DEVELOPMENT OF SOIL ERODIBILITY EVALUATION BY SIMPLE TESTS

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Summary.

Soil erodibility tests that are simple to carry out, not demanding a long time to perform, needing equipment that can be easily carried to any place in the field, have been selected from existing procedures, and some tests have been developed new. These tests together applied to a soil give strectrum of reactions by which to judge the soils erodibillity. Soil erodibility is considered to indicate the availability of erodable material and the overland flow production. (The erosive power of the overland flow is mostly determined by the relief and the plant cover, and thereby part of the erosion hazard, not the erodibility).

Aspects of erodibility that are reflected in the test results are: soil surface structure, soil structural stability, sealing, infiltration, profile storage, interrill erosion on a small plot, and to some extent the sensitivity of the soil profile to rill erosion.

Test employed in the field are: crum test, modified pinhole test, manipulation test, rainfall acceptance test, soil loss test. Tests employed in the lab are: drop test, sealing test C5-10, wet and dry sieving.

Evaluation of the test results is done by A) judgement based on (local) experience, B) judgement plus a ranking system of the soils according to the test results, and C) the results of the soil loss test alone. Results are presented to show the agreement between the three methods of evaluation, for soils investigated in Sri Lanka, the Netherlands and Spain.

The procedures which have been followed promise to be effective for any short term investigation such as for development projects and consulting work.

EXCERPTS OF FIELD INSTRUCTIONS ON SOIL ERODIBILITY EVALUATION USING SIMPLE TES
- INTRODUCTION

Tests of erodibility are considered here which are to be used in surveys o erosion hazard, and therefore should be simple, have a relation to soil loss, and give the same results when done by different operators.

The following tests are considered:

Table: Selected simple field and lab tests of soil erodibility.

FIELD TESTS.	LAB TESTS.
Crumb test	Drop test
Pinhole field test	C5-10 sealing test
Manipulation test	Wet sieving, or dry plus wet sieving (probably superfluous to other tests)
Rainfall acceptance test	
Soil loss test	
Rilling test	
Shear test	

Table: Aspects of erodibility involved in certain erodibility tests and soil profile investigation.

SOIL ERODIBILITY ASPECTS	Erodibility tests and soil profile investigation: Field								Lab	
	Soil profile description	Crumb test	Field Pinhole test	Manipulation test	Rainfall Acceptance test	Soil loss test	Rilling test *	Shear test *	Drop test	C5-10 sealing test*
Soil surface structure<>	+	-	-	-	0	0	-	0	-	-
Structural stability	0	+	+ rill scour*	+	+	0	+	+	+	0
Sealing, infiltration	0	0	0	0	+	0	-	-	0	+
Permeability	0	-	-	-	0	-	-	-	-	0
Profile drainage & storage	+	-	-	-	0	-	-	-	-	-
Erodibility	0	-	-	-	-	+	-	-	-	-

+ = strong evidence   0 = some evidence   -- = little evidence

<>= includes record of surface gravel

* = relates to rill formation. In soil loss test: the flow volume. The rilling and shear tests assume high overland flow volume. Whether this is real is indicated by rainacceptance test, and flow volume in loss test

The SPECTRUM OF TEST RESULTS that is obtained for a soil is studied to see what is the availibility of material for erosion, and what is the overland flow volume, and what could be the effect of rill flow.

ERODIBILITY IS NOT CONSTANT, it may change over time. There is a seasonal variation, due to physical and chemical and biological changes over the seasons. Also over the years a change may occur, for instance after reclamation of a forest, soil erodibility will increase by loss of rootmat and organic matter, and a reduction in soil life. Atvthe other hand soil erodibility may decrease over the years under annuals, by the development of a pavement of coarse resisting material through selective erosion of the finer particles.

The TILLAGE CONDITION influences the soil erodibility strongly. In Indonsesia it was found (Bergsma 1987) that the loose tilled/padjolled state has a lower erodibility than the bare compact state. The difference was estimated as one or two classes of erodibility.

- DESCRIPTION OF THE TEST PROCEDURES

CRUMB TEST - RATING OF THE BEHAVIOUR OF A CRUMB THAT IS SUBMERGED IN WATER.

The test is considered to give a measure of the structural stability of the dry soil against wetting, and to give an indication of the sensitivity to sealing by wetting of the dry soil.

The test is performed on three small, air-dry, soil clods or aggregates of about 1 cm in diameter. Submersion is done carefully, in distilled water, or water of comparable constant quality, at a temperature of about 20 degrees C.

The reaction of the clods after 5 - 10 min of immersion is rated in 4 classes

XXX PINHOLE TEST - A field modification - RATING THE EFFECT OF WATERFLOW THROUGH A SOIL BALL.

The test is performed on a moulded ball of soil, at sticky point. Water conducted through a 1 mm hole is collected in a transparant plastic beaker. About 50 cc of water is used. Colouring of the water by dispersive clay in suspension is rated, and also the amount of erosion of the hole in the soil ball after breaking the ball open.

MANIPULATION TEST - A RATING OF SOIL COHERENCE.

The results of the test indicate the structural stability, and are therefore an indication (together with the strength of expression of topsoil structure) of the availibility of material for erosion.

The test consists of manipulating a volume of soil of 2 cm cube, at plastic limit, into the most complex form possible out of a series of defined forms.

RAINFALL ACCEPTANCE TEST

a fixed volume infiltration time, under splash, limiting ponding.

