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Hydrodynamic behaviour of crusted soils in the Sahel: a possible cause for runoff increase?

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Crusted soils are in extension in the Sahel. As rainfall has decreased over the past decades (it is now increasing again in the central Sahel) and no significant change was observed in rainfall intensity and in its time and space distribution, it is supposed that land use management is the main cause for crusts cover increase. Fallow shortening, lack of manure, and land overexploitation (wood harvesting, overgrazing) are frequently cited as main factors of soil degradation.

Based on field measurements in some small catchments of Western Niger, the hydrodynamics behaviour of the newly crusted soils of this area is described, mostly constituted by erosion crusts. A strong fall in soil saturated conductivity and in the active porosity as well as a rise in bulk density all lead to a quick onset of runoff production. Results are shown from field experiments in sedimentary and basement areas leading to similar conclusions. In both contexts, runoff plot production was measured at the rain event scale from 10-m2 parcels as well as at the catchment outlet.

Soil saturated conductivity was reduced by one order of magnitude when crusting occurs, leading to a sharp runoff coefficient increase, from 4% in a weeded millet field and 10% in an old fallow to more than 60% in a erosion-crusted topsoil at the plot scale. At the experimental catchment scale, runoff coefficient has doubled in less than 20 years. In pure Sahelian basins, this resulted in endorheism breaching, and in a widespread river discharge increase. For some right bank tributaries of the Niger River, discharge is three times higher now than before the drought years, in spite of the remaining rainfall deficit. On the other hand, a general increase in flooding hazard frequency is observed in the whole Sahelian stripe.

The role of surface crusts in the Sahel is discussed leading to the implementation of new experiments in the future.