4. We, ourselves, and our fathers have unfortunately, and perhaps inadvertently, helped soil erosion on its way because, as we shall see later, both European and Native people and even their cattle and small stock, have helped to make soil erosion the national peril that it is to-day. Certain elements in nature have, of course, also contributed their quota, and this quota has grown considerably in proportion to the event to which man has (humanly speaking) made it easier for these elements to do their devastating work on a bigger scale.

5. We will endeavour later on to show how great and mighty are the forces that combine to facilitate the process of erosion and, on the other hand, how small and weak are the opposing forces still.

6. Even Governments that have steered the ship of State in the past have done nothing, or next to nothing, to prevent the continuous removal of our best soil. This negligence on the part of the State may perhaps have been due to ignorance regarding the factors that, either singly or collectively, accomplish their devastating work.

7. The author has met many farmers and visited many farms in various countries overseas and for the last 20 years has moved about almost continuously among the farming community of the Union of South Africa; and although we should have liked to draw a comparison between our difficulties and farming methods and those of other countries we shall be obliged to draw the line here as otherwise we shall be getting too far away from our subject. It would perhaps be sufficient to state that although the rapid progress that is being made by the various branches of our farming industry on scientific and economic lines is most encouraging, there are still certain mighty and destructive forces in our country, that are permitted to continue their activities undisturbed, apparently without the least notice being taken by a large proportion of our population. One of these factors or national evils is undoubtedly *soil erosion.*

8. In paragraphs 3 and 4 it has been admitted that we, ourselves, and our ancestors have, on account of a lack of agricultural knowledge contributed our quota towards the removal of our best soil. Somebody may perhaps ask — and rightly so, too — " But how can we now possibly educate our farming farmers in the higher branches of agricultural science?" The reason for the apparent indifference of a large proportion of our farming population in connection with soil erosion and other important matters that affect the farming industry does not, in my opinion, lie so much with the farmers of South Africa as in the system of education that has obtained for so many years in this country. It is, however, a pleasure

to acknowledge here that most of our authorities on education are to-day fully alive to the necessity of agricultural tuition in our public schools, and so far as the present machinery of the Education Departments permits, much good work is already being done in that direction, and as the necessity arises, and more qualified teachers become available, in like proportion, so will agricultural knowledge be disseminated more rapidly and generally among the youth of our people.

9. Before dealing with our subject proper, it would perhaps be as well to deal briefly with a few elementary subjects in connection with the soil itself.

Chapter I

WHAT IS SOIL?

10. Prof. P. Merrill gives the following definition:— "The soil is the losely coherent, highly decomposed layer of mineral matter resulting from rock decay, which furnishes food and foothold for plant and animal life."

11. The above definition refers only to the inorganic part of the soil, because with this portion of the soil is almost invariably commingled, more or less, organic matter, mainly of vegetable origin. Such organic matter is but the decomposed remains of earlier plants, which must primarily have grown on wholly inorganic soils.

12. Soil, such as described in paragraphs 10 and 11, is, therefore, the more or less fine layer of highly decomposed mineral and vegetable matter, mixed together in varying proportion, over the exposed part of the globe.

SOIL AND SUBSOIL.

13. It will be observed that that part of the soil which is turned over by the plough, especially in old cultivated lands, is generally darker in colour and finer in structure than the underlying material which is called the subsoil. The same difference, perhaps to a smaller degree, will be noticed when a hole is dug in virgin soil. In some cases the surface soil may be regarded as being formed from the subsoil and only differs from it on account of it being cultivated, manured and exposed to the air. In certain cases, however, there is hardly any or no relationship between the surface soil and the subsoil, they

The way in which plants aid in soil formation. (Bailey).
(1)

being totally different in texture, quality, etc. The nature of the subsoil may in certain cases be such as to be either beneficial or unfavourable to the surface-soil.

Exceptionally thick layers of alluvial, aeolian, clay and peaty soils are generally called "uniform" soils i.e. when they have a depth of 5ft. or more soil, consisting of the same materials as the surface soil. In such uniform soils, subsoil is not studied so carefully by the farmer as in some other cases.

14. The best soils for general agricultural purpose are those in which the fine mineral or inorganic materials and the organic or decayed vegetable matter are proportionally correctly mixed and which also have the necessary drainage and depth.

Chapter II

THE ORIGIN OR FORMATION OF SOILS.

15. In this chapter, soils will be very briefly considered from two points of view. (1) Historically as regards their origin and formation. (2) Their content, structure and properties.

16. The soil must not be considered merely as an inert mixture composed of certain substances, because all the different parts of the soil have, throughout the ages, been formed separately, moved and sorted and then laid together as we find them to-day. Moreover, the constituents of the soil are not even yet at rest but are always taking new places and new forms and are also continually making new partnerships, entailing a never-ending series of changes and mysteries.

17. The layer of soil over the surface of the earth is, comparatively so infinitesimally thin that it cannot even be shown in proper scale on any globe or chart — and yet the soil supports all the countless myriads of men, animals, insects, plants, etc., and has supported them throughout countless centuries in the past.

If we, therefore, want the soil to continue supporting us and the many future or unborn generations of our beloved South Africa then we must make up our minds at once (not only the farmers but every one of us) to fight against the ruthless erosion and removal of our soil, which is undoubtedly the most valuable asset we possess. It is the bottom of the only ship we and all other living things on the land, have in which

(2) A type of Colluvial soil. (Bailey).

to sail through life's stormy seas. Posterity must use the same ship in ages to come and it is plainly our duty now, and later on their duty, to see that this thin ship's bottom is not only well preserved but also even strengthened in course of time so as to enable it to support more human, animal and plant life.

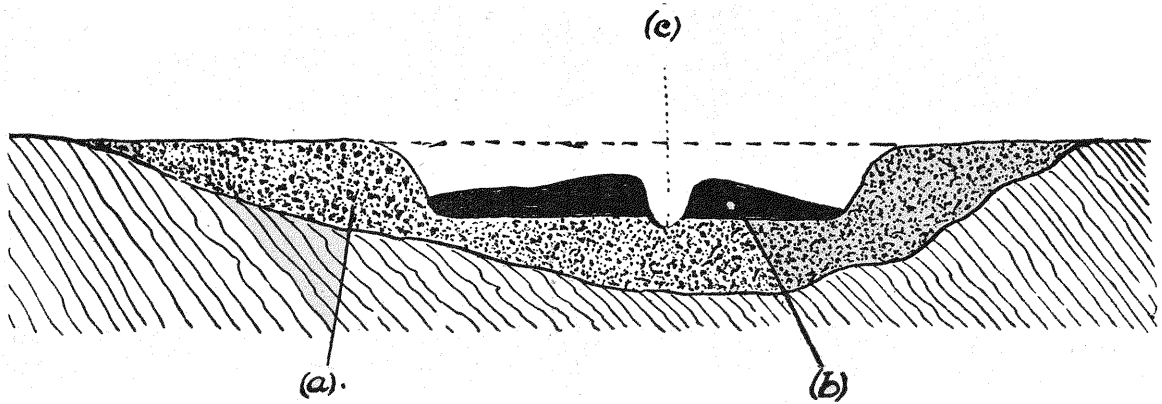
18. The earth is enveloped by a crust, composed essentially of rock or mineral matter in various stages of consolidation. If the theory of the earth's origin through cooling and condensation of an incandescent magma be accepted then the first rocks formed must have been of a lava-like nature and in composition perhaps very unlike our rocks of to-day.

The processes mainly responsible for rock decay are:— (a) physical, (b) chemical and (c) biological. For countless ages certain mechanical agencies, such as water, ice, frost, snow and wind, atmospheric action, changes of temperature, animals, insects and plants have been, and still are active in the promotion of soil formation. Presuming that the different parts played by the abovementioned agencies in the weathering, disintegrating or in the decaying of rocks are already well known to the reader, we beg leave to omit these here and in place thereof to discuss very briefly some of the rocks forming the greater portion of the earth's crust and from which most of our inorganic soils have been and are being derived.

19. *Kinds of Rock.* Geologists tell us that owing to the manifold changes that rocks have undergone throughout countless cycles, fully nine-tenths of the land surface is now occupied by rocks of a secondary nature, i.e., rocks formed from materials derived from decayed pre-existing rocks. These rocks, owing to their sedimentary manner of formation and structure are commonly called *Sedimentary rocks,* but if they have, through geological causes, undergone crystallization and other changes, they are referred to as *metamorphic rocks.*

The remaining one-tenth of the earth's crust is approximately composed of *igneous rocks,* i.e., rocks formed through the agency of heat, which have at some time or other been in a molten or fused condition and their present peculiarities are said to be due to the effects of cooling.

Varied as these rock masses may seem, it is according to geologists a peculiar fact that fully 95 per cent. of the earth's crust is composed of not more than eight or ten of the known elements and comparatively few of these are in forms of combination.



