waterholes to investigate groundwater recharge processes in further detail. Samples recovered from all piezometers were analysed for major-trace element, water stable isotopes (δ^2H and δ^{18}0), ^{3}H and ^{14}C. Water stable isotopes reveal shallow groundwater is recharged by high magnitude, low frequency monsoonal flood events, with minor evaporative enrichment probably linked to recent smaller flooding events. ^{14}C dating of dissolved inorganic carbon reveals recharge is most effective beneath the deepest channel segments of the waterholes, and that residence time of the shallow groundwater increases with distance from major waterholes, with the post 1950's ^{14}C bomb pulse signature present only in close proximity to the channels. ^{3}H allows further refinement of the shallow groundwater residence times, with no ^{3}H detected in groundwater over ~500m from the waterholes, indicating groundwater recharge is slow and restricted to major flooding events. The increase in groundwater residence time with distance from waterholes, is also accompanied by an abrupt increase in salinity, and suggests recent recharge has formed local freshwater lenses above the regional, more saline groundwater. This increase in salinity with increasing distance from the waterholes is not accompanied by an increase on the evaporative signal of water stable isotopes, suggesting evapotranspiration is the dominant mechanism of salinisation within the shallow groundwater beneath the floodplains and minor channels. This study demonstrates that detailed chemical analysis of groundwaters from arid and semi arid areas can provide a useful estimate of recharge where the remote location makes traditional detailed borehole monitoring difficult or impossible to achieve.