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Soil carbon and soil moisture dynamic redistribution in a banded ecosystem

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Arid and semiarid environments accounts approximately 30% of the Earth's continental surface and are especially sensitive to degradation or loss of their ecosystem functionality. In these ecosystems, vegetation patterns (e.g. banded vegetation) can be found as the adaptive response of the system to resource redistribution (runoff and sediments) and limitation (soil moisture and nutrients). The patterns consist on alternating densely vegetated bands (or 'groves') and bare areas (or 'intergroves'), and can be found in large regions of Africa, Asia, Australia and North America. Understanding the mechanism that regulate banded vegetation ecosystems is critical in order to identify the dynamic behaviour and maintain their functionality. In this work, we model the spatial distribution of soil moisture and soil organic carbon, in order to analyse how differences on the availability of resources can explain the functionality of the banded vegetation systems. We are studying a catchment in Bond Springs, 25 km north of Alice Springs, characterized by the presence of Acacia Aneura trees (Mulga) aligned in bands along the terrain. We use a new model: COPLAS, a tool that couples a Landform Evolution Model with dynamic vegetation and carbon pools modules. It tracks the carbon from the photosynthesis until it becomes soil carbon and the mobilization/redistribution due soil erosion. Results of the model were compared with fieldwork conducted in fifty-three soil samples and terrain surveying with unmanned aerial vehicle. Our results indicate good agreement between the model and the measurements. We found that soil moisture uphill the bands is around 33% more than downhill, and close to 120% more than in bare soil. This result could be explained because a portion of the runoff, generated from bare intercanopy patches, is redistributed downslope and infiltrated uphill the vegetated areas. Moreover, soil carbon is 20% more downhill than uphill the bands because of deposited alluvium and litter downhill and possible less microbial respiration and decomposition due smaller soil moisture content. Additionally, we found a tendency of higher soil carbon concentrations going downhill the catchment. Overall, these findings show the heterogeneous distribution of resources in the area that could explain the ecosystem functionality and highlight the importance of modelling and measuring arid and semiarid ecosystems in order to understand their dynamic behaviour.