(3) **Alluvial Deposits. (a) Older alluvium, (b) Recent alluvium, (c) Present River Bed. (Bailey).**

Accordnig to Merrill, the eight most important elements with their relative percentages are as follows:

	Per cent.
Oxygen	47.02
Silicon	28.06
Aluminium	8.16
Iron	4.64
Calcium	3.50
Magnesium	2.26
Sodium	2.63
Potassium	2.32
Total	98.95

This leaves a shortage of 1.05 per cent. which is said to be made up of all the other elements such as carbon phosphorus, sulphur, the rare metals, etc. Nitrogen does not appear in the above table because although it is an abundant constituent (approximately four-fifths) of the atmosphere, it is almost negligible as an original constituent of the earth's crust.

20. *Primary rocks.* These are eruptive or igneous rocks which must have come from deep-seated sources out of the bowels of the earth in a molten state and their present physical qualities are said to be due to variations in conditions of composition and solidification. These rocks generally have two or more essential constituents. In structure they are generally massive, glassy or crystalline and sometimes also appear in colloidal form.

These rocks are generally classified in three groups:—

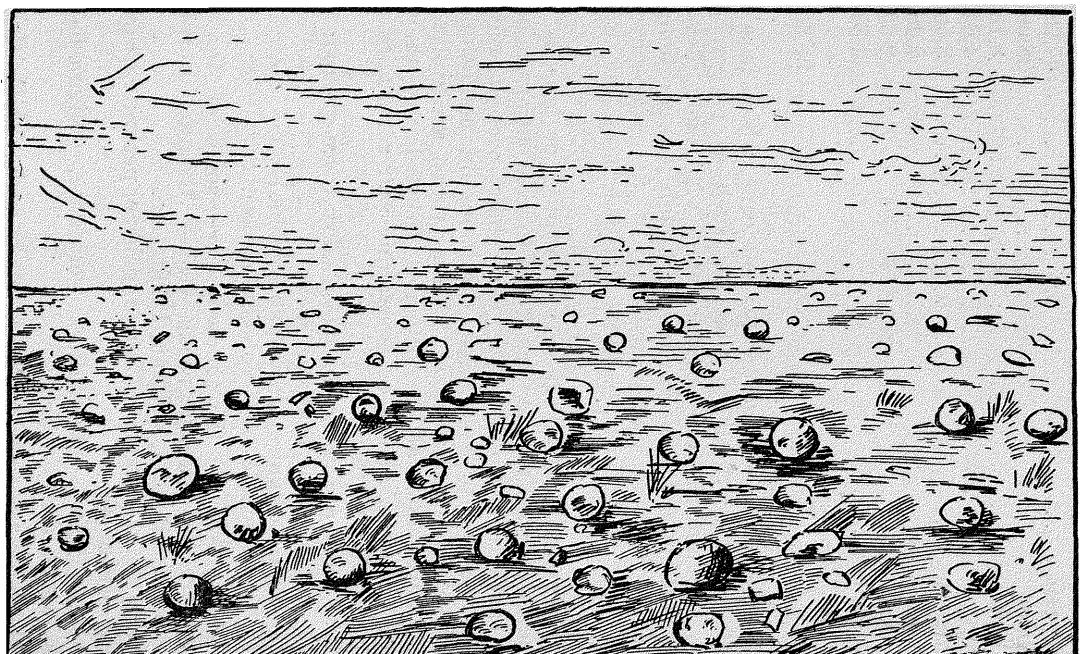
(1) Intrusive or Plutonic rocks.
(2) Paleovolcanic (old-volcanic rocks.)
(3) Neovolcanic (new-volcanic rocks).

Under group (1) the following are some of the most important of the eruptive rocks viz:— Granite, Porphyry, Granodiorite, Rhyolite, Osidian, Dacite etc.

Group (2):— Syenite, diorite, gabbro, perknite, trachyte, andesite, basalt etc.

Group (3):— Phonolite, Peridolite, Olivine-basalts, Foyaite, norite, etc.

The above are some of the primary rocks which, through their degeneration, have not only assisted to some extent the formation of soil, but have also furnished materials for the secondary rocks. Further, some of them also contain well-known minerals, ores and gems such as mica, felspar, hornblende, apatite, greenstone, iron, corundum, nickel, beryl,



(4) A type of Glacial Soil.

platinum, diamonds, topaz, amethyst, etc. Primary rocks contain no animal remains.

21. *Secondary rocks,* may on a basis of composition be divided into two main groups:—

(1) The *silicious* group and (2) the *calcareous* group. Rocks belonging to these two groups form by far the greater solid portion of our globe, and therefore also play the greatest rôle from an inorganic soil-forming point of view. From a chemical standpoint these rocks are of an extremely variable nature. In some cases they closely resemble the parent masses, and in other cases, again, they widely differ from these. The cause of these variations is said to be due to the methods of their formation.

Our object in dealing very briefly in the aforegoing paragraphs with certain kinds of rock is merely to show how extremely slow the processes of rock disruption and decomposition work, and that the formation of even a limited quantity of inorganic soil must have taken an extremely long time.

To give an idea of the size of different soil-grains we quote from the following analysis, by Prof. L. H. Bailey of America, and we also give the sizes used in soil analysis of the Union of South Africa. The figures refer to the largest soil grains in each group.

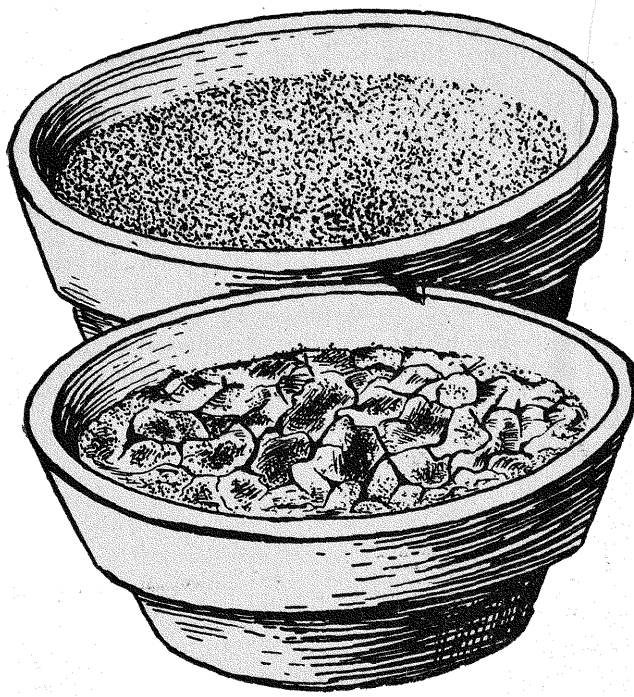
America.

	mm.
Clay	0.005
Fine Silt	0.01
Silt	0.05
Very fine sand	0.10
Fine sand	0.25
Medium sand	0.50
Coarse sand	1.00
Gravel (ordinary)	8.00

Union of South Africa.

	mm.		inches.
Clay	.001	—	.00004
Very fine silt	.003	—	.0001
Fine silt	.01	—	.0004
Silt	.03	—	.001
Fine sand	.15	—	—
Coarse sand	1.00	—	.04
Gravel	3.00	—	.12

Some of the soil grains have once upon a time formed part of colossal, solid rock masses, and one can hardly imagine how



THE TEXTURE OF THE SOIL.
The upper sample is loose garden loam.
The lower is hard pulverized clay. Both were given the same quantity of water and allowed to dry. The loam remains loose and crumbly; the clay puddles and cracks. (Bailey).

