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THE COOPER CREEK BASIN, AN EXTENSIVE DRYLAND RIVER SYSTEM IN THE CHANNEL COUNTRY OF CENTRAL AUSTRALIA

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Cooper Creek at 1500 km is the world's longest creek and surely the only one to result from the confluence of two major rivers (the Thompson and the Barcoo). The 306,000 km² basin is flat to undulating, reaching a maximum elevation of 865m in the Great Dividing Range northeast of Hughenden, but with less than a few percent of the basin over 500m and most of it below 200m. It drains to a depocentre in saline Lake Eyre, some 15m below sea level.

The basin consists of a vast complex of sparsely vegetated rocky surfaces, gibber plains, aeolian dunes, clay pans, salt lakes and muddy floodplains. Near Lake Eyre the average annual rainfall is the lowest on the continent, averaging ~125mm with a pan evaporation of ~3800mm. This deficit decreases towards the northeast of the basin where rainfall averages ~500mm and evaporation ~2400. Runoff is largely derived from northern incursions of moisture from the trades and the monsoon with major flooding episodes most often associated with the La Nina phases of ENSO.

January maximum temperatures average 36-38°C but winter minimums can approach freezing in the south. Average annual discharges decline from 3.05 km³ per year (96.7 m³s⁻¹ with some flow every year) at Windorah in the upper part of the basin, to 1.98 km³ (63m³s⁻¹ with flow nearly every year) at Innamincka (450 km downstream) to an estimated 0.63 km³ per year at Lake Eyre (a further

400 km downstream, but with flows reaching the lake only every~6-8 years).

The maximum discharge ever recorded at Windorah was $25\,000\text{ m}^3\text{s}^{-1}$ in 1974, a flood wave that declined to $6400\text{ m}^3\text{s}^{-1}$ at Innamincka. Losses average around 75% in a complex fashion; minimal losses occur during low flows confined to the anastomosing channels, greatly increasing as initial overbank flows soak into the dry cracking clays of the floodplains, before losses proportionately reduce again during major floods as floodplain surfaces become saturated. With stream gradients around 0.00015 and floodplains up to 60 km wide, floodwaves commonly take months to traverse the full length of the basin.

A distinctive feature of the vast network of floodplains and ephemeral anastomosing channels, collectively known as the 'Channel Country', are large waterholes, some hundreds of metres to 22 km in length and 3-7 m deep, many retaining permanent water in the driest years.

These are scour features resulting from enhanced flow-energy due to: 1) the concentration of flow between aeolian dunes on the floodplain surface, 2) the convergence of two or more large anabranching channels, or 3) flow impinging on the bedrock valley side.

They are an integral part of the total flow system and are clearly the product of the present flow regime. Their discontinuous nature makes them irregular manifestations of what continuous channels would look like if flow conditions in Cooper Creek were less marginal. Another distinctive characteristic of Cooper Creek are the self-mulching vertisols and muddy alluvium that dominate the upper floodplain stratigraphy.

These non-saline muds are clay rich (60-80%) with abundant smectite. They occur as pelleted fine to coarse sand-sized aggregates (d₅₀ 0.12-0.75 mm) of low density (2300 kg m^{-3}) transported mostly as traction load in the form of ripples and small dunes over the extensive floodplains.

When disaggregated by prolonged inundation, the aggregates readily reform during a few wetting-drying cycles. The transport of these

ubiquitous surficial muds as aggregates causes the development of extensive, wide, shallow braid-like flood-channels over large areas of the floodplain. Despite the abundance of mud, suspended load concentrations are low, averaging only 150-200 mg l⁻¹ at bankfull flow although sometimes up to 450 mg l⁻¹ during rising stages. Within-channel bedload yields are also low as evidenced by actual bedload sampling, low channel gradients, low width-depth ratios and the lack of well developed bedforms along most of the anabranches.

Cooper Creek has developed as a result of Neogene crustal warping that has produced depressions that define the general trend of its valley in southwestern Queensland. Late Tertiary-age gravel terraces are abundant along the middle reaches. As the river crosses into South Australia, it flows in a low antecedent gorge within the southern limb of the Innamincka Dome which is probably still rising across the river's path.

A long and detailed middle- to late-Quaternary history has been reconstructed along the length of Cooper Creek. Periods of substantial runoff, enhanced flow-energy and abundant sand transport have characterised oxygen isotope Stages 7, 5 and 3. At these times the river consisted of large meandering channels that were significantly more laterally active than is the present low-energy mud-dominated anastomosing system. The glacial and stadial periods appear to have been dry. There is evidence from the alluvial stratigraphy of the Cooper that most of eastern Australia has been drying out in a cyclical fashion since the mid Quaternary with the present (Holocene) interglacial much drier than earlier ones. At times, aeolian dunes have blocked the course of the Cooper below the Dome and sent flows down Strzelecki Creek to Lake Frome, a truly major regional-drainage disruption.

The Cooper basin is an exceptionally diverse dryland fluvial system quite unlike any other thus far described. It retains a remarkable record of Quaternary environmental change for eastern Australia, and is providing important details of the broader picture of climate change in the Southern Hemisphere.