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Vegetation mosaics in arid Australia: linked roles for climate and soils

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It is widely considered that quasi-regular patterns in dryland soils and vegetation reflect a process of self-organisation. In such a view, the spatial patterns emerge from multiple interactions and feedbacks among the elements of the ecogeomorphic system. In arid western NSW, Australia, key elements affecting the self-organisation of strongly banded vegetation appear to include the extreme climatic variability (related to ENSO and other global climate phenomena) and the geomorphic history of the landscape, which involves major glacial-period accessions of exotic aeolian clays of the illite family, which exhibit very marked shrink-swell behaviour. The latter may be a prerequisite for pattern emergence, and the former a key driver of emergence. A cellular model of pattern emergence was driven by a timeseries of annual rainfalls exhibiting occasional marked wet La Niña years and also multi-year El Niño droughts, in order to explore how this climatic driver affects pattern emergence. Importantly, the model incorporated the effects of drying and contraction of the deeper subsoils during multi-year droughts. In the field, extreme soil desiccation is seen to result in widespread tension cracking and collapse of the surface soils into voids in the more clay rich, and more strongly contracted, subsoil. The collapse features maintain the water trapping efficiency of the vegetation groves even when the plant cover has declined greatly. Trapping efficiency remains low within intergroves, because the subsoils there are always relatively dry, owing to their impermeable soil surfaces. Modelling excluding soil collapse during drought showed much greater loss of groves and resultant changes in grove spacing that is not seen in long-term field monitoring data. This suggests that the variability of annual rainfalls (and not just the average climatic aridity) may actually confer stability on the banded vegetation communities via a little-explored linkage of soil and climatic factors.