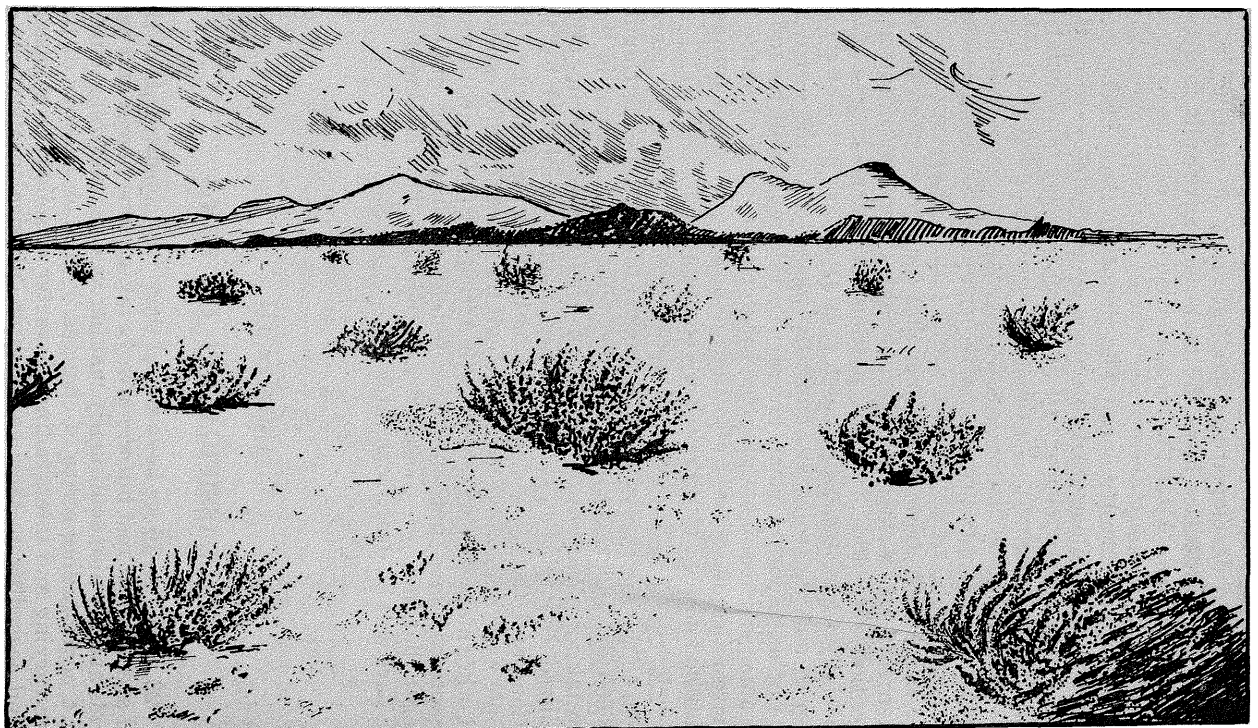
many ages must have elapsed before some huge mass of solid, hard rock had developed the smallest crack or opening in its body. Many centuries later the rock may have split into two or more portions. After the rock weathering agencies had been at work for many centuries, these portions may have broken up into smaller ones. The time that these agencies of nature must have occupied to reduce even a cubic yard of this rock — say, to particles of 0.01 mm., can scarcely be calculated, described or imagined. To this time must be added the period that these inorganic materials must have taken to move from place to place, to intermix properly with organic and other necessary soil matters and to settle down ultimately in the form of cultivable farm land. Now if the time that a cubic yard of soil has taken to form, is well nigh incalculable, then the uninitiated (mentioned in Par. 3) must pardon us for making a fuss, especially when it is well known that 91 square miles of a foot deep of our best soils, are annually washed into the ocean by nine of our South-African rivers. To this must still be added the amount of valuable plantfood materials contained in the 91 square miles of soil and also the unknown amount of soil and plantfood carried into the sea by our smaller rivers.

22. According to recent returns the Mississippi carries down to the sea every year 406,250,000 tons of soil, the Danube 108,000,000 and the Nile 54,000,000 tons. Soil erosion is thus also taking place in other parts of the world, but in other civilized countries it is being energetically combated by the nations and their Governments; in France, for instance, the people have almost overcome the evil by means of afforestation and other measures, while in South Africa our people, with some exceptions, have not only not fought against this national danger, but have even assisted its progress. This slackness on our part will be dealt with later on.

Chapter III

CLASSIFICATION OF SOILS.

23. In Par. 16 we have stated that "the constituents of the soil are never at rest but are always taking new places and new forms and are also continually making new partnerships, entailing a never-ending series of changes." It is on account of this ever-varying and intergrading character of soils that a classification according to their composition, physical proportions or texture has proved a difficult problem. However, from a genetic standpoint or from a standpoint of origin, soils are generally



(6) **Brak or Alkali soil, in an advanced stage.**

classified in two main groups viz.:—(1) *Sedentary* and (2) *Transported* soils.

24. *Sedentary Soils.* (Latin, sedo-sedere, to sit) have been formed by some or all of the agencies mentioned in Par. 18, or from organic accumulations. These soils occupy more or less their original sites or they have remained in the same places or nearby areas where they were originally formed. They are the primary types of all other soils, as those of drift origin are but derived from sedentary materials through the transporting power of water, wind and ice.

Sedentary soils are grouped under two classes viz:—

(1) Residual soils and (2) cumulose soils.

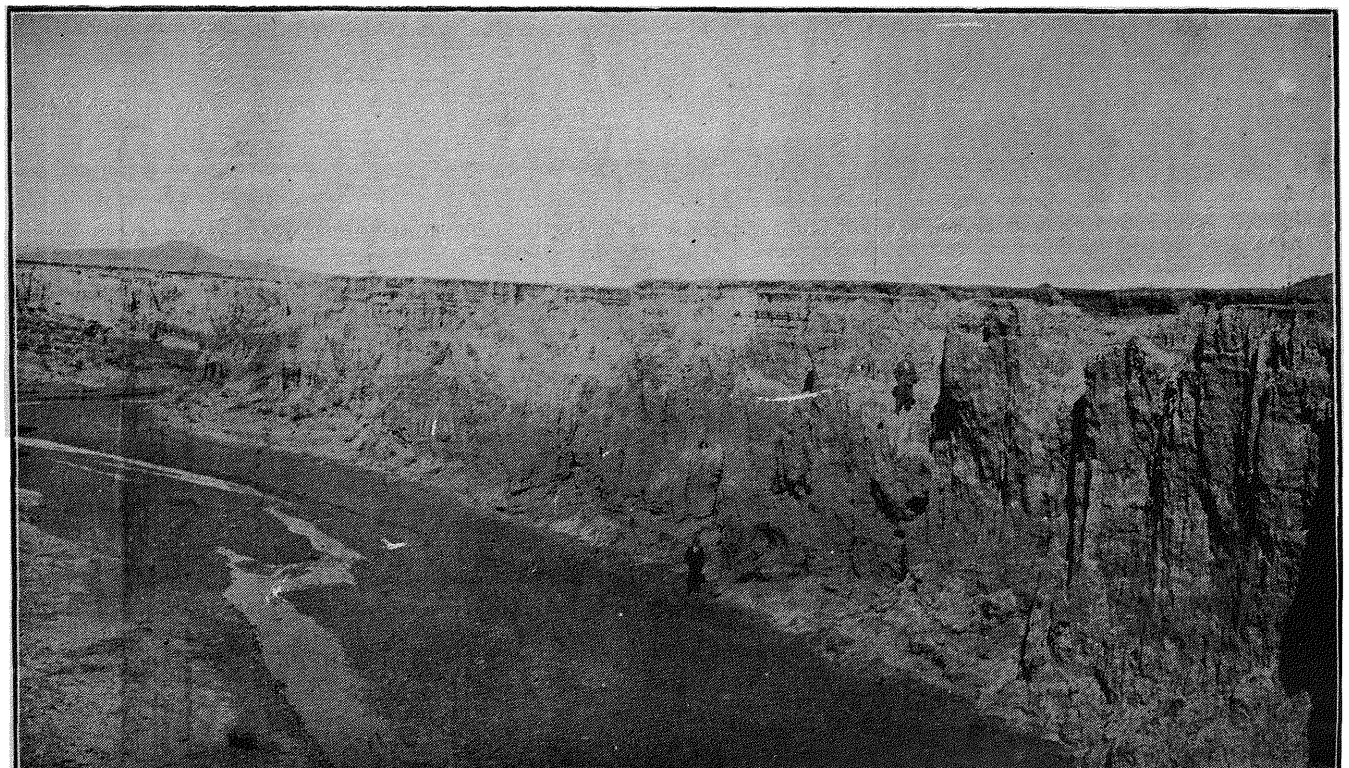
(a) Residual soils are the remains or the residues of decomposed rocks left behind on or near the place where they have been formed, while the more soluble ingredients have washed away in a soluble form.

(2) *Cumulose Soils*. are accumulations of decomposed vegetable matter. They are generally deep brown, dark or black in colour and are mostly found in places where plants must have grown abundantly, such as vleis, swamps, bogs, etc. Peat bogs in other countries or some of our black clay deposits are instances of Cumulose deposits.

25. *Transported Soils* are classified as follows:— (a) Colluvial, (b) Alluvial, (c) Aeolian and (d) Glacial soils, (a) *Colluvial soil* (Latin: "Colluvies," a mixture) is a heterogeneous mixture of clay, sand, gravel, rock detritus, small and large boulders, etc. The rock particles in such deposits are generally more or less sharp-edged and rarely in a condition of advanced decay. Gravity has been the controlling factor in the formation or creation of this soil. These deposits are generally found along the slopes or at the foot of steep hills and mountains or in kloofs. Huge boulders breaking loose during heavy rains or after the melting of heavy snow-falls, slide or rush down these slopes, loosening other stones in their course and bringing in their wake a mixture of all sorts of materials. The lighter materials of such deposits are often carried away by water and deposited further and further away from the mountains until these finer materials may ultimately pass into the proper alluvial sphere. The coarse colluvial deposits which have remained at the foot of mountains are, from an agricultural standpoint, of no great importance.

26. (b) *Alluvial Soils.* The constituents of pure alluvial deposits are finer and more uniform than even those of the less coarse colluvial types.

