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Water redistribution in lateritic soils of lower (Senegal)

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INTRODUCTION

The Djiguinoum valley is located in an area affected by West Africa drought since 1970. The lowlands degraded by acidification and salinization are protected against seawater intrusion by an anti-salt dam. Considerable amount of runoff water generated within the catchment during the rainy season is collected and stored for rice culture rehabilitation and then for evaporation in the dry season (MONTOROI, 1994).

The decrease of rice production in the valley makes more effective the pressure of farmers on the uplands. Forest ecosystem becomes more and more degraded by human domestic activities. Crops, such as groundnut, millet and sorghum, increase regularly and soils become sensible to runoff processes.

This paper reports an experiment which was conducted to evaluate the susceptibility of these soils to runoff and their contribution to the water supply of the valley.

MATERIALS AND METHODS

The experiments were carried out in 1990, in the southern part of the watershed. The two following soils were studied : a ferrallitic soil (upslope) and a ferruginous one (midslope).

Three parameters were measured :

• Infiltration rate in saturated conditions with a double ring infiltrometer : the internal ring was 55 cm across and the external one twice as high. A water amount of 300 mm was applied with a constant charge of 3 cm during 2 hours for ferrallitic soil and less than 1 h for ferruginous soil. For the last one, two tests were carried out.

• Infiltration rate in natural conditions during the rainy season : soil water profiles were monitored with a neutron probe (Nardeux Humisol) to a maximum of 300 cm.

• Runoff data were collected for each soil with a rainfall simulator used at three locations characterized by cultivated, natural and fallow surfaces. The field experiment was conducted under controlled conditions on a 1 m2 plot (1 m x 1 m) : the rain pattern was adapted to the regional conditions (CASENAVE and VALENTIN, 1989 ; ALBERGEL and al., 1991).

A water balance was calculated for each soil taking into account the rainfall, runoff and water storage amounts.

RESULTS AND DISCUSSION

Soil water infiltration

Figure 1 shows the maximum water profile during the rainy season and the total porosity profile for each soil. The saturation conditions are never reached. For the ferrallitic soil, infiltration is regular with an average rate of 90 mm j-1. The maximum saturation rate ranges from 75 to 80 %. For the ferruginous soil, temporarly saturated layers related to the decrease of total porosity can occur with the strongest rains. The average infiltration rate is 67 mm j-1 and the maximum saturation rate ranges from 40 to 60 %.

In saturated conditions, the permeability is higher for the ferruginous soil (350 to 600 mm h-1) than the ferrallitic soil (100 mm h-1). The increase of total porosity in the upper horizons explains the highest values of permeability.

Runoff

Runoff coefficients are higher for the ferruginous soil whatever the type of soil surface. When the ferrallitic soil is already wet, runoff can rapidly appear (34 %).

Water balance

Table 1 presents the different parameters of water balance carried out for a soil depth of 265 cm. Drainage fluxes are higher for the ferrallitic soil and supply ground water 5 months after the beginning of the rainy season due to the water table depth (about 25 m). For the ferruginous soil, vertical drainage water reaches ground water 3 months after the first rainfalls.

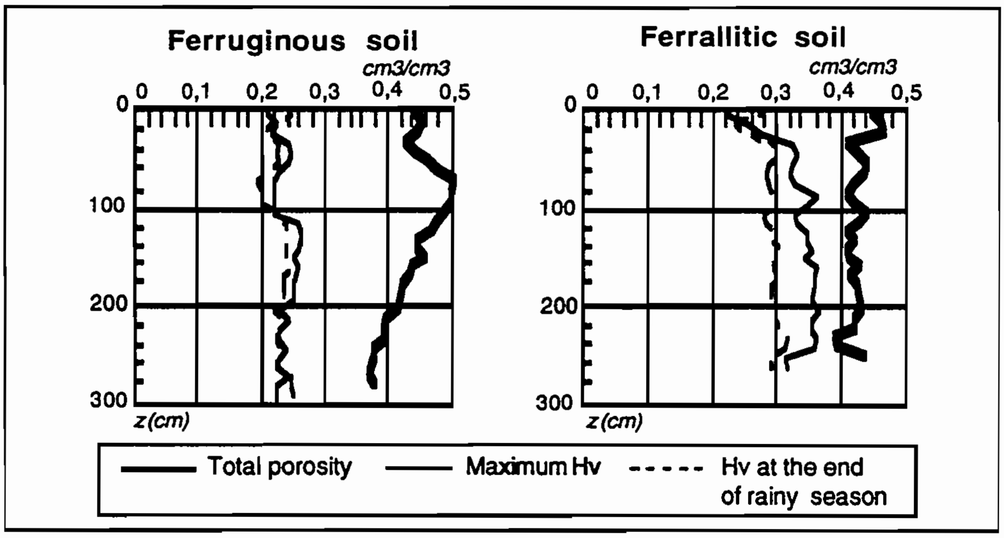

Figure 1 - Moisture profiles for two soils of the Djiguinoum watershed during the 1990 rainy season (Hv soil water content)

Period	Rainfall	Runoff	Water storage	Storage variation	n	ETR + Drainage	
			(mm)		(j)	(mm)	(mm j-1)
			Ferrallitic soil				
16 June			490.8				
	1081.5	19.0		214.9	127	847.6	6.7
21 October			705.5				
			Ferruginous soil				
16 June			299.1				
	1068.3	28.8		237.5	127	802.0	6.3
21 October			536.6				

n number of days for the considered period   ETR actual evapotranspiration

Table 1 - Water balance for two soils of the Djiguinoum watershed during the 1990 rainy season

CONCLUSION

For the two studied soils, water movements are very different and can be explained by their morphological and physical characteristics. In the watershed, water and solute fluxes lead to soil transformations along the catena (CHAUVEL, 1977).

Runoff processes cause colluvial deposits in the lowlands. Geochemical processes in valley soils depend on the soluble and solid matter supplied by the upper part of the watershed. In lower Casamance, even many soil erosion features are visible in landscapes, the soil loss is not so high as to worry the farmers in the short term.

However, in this climatic zone, erosion risks exist for the cropping areas or are potential for the forest surfaces. It seems that the human activities related to the environmental evolution are the main factor likely to accelerate further erosion development. Conservation measures (smooth clearing, higher fallow duration, organic matter supply) in the uplands will be recommended to prevent an irreversible transformation of landscapes and to sustain the current production system (ROOSE and SARRAILH, 1989-90).

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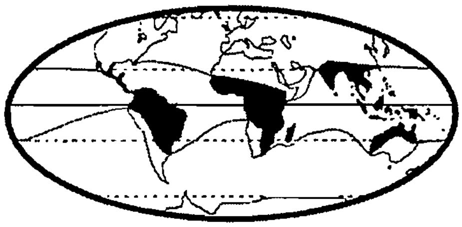

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