CARIBBEAN FOOD CROPS SOCIETY

PROCEEDINGS

ELEVENTH ANNUAL MEETING

SYSTEM FOR FIELD MEASURE OF EROSION, RUN OFF, AND OBLIQUE DRAINAGE IN FERRALLITIC SOILS ON GRANITIC MATRICES IN FRENCH GUIANA

by

PHILIPPE BLANCANEAUX
Soil Scientist, ORSTOM, Cayenne, French Guiana.

INTRODUCTION

This note is the presentation of an experimental system for qualitative and quantitative measures of the run off erosion and oblique drainage in soils (in situ). In French Guiana, as in many other humid tropical countries, an improverishment of the colloidal fraction in the top horizons of the profiles is generally observed. The term "impoverishment" in the French classification introduced by AUBERT (G.) and SEGALEN (P.) (1966) is used for the colloidal part and "LIXIVIATION" for movements of bases and silica. "LEACHING" is reserved for the movement of iron and clay from an impoverished layer to an enriched one. In many cases, in French Guiana, leaching of the colloidal part (and more specifically of the clay fraction) down from top horizons is observed without any accumulation in deeper layers. These soils are classified as "impoverished" in opposition to the "leached" ones which show an accumulation layer at a variable and generally small depth.

The aim of the experimental device we present here is an approach to the dynamics of elements moving under the influence of water, *in* and *on* the soil, the evaluation of each responsible factor (erosion, run off, oblique drainage), the hydrologic balance-sheet estimation characterizing these soils in relation to the climate; in short, to reach a quantitative evaluation, worked out for each of these factors, and defining their role in pedogenesis.

Agronomically, these measures may be used to obtain information about fertilizers and lixivation velocity, as well as to glimpse the most convenient time and the optimal granulometric characteristics for their application.

This survey is a working part of a vast research programme on erosion, colloidal impoverishment, hydrological and chemical balance-sheet in equatorial and subequatorial countries under natural or cultivated vegetation. It started in 1964 and including experimental plots at ADIOPODOUME (ORSTOM) ANGUEDEDOU (IRCA), AZAGUIE (IFAC) DIVO (IFCC), BOUAKE, MAN, FERDESSEDOUGOU (IRAT), KORHCGO (ORSTOM), OUAGADOUGOU (CTFT).

THE EXPERIMENTAL DEVICE

(a) Description

A plot of 25 metres long and 6 metres wide has been set out on a slope of about ten per cent by boards (25 cm) driven approximately 10 cm into the soil, so that trickling water can not come in or go out. This plot lies in undisturbed primary forest vegetation. Lower down on the slope, below the plot, we dug two distinct pits in order to collect trickling water and to intercept oblique drainage. This experimental disposition has been thought out by E. J. ROOSE (1968).

On the lower parts of the plot, just above the pits, we have directly plastified the soil in order to realize a run off drainage channel conducting the water towards two casks. The first one contains 15 distributors, one of them discharging into the second tank having a capacity of 225 litres. The entire stocking capacity thus is of 3,375 litres. This system may be insufficient to contain water issued from rainfall higher than 100 mm. Perhaps we may have to increase the number of distributors and to increase the casking volume.

During the rainy season, run off is so important on granitic soils that the ditches, though covered by a roof, quickly fill up with water, so we shall have to dig a special channel to drain the excess water away out of the experimental area.