Flood waters, flowing over our veld, in sloots, valleys, etc., are generally muddy. This muddiness is but an accumulation of all kinds of lighter and finer soil materials, scoured off the



(7) DESTRUCTIVE SLOOT FORMATIONS IN THE O.F.S.[7]

surface soil or cut out of dongas, etc., by the water. Alluvial deposits are generally found along river valleys, depressions or low-lying lands and also in delta-form at the mouths of certain rivers or on certain river islands, etc. A preponderatingly large proportion of this fertile "soil extract" is, however, not deposited anywhere en route but is poured into the sea by our rivers and lost for ever to us and to posterity.

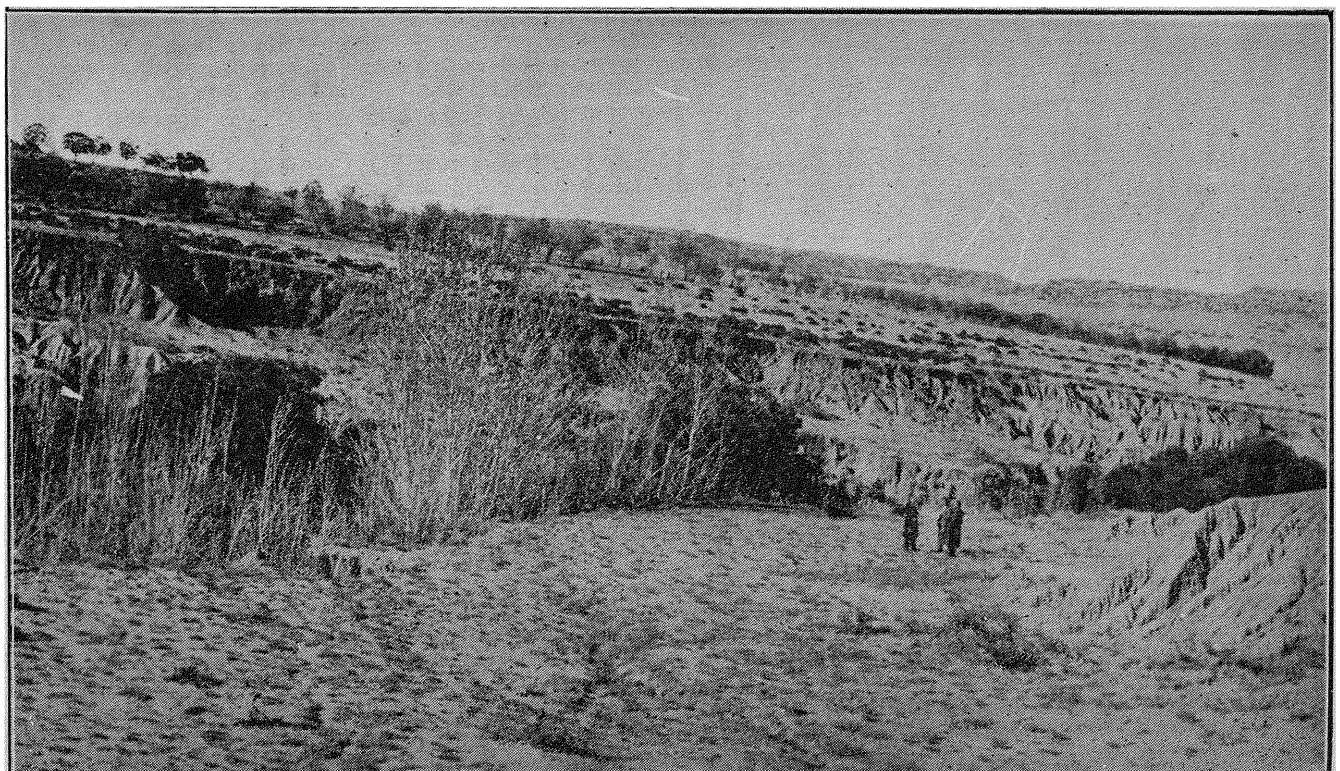
27. (c) *Aeolian or Wind-drifted Soils.* The wind often plays an important part in influencing the character and distribution of soils. We often see huge dust clouds travelling in one direction or another. These dust storms are more noticeable in the semi- arid or arid regions, where the vegetal covering is poor. Unlike alluvial deposits, where the soil materials can only move from higher to lower levels, aeolian soil particles can travel in all directions and all kinds of soil, when fine, light and dry enough, are carried about by the wind. In South Africa aeolian deposits are found in many places, especially in the Kalahari and adjoining semi-arid regions and also in the North Western and Midland districts of the Cape Province, Western Free State, Bechuanaland and Western Transvaal. In America, China and Russia, very many thousands of sq. miles of aeolian soils are found. It is claimed that a very large proportion of the renowned fertile loess soils in the abovenamed continents is of aeolian origin.

28. (d) *Glacial Soil Deposits.* It is said by geologists that during the glacial epoch enormous glaciers travelled with tremendous pressure over many parts of the world, carrying many rocks, gravels or other materials either on or in them and crushing, grinding or rolling other rocks underneath. These masses of rock that fell either on or under the ice were transported varying distances and ultimately deposited in the form of sand, gravel, rounded boulders, etc. In the Frigid Zone, glaciers are still soil-producing agents of great vigour.

29. In paragraphs 23—28, we have endeavoured to distinguish one kind of soil from another, i.e. from a genetic standpoint or from a standpoint of origin. For agricultural purposes, however, it may be more practical to classify soils according to their mechanical composition or according to the relative percentages of the materials of which such soils are composed.

The common terms used for different soils by our farmers in this country are the following:—

(a) Gravelly soils.
(b) Sandy soils.
(c) Sandy loam soils.
(d) Loam soils.
(e) Clay-loam soils.



(8) Here is a case where the farmer is fighting soil erosion with plants and he has almost won the Battle.

(f) Clay soils.
(g) Turf soils.
(h) Alluvial soils.
(i) Brak or Alkali soils.
(j) "Heavy" or "Light" soils.
(k) "Sour" or "Sweet" soils.
(l) Humine (Humus) soils.

30. *Gravelly Soils* are those in which the relative percentage of gravel predominates over all the other soil materials present.

31. *Sandy-Soils* contain more sand than other soil constituents that may be present.

32. *Sandy-loam Soils.* In these soils, sand is still preponderant, but the percentages of clay and silt are considerably higher than in sandy-soils.

33. *Loam-Soils.* These contain more or less the correct mixture of sand and clay. The sand apparently breaks the density or imperviousness of the clay and the clay again binds the looseness of the sand. (In Fig. 5 it will be noticed that a proper mixture of clay and sand is always soft and mulchy, while the clay alone may go to extremes of softness and hardness.) Having the proper depth, drainage, etc., loam soils are considered the best for general agricultural purposes.

34. *Clay-Loams,* contain more clay than loam soils and are therefore somewhat heavier than the latter.

35. *Clay Soils.* In Par. 21 we have seen that the grains of gravelly soils are the largest, while those of clay are the smallest The particles of clay are so minute that one particle cannot be distinguished from another with the naked eye. Most of our clay soils are dark brown or black, but we also have our "Rooi Turf" (Red Turf) soils in some parts of the Union. The dark brown or black colour in our black clay soils is due to organic matter, or to the parent rocks, such as norite or syenite, or to both organic matter and parent rocks.

Clay soils absorb water not so readily as sandy soils, but part with it more slowly. They further have the unfortunate characteristic of cracking and caking on drying.

36. *Turf Soils.* Both our black and red turf soils are very sticky or adhesive when wet and hard when dry. The black turf has similar characteristics as the black clay soil with regard to its waterholding capacity, cracking and baking, etc., when dry but is more adhesive than the common black soil when wet.

37. "Turf;" this name is given to both the black and red turf soils, but it is, in most cases, a misnomer, because "Turf" is the Dutch word for peat and we have only a very few places