The test measures the time needed for the infiltration without ponding of 24mm artificial rain falling from 30 cm height, and released under pressure.

A food-tin with a diameter of 10 cm and height of about 15 cm is pressed gently 2 cm deep in the soil surface. Water is sprayed from a plastic cup with perforated lid, kept upside down, 30 cm above the soil surface. Rain is produced by pressing the plastic bottom, and the gust is stopped as soon as ponding occurs over the surface. Raining is resumed as soon as 10% or less of the soil surface is left under water.

SOIL LOSS TEST - SEDIMENT ERODED FROM A SMALL AREA OF CERTAIN STEEPNESS BY A CERTAIN RAINFALL

The amount of sediment eroded from a small area with defined steepness is recorded. A mini-rainulator is used.

THE RILLING TEST, a test of the sensitivity of the soil surface to scour by concentrated flow.

On the wet surface of the soil loss test, two plastic transparant rulers are inserted into the topsoil by their tapered part till this part is in the soil. The spacing of the rulers is 4 cm. The downslope end of the rulers is placed flush with the tray, in place to collect flow and sediment. Plan the placing of the rulers so that you can repeat the placing four times on the area of the tes plot.

THE SHEAR TEST - testing the resistance of the undisturbed soil surface against the pressure of torvanes.

A torvane apparatus, with blades of 4 cm high and 2 cm wide, is pressed 2 deep into the undisturbed surface soil of the test plot which has been used the soil loss test and the rilling test, in places which have not been disturbed. Ten readings are made in this way.

- EVALUATION OF RESULTS

A) BASED ON JUDGEMENT

Aspects related to the availability of material and aspects related to th production of overland flow are considered seperately, and evaluated.

Subsequently a judgement is made about the overall soil erodibility. A rating is made using five classes.

This judgement relies entirely on personal experience and local referenc level.

B) JUDGEMENT PLUS RANKING SYSTEM

The same procedure is followed as under A but in a more systematic (but al a more automatic) way.

A ranking of the soils according to the test results is made, for each test seperately. For each soil the ranks are summed for two groups of tests: those that reflect the availability of erodable material and those that refle the production of overland flow. The soil loss test is not included.

These groups of tests are the following:

Tests about availibility of erodable material:

- crumb test
- field pinhole test
- manipulation test
- rilling test
- shear test
- drop test

Tests about overland flow production:

- rainfall acceptance test
- overland flow volume in soil loss test

For a soil the ranks for the tests in these two groups are added. Then the soils are ranked seperately for each of the two ranking sums. The lowest of th ramking sums is taken to be indicating the most limiting aspect for the rain erosion: or the available material, or the amount of overland flow.. The soils are then ranked again according to this lowest rank, giving the final rank.

The final rank is classified in a system of 5 soil erodibility classes, based on the number of soils divided into five equally wide parts

C) THE SOIL LOSS TEST.

The soil loss test incorporates to some extent all aspects of soil erodibility for interrill erosion. The results of the soil loss test are ranked. The ranks are translated into relative erodibility classes in a wa as for method B. Corrections may be necessary for the expected rillibility, bu only in case a high volume of overland flow is expected.

- DISCUSSION OF THE METHOD.

a) PREVIOUS RESULTS.

Results of the tests on Spanish and Sri Lankan soils showed an agreement between between method B and C as follows:

complete agreement: 50%
one class difference 26%
two classes difference 24%

After considering the conclusion by method A (judgement only) conclusions based on agreement of results could be reached in 85%.

It was possible to decrease divergence in test conclusions by recognising soils that have an instable soil surface structure (crusting) but which did no show sealing.

Contradictions greater than one class difference between method A, B and C remained in 15% of the cases.

b) REDUCTION OF DISGREEMENTS between method A,B and C.
Contradictions in the test results may be reduced by:
- improvements of the ranking system,
- reducing the operator effect on the test results and possibly
- repetitions of tests to ensure errors are avoided as much as possible.

c) The OPERATOR influence.
A micro rainfall simulator is in development since 1984 (Kamphorst and Bergsma, 1985) to produce a more standardised rainfall as in the fieldtest of soil loss. It gave as provisional results that (good) operators in the less standardised method C do not influence significantly the results of that test.

d) The RELATIVE IMPORTANCE OF the tests.
Certainly a further study is needed about the RELATIVE IMPORTANCE of erodibility aspects, to determine which erodibility aspects are dominant in certain cases.

e) A tentative CORRELATION WITH K-VALUES may be obtained by equalling the five relative erodibility classes with 5 equal parts of the usual range of K-values, being 0.00 - 0.7

f) Evaluation of sensitivity to RILL EROSION.
To some degree the tests can also predict the conditions that will lead to rill formation, being a process largely determined by the amount of overland flow, the steepness of the slope and the properties of the material. Several tests have a bearing on the amount of overland flow that can be expected. These tests are:
- field pinhole test
- the increase in infiltration time during the rainfall acceptance test.
- overland flow volume in soil loss test
- rilling test
- shear test

In order to predict rill erosion the tests results have to be combined with information about the general site, such a steepness, slope form and drainage condition. Convergence or divergence of flow lines for surface or subsurface flow, and the accumulation of moisture on concave forms (queu effect of Zaslavski) may play a role.
The potential for rill erosion hazard is represented by conditions of absence of plant cover and conservation practices. In the presence of plant cover and/or practices the actual rill erosion hazard will be much lower.

xxx selected REFERENCES (see also detailed field instructions, obtainable on request).

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