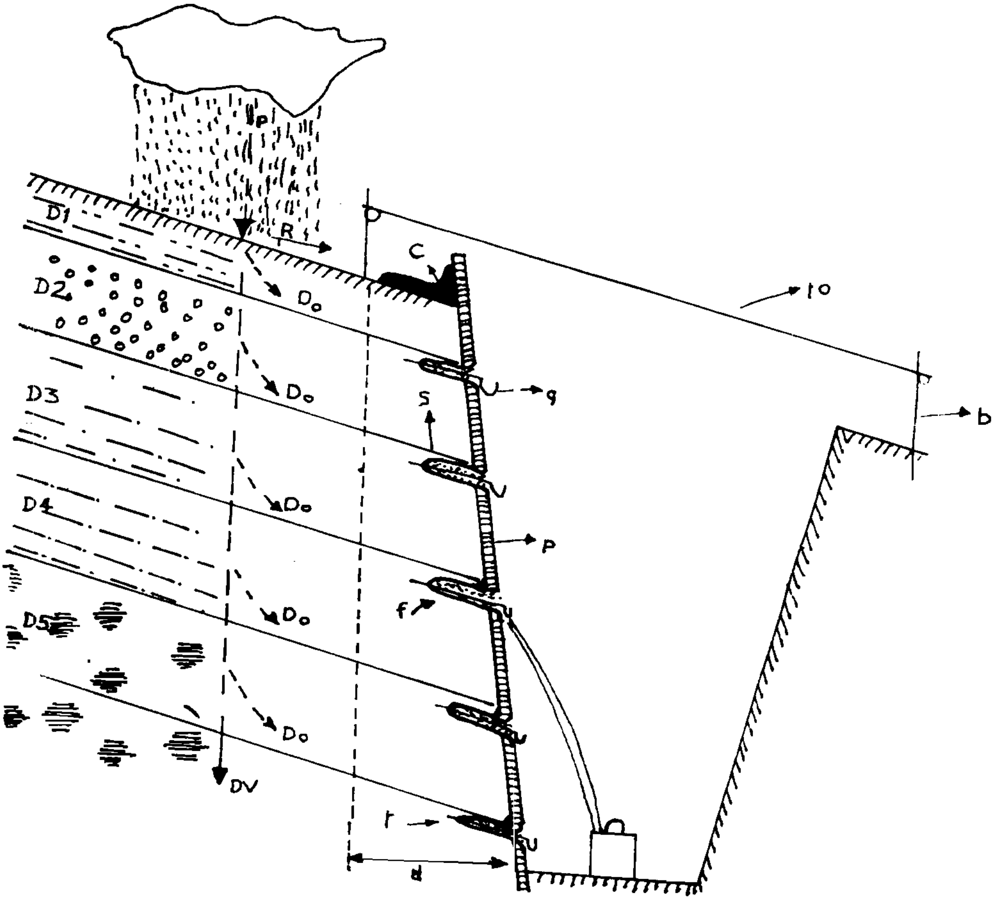
Pluviometry is measured on the spot by a set of pluviographs being placed in different points on the soil. Forest interception of rainfall is deduced from values registered by self-recording rain-gauges situated in a clearing on top of the hill.

(b) Water movement in the soil owing to gravity

Preponderantly, soils on granitic matrices in French Guiana show, at a moderate depth (50cm), a layer that is relatively less permeable than the top horizons. When a certain quantity of rain (P) falls on such a soil, one part of the water will run off the surface (R) and another part will infiltrate vertically; this is the vertical drainage (D.V.)

But when the soil capacity of the top horizon is reached, a part of the free water infiltrating vertically in this horizon will start an oblique movement following the slope. This is the oblique drainage (D.O.). At the less permeable level a temporary and perched ground-watertable may come into being, drying up again several days after the end of the rainfall.

In our "ERLO" hut – name of the whole experimental device – a slice of soil about 30 centimetres wide and situated above the oblique drainage ditch is protected from rainfall by a galvanized iron roof: water collected in the run off channel therefore can only come from the oblique drainage of the water moving freely inside the plot. We do not collect water implied in vertical drainage. This can be measured in situ by another appropriate system.



Diagrammatic representation of water flow and of an oblique drainage case. (E.J. ROOSE 1968).

P = rain.
R = run off.
D.v. = Vertical drainage.
D.o. = oblique drainage.
D 1,2,3,4 = Pedological horizons.
C = run off drainage channel.
G = gutter.
t = sheet.

f = crack.
S = washed sand.
d = slice of soil protected by the run off drainage-channel (C) and by the roof (t^0).

b = frame supporting the roof.
P = board.

Run off

Run-off directly depends on rainfall intensity; it stops quickly when rainfall ceases; it's a rapid flow on the soil surface.