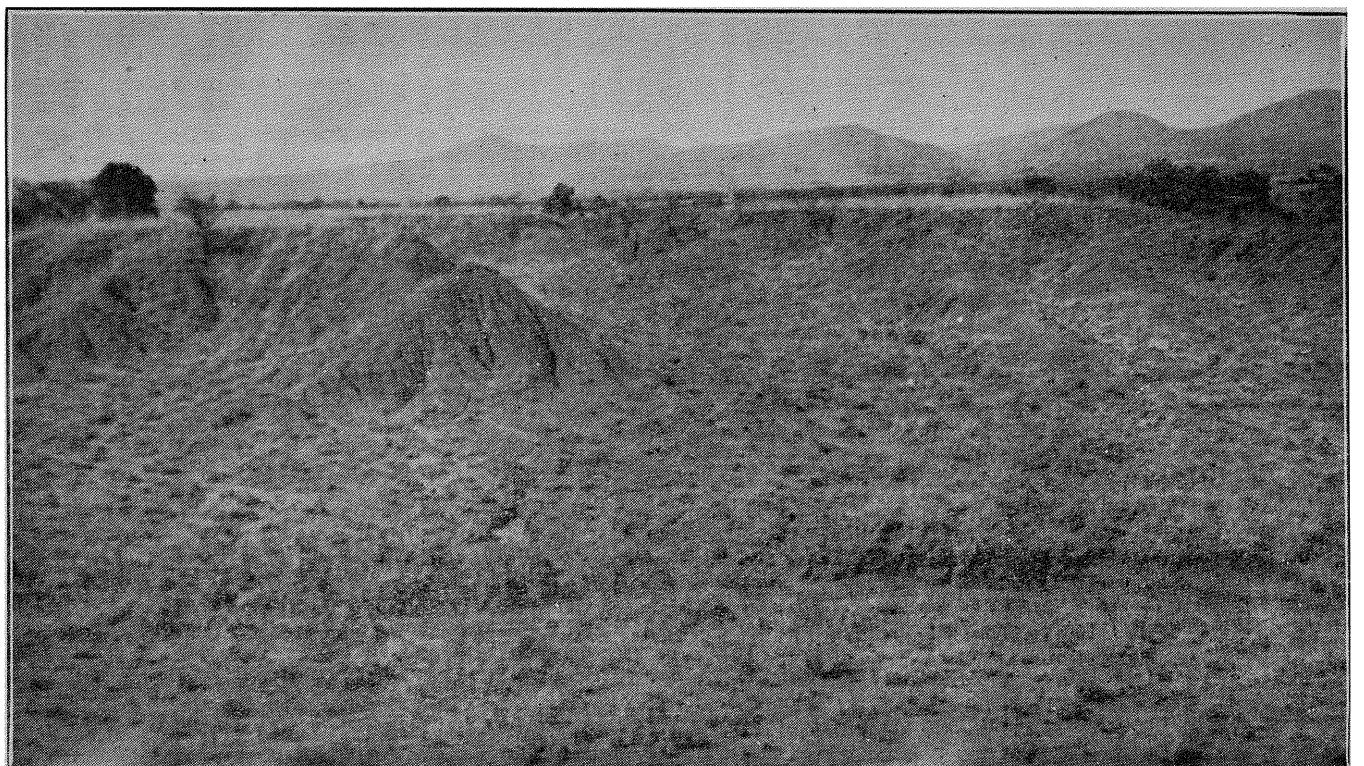
In this case soil erosion reigns supreme. The rainfall in this locality is higher than under Fig. 8, and yet the farmer does not take the trouble to plant any tree or shrub to stop the sloots on his farm. Note the mound of soil held by the roots of the single bush growing on top of it.
(9)

in the Union where real peat that can be used for fuel purposes is found. Peat contains an exceedingly high percentage of organic matter, while some of the black turf soils are even deficient in decomposed vegetable matter, and must, to a great extent, have derived from trappean (quartzless) rocks (see Paragraphs 35 and 44).

"Red Turf" Soils. These soils are not quite as sticky or adhesive as black turf soils but very slippery when wet. There is, comparatively, not much of this soil type in the Union, and the percentage of organic matter they may contain, is so small that the name " turf " is entirely a misnomer. This soil is of rock formation and the red colour imparted to it is due to the action of iron.

38. *Alluvial Soils,* have already been briefly described in Par. 26. The alluvial deposits are, as a rule, very fertile, being in many cases the cream of other soils.

39. *Brak or Alkali Soils,* are not separate soil types in themselves because any soil can be infected or polluted with brak when circumstances permit. An alkali soil generally contains several kinds of salts. Our older farmers, however, generally speak of "black" and "white brak" only. A soil containing a high percentage of sodium carbonate (sal-soda or washing soda etc.) is according to them "a land contaminated with the dreaded "black brak" while sulphate of soda (Glauber salt etc.) is spoken of by farmers as the less dreaded but very troublesome "white brak". Rocks contain many soluble materials and with the disintegrading of such rocks these materials (chemical salts etc.) are liberated and gradually carried off by water in a dissolved or partially dissolved state. The water carrying these salts, collects in shallow pans or remains standing on level places, is eventually evaporated by the sun and these injurious salts are left behind on the land. Large alkali areas are more often found in regions where the land is flat and the rainfall small, because in such regions the alkali salts are not rapidly taken into solution by water and carried off to the ocean, but they collect and remain on the land. Lands free of injurious salts are often contaminated by flood or irrigation water containing these salts in solution. "Brak or Salt Pans" are but extreme instances of alkali and other salt accumulations in — and on the ground. The various salts which are injurious to plant growth as well as the different methods employed to, either get rid of the alkali, or to prevent its spreading, have been dealt with in many books and need not be discussed here. Suffice it to say, that the alkali problem, throughout the agricultural world, is apparently still a difficult



Deep dongas eating their way back so fast, that ere long all the soil and plants, up to the foot of the mountains at the back, will be carried away.

(10)

40. "*Sour or Sweet Soils.*" "Acid or sweet" soils fall under the same category as alkali soils in that they do not represent a special type of soil, because any type of soil can be "sweet" or "sour" and these names have simply been mentioned because they are in common use in South Africa.

In regions with a high rainfall the soluble (basic) constituents of the soil, are continually being washed out and carried away by sloots and rivers. A soil so depleted of its essential plantfood materials is a so called "sour soil". Soils containing a sufficient amount of potassium, sodium, magnesium, calcium, phosphoric acid etc., are the so called "sweet soils" and are generally found in those regions where the rainfall is not very high and where the slope of the land is not so steep as to assist the flood waters in turning the soil acid.

41. "LIGHT AND HEAVY SOILS."

By this term is meant soils that are either easy or difficult to cultivate. Soils in which sand predominates are called "light," while those in which clay is the ruling factor are called "heavy soils".

42. A cubic foot of pure dry sand, actually weighs more than a cubic foot of dry clay but, because the draught of the plough is lighter or easier through sandy soils than through clay or clayey soils, the terms "light" and "heavy soils" are used.

43 *Humus Soils.* Humus is a very important factor to plant life. It is derived from the partial decay in the soil of organic matter and it imparts to the soil a brown or black colour. In places where animal and plant life have been particularly active, humus is found in the form of peat-beds or as brown or black humus soils. Prof. King says:—"Humus is simply the abandoned tissues out of which life has moved and which are falling back by degrees into carbonic acid, water, free nitrogen and ashes out of which life reared its marvelous structures." The remains of animals, and plants that have washed down from higher to lower levels and which have accumulated in hollows, vleis, etc., have there commingled with deposits of fine earth and have thus formed the compounds known as *humus*. Keeping this in mind, we can perhaps better appreciate the importance of good kraal and stable manures for through their decay, humus is formed.

44. The brown or black colour of a soil or the clayey appearance thereof, is not always due to decomposed animal or vegetable matter, but is often inherited from the parent rocks. (See Paragraphs 35 and 37.)

45. *The waterholding capacity of Soils.* The waterholding capacity varies widely in different soils. A cubic foot of saturated soil will hold approximately from 20 to 32 lbs. of

Note the 6ft. tall man standing on the bottom of the sloot. The trees are on the edge of the donga's banks. (O.F.S.)
(11)

moisture. The waterholding capacity of sand is lowest; is greater in loam or clay, and reaches its highest point in soils containing a large percentage of organic matter.

46. We wish to make it perfectly clear to the reader, once more that the very brief statements made in the previous pages on *rocks* and *soils* were never intended as, even an attempt, to deal with those subjects as such, but it is only an endeavour to show:—(a) What the soil is made of. (b) How exceedingly slow the soilforming mills are grinding. (c) That the soil of the Union is a *definitely limited* and *irreplaceable* quantity, and (d) That we as a nation, are morally and economically bound to conserve it, instead of assisting the elements of nature to take it away for ever from under our feet.

47. Although more soil is continually being formed, the time taken to produce even so small a quantity as an inch depth of soil, is so long in comparison with the span of human life, that the little formed during a generation may be neglected as far as we are concerned. The soil is our greatest national asset, the ultimate source of all food, animal as well as vegetable; the source of all our clothing furniture and a large part of our buildings.

48. When left to herself nature arranges a state of balance between the various factors, rainfall, run-off, soil, aspect, slope and vegetation suitable to the climate. When man arrives in the arena and upsets the balance by destruction of the vegetation, trouble must follow.

