Geophysical Research Abstracts
Vol. 18, EGU2016-10559, 2016
EGU General Assembly 2016

Controls on matrix flow, preferential flow and deep drainage rates in an alluvial Vertisol.

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Deep drainage is the process that describes water percolating from the land surface to a depth below the root zone where it may contribute to groundwater recharge. Quantitative estimation of deep drainage through Vertisols is challenging, largely due to the unknown relative contributions from: (i) flow through the soil matrix; and (ii) flow along preferential pathways in particular soil cracks, and how to model the transience of the relative contributions. The Condamine River Alluvium, a significant aquifer in semi-arid eastern Australia, is mostly covered by uniform dark cracking clays such as Black and Grey Vertisols. The aim of this study was to identify the environmental conditions (rainfall, antecedent soil moisture, etc) controlling matrix and preferential flow in selected Vertisol profiles at the time scale of individual rainfall events.
Field experiments (including 16 probes recording soil moisture at one hour intervals across eight depths between 100 mm and 4000 mm) provide extensive soil moisture data, supplemented by weather station data collected at 15-minute intervals. In addition, laboratory experiments were used to infer the water retention curves.
These data were used to (i) derive deep drainage rates using the zero-flux plane method, and (ii) calibrate a soil moisture balance model that represents both matrix and preferential flow. The model was used to estimate the parts of the vertical water flux attributed to soil matrix and preferential flow. High antecedent soil moisture was associated with low fluxes at shallow depths, however at deeper depths both low and high antecedent soil moisture were associated with larger fluxes. Further, both rainfall amount and intensity controlled the interplay between matrix and preferential flow. The results reveal new insights into deep drainage processes in Vertisols and provide the basis for developing a practical approach for deep drainage estimation.