Ground-watertable

This factor is responsible for the basic level-flow of a permanent river by means of invisible sources. It is the more general case of water flow in a soil constituted by a permeable level over a very impermeable layer.

Interflows

These flows are situated between the proceeding types. We distinguish among them:

(1) Subsurface run off.

This run off may occur in certain soils showing at little depth, a level clearly less permeable than the superficial part of the profile. Rainfall chokes the porous horizon and saturates it. When the soil surface is not level, temporary perched micro-ground-watertables may form, the head-waters of which will flow obliquely to the less permeable level; this flow could explain the white-washed sands in the top horizons of some soils, this hypodermic run off is slightly retarded with reference to the surface run off.

(2) Oblique drainage.

It is the most usual internal water flow when permeability gradually decreases with depth in a soil profile Small free water accumulation may then occur under each horizon.

According to the slope, there may be oblique water movement; these flows are limited and generally stop some minutes after the end of the rainfall.

(3) **Perched watertables.**

Their existence is due to a layer of total impermeability (lateritic shield, layer of bed-rock alteration, clay accumulation layer etc...) surmounted by one or several porous and permeable horizons. Infiltrating water, the vertical drainage of which is stopped, thus accumulates at this level; flows supplied by those watertables may continue to run several days after rainfall has ceased. This case seems to be very usual in French Guiana on such types of soils.

CHOICE OF THE IMPLANTATION SITE FOR THE "ERLO" HUT

Situation

The plot where this work has been undertaken and will continue during 3 years, is situated in the experimental ORSTOM watershed station of Crique Gregoire on the Sinnamary river. A pedological map (1/30.000) of this catchment area has been made. The whole watershed ($24 km^2$) lies on a matrix of Caribbean granito-gneiss. We note that granites are the geological formations most largely represented in French Guiana and cover about 33,000 km^2 on a total of 90,000 km^2.

Climatology

Average annual rainfall for the period 1968 – 1970 at Gregoire was 3,375 mm.

In 1969 maximal percipitation during 24 H, in mm are:

Year	J	F	M	A	M	J	J	A	S	O	N	D
1969	56.5	105.5	111.5	32.5	78.0	95.5	20.5	31.0	29.0	14.5	60.0	23.5

August, September, and October are the "dry" months of the year. Pluviometric curves show a deflection at the end of February ("little summer of March"); yet, atmospheric precipitation remains about 250 mm during these two months and in consequence these soils are maintained in a quite completely saturated condition. The implications for soil erosion also are clear.

The average annual temperature is about 26⁰ C. Average relative humidity is about 97%.

Vegetation

The water catchment area is covered by primary tropical Rain Forest. Many uprooted trees are observed, most frequently on hilltops. With regard to the flora the forest is dominated by the same plant families as nearly everywhere in the Guiana's: Leguminosae Lecythidaceae, Lauraceae, Burseraceae, Sapotaceae in the first places.

The soil

On the plot, soil is ferrallitic, highly unsaturated in B, leached modal (ultisol) and on granito-gneiss. The general landscape of these granito-gneissic formations is strongly undulating. Slopes are up to 35%. Under the summits, many holes, originating from the uprooting of trees (Djougoung-Pété), filled with water and organic matter are generally observed. Run off is strong and easily visible when it rains heavily; most of the watershed soils are leached as well as eroded. Rejuvenation is remarkable in the great majority of the profiles. Actual erosion is hampered by intense root development at the soil surface; however, it is visible and the surface water flows carry a heavy load of organic matter. The bedrock is always rather near the surface (about 2 metres deep).

ANALYTICAL DETERMINATIONS BEING UNDERTAKEN

- Volume of run off and drainage water
  - Run off
  - Oblique drainage.
- Analytical characteristic of collected water
  - Physical
    - Run off water
      - Turbidity
      - Erosion.
    - Oblique drainage
      - Leaching of colloidal Clay.
  - Chemical
    - pH
    - Conductivity
    - Organic matter
    - Fe_2O_3, Al_2O_3, SiO_2
    - Ca^{++}, Mg^{++}, Na^{+}, K^{+}

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