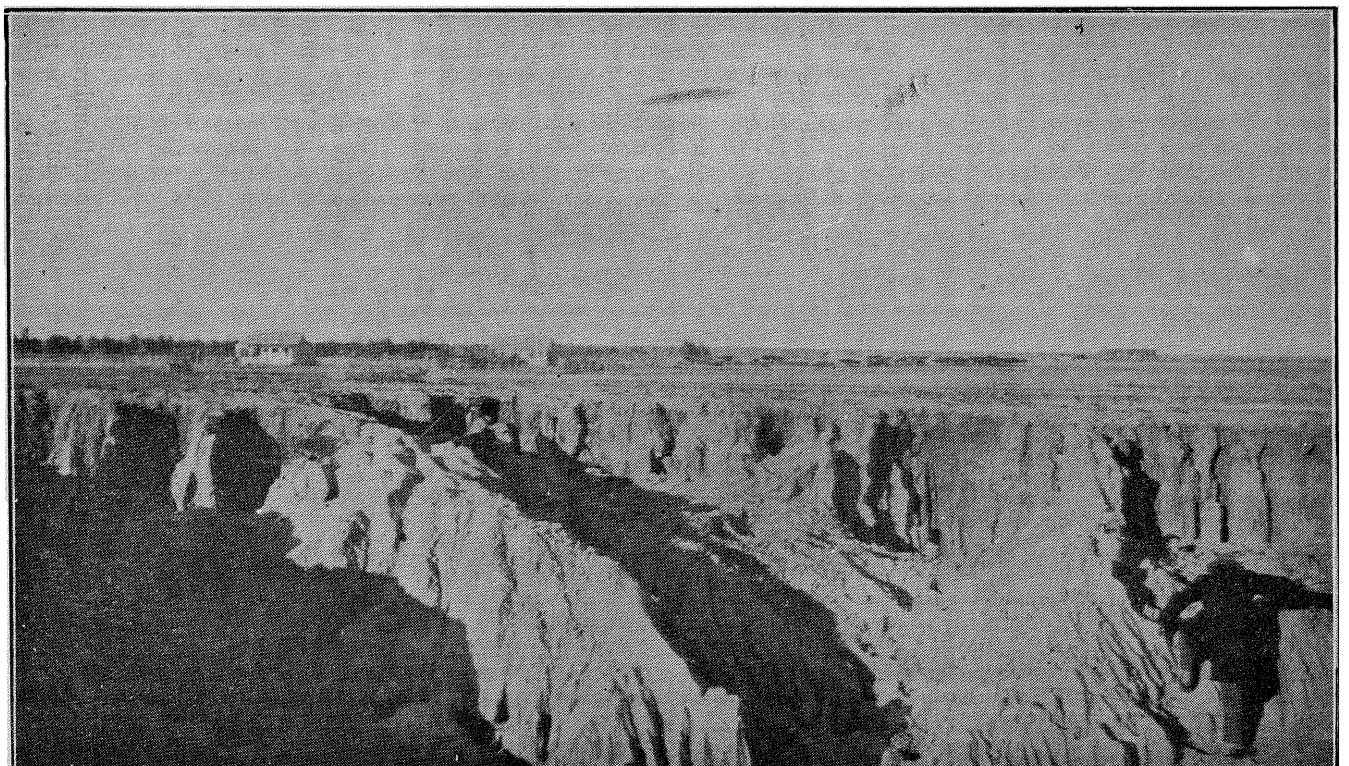
49. The resistance of a given soil to erosion depends also on the physical, and in special cases, on the chemical composition of the soil and the nature of the sub-soil and, naturally, also on the slope of the surface and the amount of water reaching it from higher levels. And last, but not least, a big controlling factor is the amount of vegetable covering by which the soil is protected.

50. While man has been responsible for so much destruction of vegetation in the Union probably no one class of destruction has affected so large an area as that occasioned by the small stock farmer, the veld burner and by the very wasteful system of veld management.

Chapter IV

SOIL EROSION.

5. The elements of Nature are so mighty and all-embracing that it is impossible for man to ensure that absolutely no soil shall be lost. So far, however, mankind has, generally, assisted the powers of Nature very efficiently in robbing us of our best



All vegetation between these unsightly sloots have disappeared, while not so many years ago it was one of the best pieces of veld on the farm.

(12)

soil, and it is against this calamitous state of affairs that we earnestly desire to utter a word of warning.

52. Soil erosion can take place in three ways, as follows:—

(a) *Through surface erosion by water* (See paragraph 26.)

(b) *Through surface erosion by Wind* (See paragraph 27.)

(c) *Through sloot formation, caused mostly by stormwater.*

53. Surface erosion, (a) is in a sense the most dangerous form. It is an evil creeping in unseen like a thief in the night and robbing us of our national wealth. The far-reaching effect of this evil is not yet realised, even by many of our soil-conservation enthusiasts.

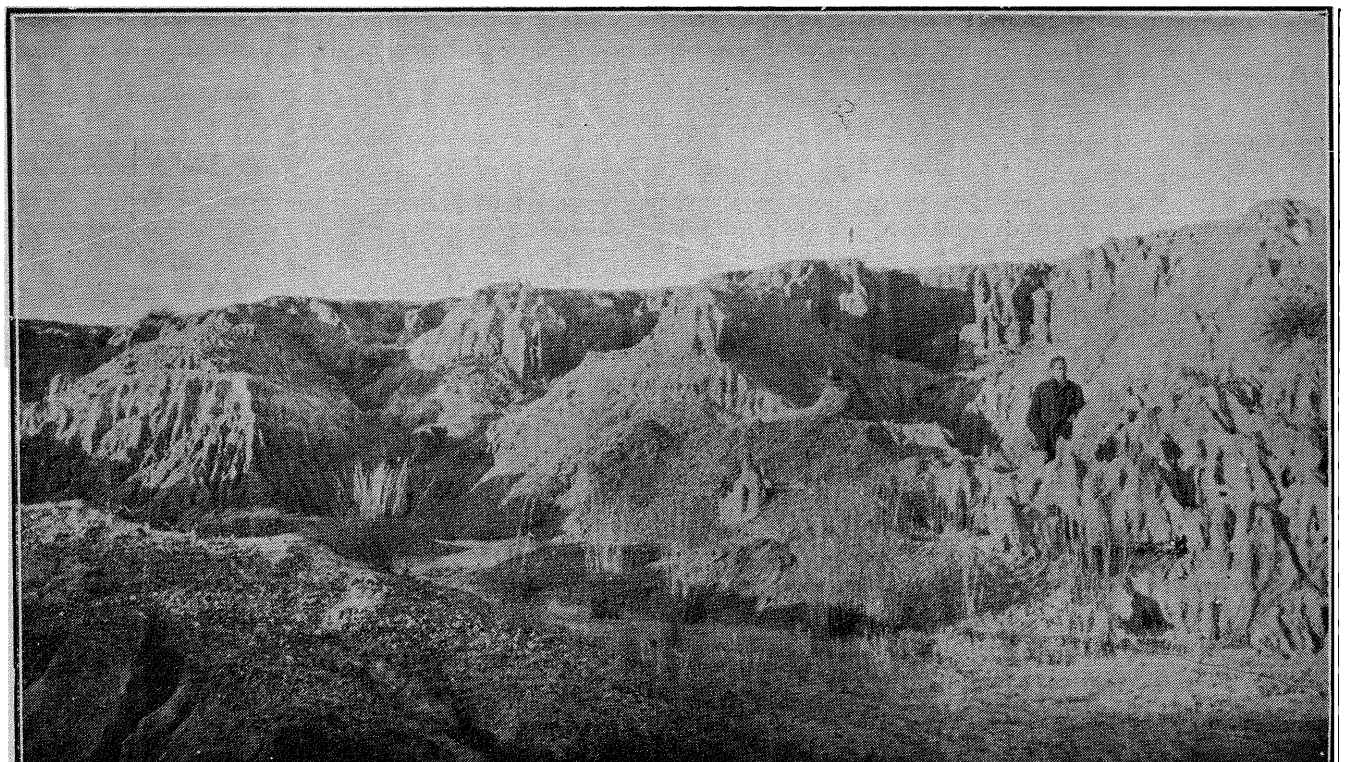
54. Sloot formation differs from surface erosion in that it is always visible, even from its first beginnings as a little stream hurrying undisturbed on its tortuous course. Surface erosion, on the other hand, often takes place unseen and in the continual removal of the surface layers, the country is losing the most valuable soil and plant food materials.

55. In the latter part of Par. 26 we touched on surface erosion by water and in Par. 27 we discussed to some extent the effect of wind on the surface. The carrying capacity of water as well as of wind depends on the rate of motion of these elements, and their carrying capacity is under certain conditions, as most of us know, enormous—terrific.

56. In the case of wind erosion (b), it is again the rich surface layer that is first removed. In certain parts of the Union ploughed lands have been bodily removed and piled in huge sand dunes which, in their progressive rolling cover, suffocate and destroy all vegetation in their path. This visible type of wind erosion, however, causes a comparatively small proportion of the total damage inflicted. The carrying capacity of the wind is enormous and when one compares the number of hours during which a scouring sheet of water is passing over the more arid portions of the Union, with the number of hours that a strong dust-bearing wind is blowing over the same area, the relation between wind and water surface erosion becomes more evident.

57. While water can carry the eroded material in only one direction—downhill and seawards—wind may carry dust uphill or down dale; but however much the dust may be tossed about, backwards and forwards the greater portion of it must ultimately move in one direction, i.e. the main direction of motion as determined by the wind prevailing during the dry season.

