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Measured surface runoff scale effects in West African watersheds

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Measurements of surface runoff from uniform slopes of different lengths in West Africa have shown that longer slopes tend to have less runoff per unit of length than short slopes. The main reason for this scale effect is that when the rain stops, water on long slopes has more opportunity time to infiltrate than water on short slopes. This process is, therefore, also called recession infiltration. By installing plots with different lengths, the scale effect can be quantified. Experiments with different plot lengths were performed in three West African countries by different teams: Cote d'Ivoire (Ivory Coast), Burkina Faso and Ghana. These three areas are situated in different agro-ecological zones. Here, we present a comparative overview of the results.

The plots in Cote d'Ivoire were near Bouake (7˚42'N, 5˚06'W) with a pseudo-bimodal monsoon rainfall pattern with a total of 1100mm/yr. Here, the slopes had a tangent of 0.04, were planted with rainfed rice, and the runoff plots had lengths of 1.25 m and 12 m. In Burkina Faso (11˚08'N, 0˚59' E), the rainy season is characterized by one peak from May through October (monomodal), with a total rainfall of 900mm/yr. Here, the plots were installed in fallow vegetation, had slope tangents of 0.02, and plots had lengths of 1m and 5 m. In Ghana, the plots were installed near Ejura (7˚20' N, 1˚16' W) in the forest-savanna transition zone, with a bimodal rainfall pattern, and total rainfall of 1445 mm/yr. Here, the measurement sites were intensively cultivated (maize, yam, cassava), the lengths of the plots were 2 m, 6 m, and 18 m.

The results show that runoff coefficients from short plots were consistently significantly higher than from longer ones. In Cote d'Ivoire, runoff from plots with major

crusting was 42% of total rainfall for the 1.25 m plots and 24% for the long plot of 12m. For plots with less crusting, the runoff coefficient reduction was even more pronounced, from 29% for the short plot to 6% for the long plot. In Burkina Faso, a similar reduction in runoff from the short plot to the long plot was observed. The runoff coefficient for the 1m plot was 35% and for the 5 m plot, it was 5%. Also in Ghana this phenomenon was observed. For each of the experimental sites, a significant reduction was observed and the runoff coefficients were 32%, 12% and 5% respectively for the short (2 m), medium (6 m), and long (18 m) plots.

These different studies conducted in different regions and by different teams highlight the relevance of slope length for predicting total runoff from slopes. Additional parameters, like hydraulic conductivity, soil roughness, intensity and duration of rainfall explain the differences in runoff coefficients found for the different areas.