Analysis and synthesis of data on relationships between soil factors and soil erosion in South Africa

By

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Declaration

I declare that this mini-dissertation describes my original work, except where specific acknowledgement is made to the work of others, and has not previously in its entirety or in part been submitted for a degree to any other university

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Signature .... Date 27/03/02....

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ABSTRACT

South Africa is dominated by soils that are inherently unstable and extremely vulnerable to erosion. Soil erosion is most severe in the semi-arid regions although it is not confined solely to these areas. The Karoo, former Transkei, parts of the western Orange Free State and former Transvaal and a considerable part of Kwazulu Natal are subject to severe erosion by water.

Work reported in a number of post graduate studies on erosion in South Africa was critically evaluated and the most important results reported. Soil formation from different parent materials was investigated in a number of these studies. It was found that the stability of the soils developed on dolerite was higher than the stability of the soils on granite and sedimentary rocks. The soils on dolerite have lower stability with decreasing rainfall. The soils on granite do not show the same decrease in stability with a decrease in rainfall.

It was also found that some soils erode more easily than others under the same conditions of rainfall, vegetation and topography. This shows that the nature of the soil plays an important role in the occurrence and severity of erosion.

A distinction between hydraulic conductivity (HC) and infiltration rate (IR) was also studied. HC is usually measured under conditions where the soil surface is not disturbed. Considerable surface disturbance occurs when IR is measured, especially when precipitation is involved, leading to crust formation at the soil surface and thus to differentiated water transmission properties of the crusted layer compared with the underlying soil. The HC of the soil depends to a large extent on the exchangeable sodium percentage (ESP) of the soil and the salt concentration of the percolating solution.

Levy (1988) studied the effect of clay mineralogy and soil sodicity on the IR of soils subject to rain. The IR experiments were carried out using a laboratory rainfall simulator.

On the basis of the results presented by Levy, it is suggested that as far as clay mineralogy is concerned, the order of soil sensitivity to crust formation and its dependence on the level of soil sodicity is as follows: smectite>illitic> kaolinitic.

Threshold slope criteria were established for the dominant soils of three different pedosystems of the former Ciskei. Pilot areas were selected by means of aerial photographs and orthophoto maps.

Sumner (1957), D'Huyvetter (1985) and Bloem (1992) evaluated the effect of texture on erosion. Sumner and Bloem showed that clay content is the soil parameter with the biggest effect on surface sealing. Sumner indicated that crust formation could develop with any type of texture except sand with very low silt and clay. D'Huyvetter found that in all three main pedosystems namely, Mavuso, Keiskammahoek and Middledrift, topsoils with less than 20 per cent clay were found to be highly erodable while those which had a clay content of more than 20 per cent were found to be less erodable.

The effects of soil properties (e.g. texture, clay mineralogy, exchangeable cations, organic matter content) and experimental conditions (e.g. soil bulk density, moisture content, aging duration, prewetting rate) on rill erodibilities were investigated. Rill erosion depends on flow shear stress and stream power, the shear strength of the soil and cohesion forces between soil particles and the stream transporting capacity.

Stern (1990) studied the effects of slope and phosphogypsum (PG) application on seal formation, runoff and erosion from kaolinitic soils which vary in their response to rainfall and mechanisms which account for these variabilities were proposed. He found that PG was beneficial in increasing the IR of the soils. He also established that by diminishing chemical dispersion at the soil surface, the PG treatment slowed down seal formation and reduced removal of seal by erosion. The kaolinitic soils were divided into two categories: stable (S) and dispersive (D) soils. The presence of small amounts of swelling minerals caused dispersion, seal formation, high runoff and high soil loss on the dispersive kaolinite soils. Stable kaolinite soils did not contain swelling minerals.

Stern (1990) also studied the effects of surface application of mulch cover, PG, and polyacrylamide (PAM) on runoff during natural rainstorms. Runoff from control (bare) plots were high and during high intensities storm events most of the rain was lost through runoff. Mulch was beneficial in reducing runoff, indicating water infiltration was restricted by seal formation rather than by the hydraulic properties of the profile. PG reduced runoff to about half the amount from control plots. PAM treatment reduced runoff by three fold compared with the control treatment.

Knowledge of soil properties is essential for adequate land use planning in ensuring sustainable utilization of soil and preventing erosion and the mistakes of the past.

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