58. By reason of the fact that wind moves the fine, eroded material to and fro over the land and that it does not, like water, carry it only from higher to lower levels i.e. down to the valleys,



(13) **Ugly donga's doing their devastating work undisturbed (in the Transvaal).**

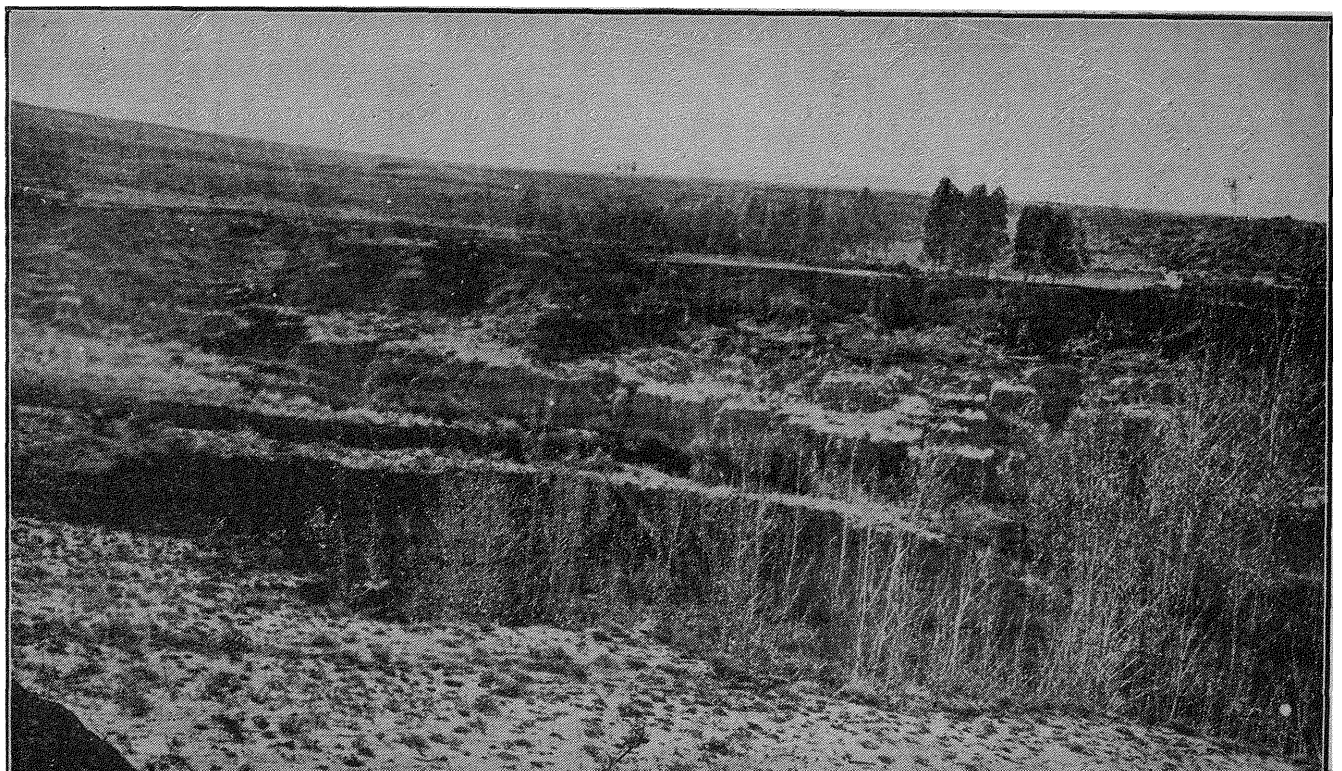
spruits and rivers, the proportion of the soil that is carried by the wind direct to the sea, is very small compared with the quantity that is carried down to the ocean by water. Indirectly, however, the destructive action of the water is greatly assisted and facilitated by wind. This help consists not only in the blowing down and piling up of soil in valleys, spruits and rivers whence it can be carried further by water, but also by hot winds that blow over the surface, drying out and loosening the surface layer, which is then easily removed by storm water—hence the first beginning of some sloot formations.

In some instances, however, the wind has done a great deal of good in that it has deposited rich soil in certain areas where, otherwise, very little or no vegetation would have grown or where crops of any description could scarcely have been produced. (See Par. 27.)

59. Sloot erosion removes soil as well as water, and as it develops it destroys a mass of vegetable growth. It further helps and facilitates the removal of soil that is occassioned by surface erosion; it carries away soil and sub-soil; reduces the carrying capacity of the veld; accelerates the run-off so that the rain water has very little chance of soaking into the ground; drains even the ground in the vicinity; causes the water table to sink, etc., etc.

60. Most of us will have noticed, for example, how a wheel rut, a little footpath or even an innocent little plough furrow, will in course of time be washed deeper and wider by storm water. A few years later it has developed from a runlet or a gulley to a deep water course known to us as a "sloot" or a "donga" with its little tributary sloots. Still a few years later we find that the sloot has together with its tributary sloots increased enormously in width and depth. Side or auxiliary sloots have linked up with the big sloot but each of the former has also developed its own system of tributaries so that, ultimately, we have a large and complete network of sloots. In between and round about this network a derelict thornbush or "bitterbossie" might perhaps still be found hanging on by its roots, but otherwise the vegetation that once formed a portion of the best veld in that vicinity has long since disappeared. These sloots vary in depth from a few inches to dozens of feet. Everything depends on the volume of water passing down them, as also on the nature and depth of the soil and sub-soil, on the slope of the original surface and the presence (if any) of dykes of rock or similar controlling factors. (See Par. 49).

61. By the lowering of the level of the water surface in the deepening water-course, the virtual gradient along which the storm water is carried from the veld to the bottom of the donga, is greatly increased. This results, in the first instance,



(14) Here the evil is being conquered by plants and diverting Canals (see Fig. 17 and paragraphs 132—139.

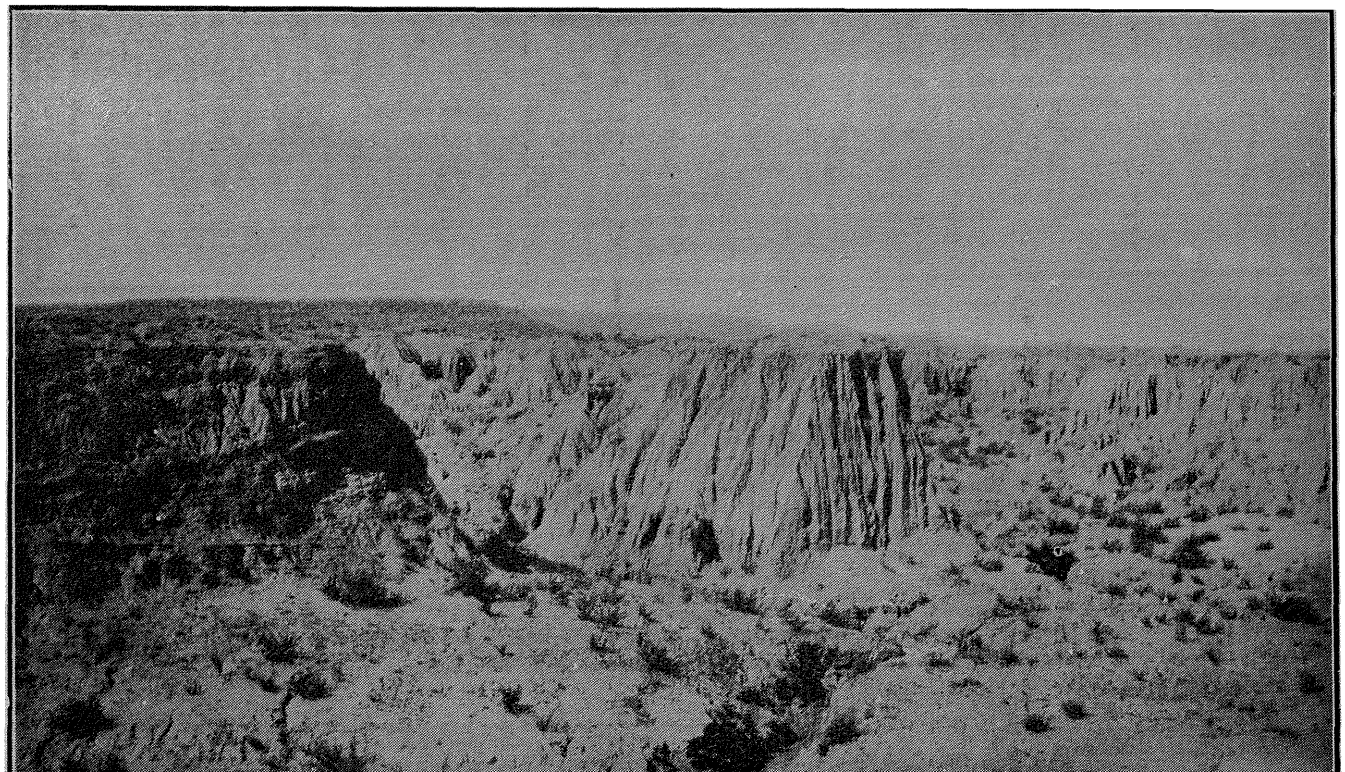
in innumerable branch sloots eating their way back from the banks in ever-increasing ramifications and, consequently, in an accelarated surface erosion in the surrounding area. In this manner all the surface soil is eventually removed in the vicinity of such sloots in many parts of the Union.

