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Hydrological Processes Modifications Induced by Land-Use Changes in the Caetité Region, Northeastern Brazil

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Land-use changes can generate important modifications in hydrological processes, especially those that take place close to the soil surface. These changes usually lead to a decrease in infiltration rates and to an increase in surface runoff and soil erosion. Besides, in the long-term, they tend to reduce groundwater recharge. Such effect can be amplified when intensive groundwater pumping is carried out in order to support mining and milling activities. This is the case in the region close to Caetité, in the southwestern portion of Bahia state located in northeastern Brazil, where an already problematic situation in terms of water supply due to the semi-arid conditions is becoming worse due to the exhaustive pumping, mainly for supporting the uranium mining and concentration activities, leading to a variety of potential conflicts concerning the water management in the basin. Since 2008 an experimental basin was installed in the area in order to characterize, through field monitoring and modeling, the evolution of the hydrogeochemical processes in the basin. This study aims, besides the assessment of the water quality, to characterize the effects produced by land-use changes in the hydrological processes that take place at the soil surface, especially on the soil infiltration capacity and saturated hydraulic conductivity (ksat). The Caetité experimental basin has a total area of about 65 km2 that includes portions with natural vegetation (dense and sparse), agriculture (usually small farms), grazing, as well as those resulting from the mining and milling activities (open pit, waste rock piles , industrial plant, ponds and access dirty roads). Although the mining activities have been only recently installed in the area (year of 2000), farmers have been established in the basin for up to 40 years. Average total annual rainfall in the basin is about 710 mm, with a long dry period (from April to October). The geological frame of the area comprises an Archaean gneiss-migmatite complex leading to gentle topography with long convex hillslopes separated by wide flat tops at the divides, where elevations vary from 750 to 1100 m. At the flat tops, thick highly weathered Oxisols (more than 20 m thick) develop over an old lateritic cover. At the lower elevations, hillslope dissection contributed to the formation of less developed and thinner soils, sometimes less than 1m thick. Soil texture may vary significantly inside the basin due to the changes in the mineralogical composition of the different bedrocks, with clay soils developing over alkaline metassomatic rocks. In this study we carried out an initial characterization of the spatial variation of soil infiltration capacity and ksat inside the experimental basin. The infiltration capacity was measured using double-ring infiltrometers (5 cm head). In situ measurements of ksat at 20cm depth were conducted using a Guelph permeameter. These in situ field measurements were carried out in 12 sites in the basin, with 2 repetitions, involving different conditions of land-use (natural vegetation, agriculture and grazing), soil type (Oxisols and Cambisols), geology (granite and gneisses) and topography (flat top and hillslope). Besides, undisturbed soil samples were collected from the upper portion of the soil profile (0-5, 10-15 and 20-25cm depths) to analyze the main physical and hydrological soil properties, including soil texture, bulk density, porosity (micro, macro and total), as well as the water retention curve. The initial results show that areas with dense natural vegetation, independently of soil and topography conditions, present the highest infiltration capacity values in the basin, with minimum infiltration rates (MIR) of up to 100 cm/h. In areas under agriculture, the MIR is reduced by about a factor of 3 when compared with that one of the natural vegetation. MIR values for soils under grazing for more than 10 years show a reduction of up to about a factor of 30, attaining values as low as 3 cm/h. However, long-term grazing in this area tends to favor biogenic activity, mainly by ants. In these areas, the soil disturbing and the pore network produced increase infiltration rates, bringing MIR values to that ones of soil under agriculture. In other words, biogenic activity induced changes due to grazing activity in the area may improve soil infiltration conditions, increasing MIR values by about one order of magnitude. In areas under sparse natural vegetation, splash processes take place favoring surface sealing, leading to MIR values similar to the ones

observed for grazing. Differently from what was observed in the infiltration rate, the effects of land-use on ksat are not clear. In general, the greater ksat values observed in the basin were at the main drainage divides, with soil are well-developed over large flat tops. The average ksat value for the basin was 5.68×10-2 cm/s. The results presented here, although preliminary, suggest that the land-use changes that took place in the area during the last decades induced important modifications in the hydrological processes.