The resultant destruction of the vegetation and the laying bare of the surface cause an increased and accelerated run-off and a reduction in the quantity of water soaking into the ground. Such deep dongas also serve to drain the soil on its banks of the water which may have managed to soak into the ground.

62. The steeper the slope and the greater the volume of water, and the more such water is concentrated the greater will be its velocity, force, carrying and sloot-cutting power. It is a well-known principle that the carrying power of a stream increases as the sixth power of the velocity of the current, etc.

63. Depressions, valleys and vleis lying more or less against slopes, and which usually catch and carry away a certain amount of rain water, also constitute a dangerous source of sloot-formation. When a heavy thunder storm descends on a steep kloof so much storm water rushes down it at once that any obstacles such as stones, bushes or grass, which under normal conditions might have served to check the run-off to some extent, are simply swept away by the roaring torrent with the result that a large yawning sloot is formed. The banks of such a sloot are undercut and caved-in, branch sloots are formed, etc. In the interests of the farmers themselves, who are owners of farms on which slooting is taking place, and in the interests also of their children and of the citizens of the State generally, it is essential that such owners should without delay deal with the sloots in such a manner as to permit of their being silted up so that trees, shrubs and other plants can be grown in them to check the run-off and prevent further slooting.

64. This Earth on which we live is very old and although the nature and incidence of the rainfall, of our summer-rainfall areas, are somewhat different to what they were formerly, South Africa certainly had her thunder storms and floods also in former times, and still we find that the major proportion of the gaping dongas in the Union is of *fairly recent occurrence*, there having been no sign of them not so many years ago. The writer for instance, is not so very old and he has still a clear recollection of certain districts in which, not so long ago, were to be found many fine vleis, well covered with wild clover, good vlei grasses and other useful plants, and containing pools filled throughout the year with clear, clean water. Around such pools grew rushes (*preonium serratum*), "matjiesgoed" (*cyperus textilis*) and other beautiful plants. In these pools, during the



(15) Soil Erosion— Unrestrained. (C.P.)

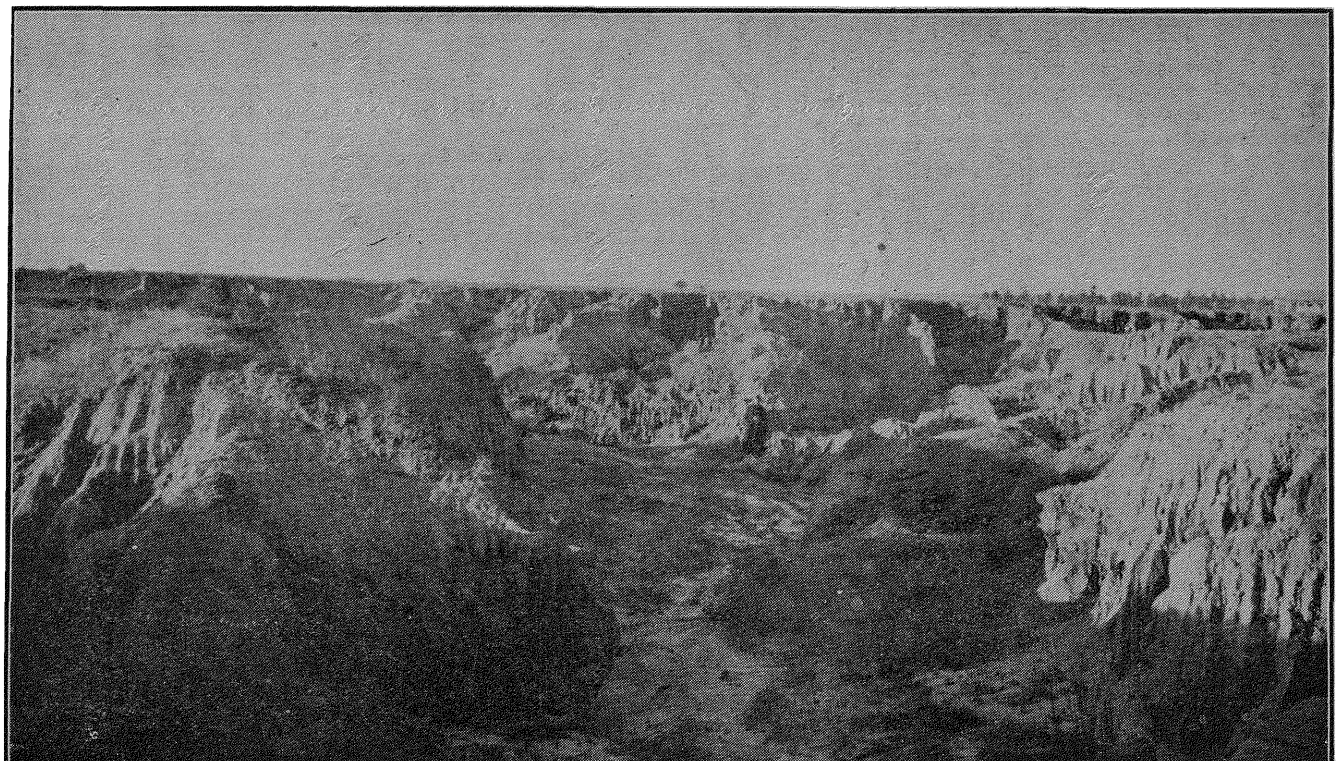
summer months, grew beautiful water lilies which we often, accompanied by Lily, Mimmie, Annie, Hettie or Bettie, went to pick. Where are those beautiful vleis to-day? In their stead we find a network of unsightly sloots, and where sweet clover flourished we find to-day, here and there, a miserable little "bitterbossie" (*chrysocoma tenuifolia*). Not a drop of water is now to be found there because the network of gulleys form such a perfect drainage system that as soon as the rainwater falls on the ground it is carried down to the bigger sloots, which carry it further to the sea. This vlei area, which at one time could carry and fatten more live-stock than any other part of equal size of the veld on the farm, cannot to-day provide sufficient sustenance for a tortoise. The nice warm kloofs, that at one time furnished excellent winter grazing, and the fine ganna flats have all shared the fate of the vlei. Grootvlei, Groenvlei, Lekkervlei, Klawervlei, Rondevlei, etc., are all well-known farm names. The farms are still there but the vleis from which they derived their names have long since vanished. Twenty, forty or sixty years ago these vleis were still in existence but to-day the farms could be more appropriately named "Grootsloot, Droësloot, Lekkersloot, Dubbelsloot, Langsloot, Dwarssloot, Kruissloot," etc.

65. We have, in previous paragraphs, endeavoured to show how various factors have worked separately and jointly to destroy the vegetal covering of our veld and to erode our soil. The part that man has played in this devastating work will be further dealt with in the pages to follow.

66. What the actual annual loss of soil to the Union through transportation by rivers is, is at present unknown. However, according to figures obtained from the Irrigation Department by the Drought Investigation Commission on the measurements of silt taken from some of our rivers, a rough but conservative estimate shows that nine of our principal rivers annually carry away some 187,000,000 tons of earth, equivalent to 91 square miles of soil one foot deep. (See Final Report Dr. Inv. Comm. Chapter 28).

67. The amount of plant food materials lost annually out of our soils, is also at present unknown, but judging from the amount of soil we are losing annually, the quantity of plant nutrients lost must be very large and the equivalent in £ s. d.—immense.

We quote the following from—"Soil Erosion a National Menace"—issued by the United States Department of Agriculture in April 1928, viz:—"Not less than 126,000,000,000 lbs. of plant food material is removed from the fields and pastures of the United States of America every year. The value of



(16) Fast spreading sloots—unrestrained (Natal.)

the plant food elements (considering only phosphorus, Potash and Nitrogen) in this waste, as estimated on the basis of 389 samples of surface soil, collected throughout the United States and the recent selling prices of the cheapest form of fertilizer materials contained in these plant nutrients, exceeds annually 2,000,000,000 dollars (£400,000,000). Of this amount there is evidence to indicate that at least 200,000,000 dollars (£40,000,000) can be charged up as a tangible yearly loss to the farmers of the Nation. These calculations do not take into account the losses of lime, magnesia and sulphur." The above figures are considered conservative by certain people who can speak with authority.

68. The ever increasing sloots in our country must result not only in greater losses of our vegetation, soils and plant food materials, but they are also the cause of an increased and accelerated run-off of our rain-waters. As a result, floods in our rivers may be expected to increase in severity, but decrease in their time of flow, while periods of no flow will naturally become proportionately longer.

69. South Africa, is to a large extent, a semi-arid country and needs a great deal of irrigation, if for no other purpose than for the full development of its livestock raising potentialities. The irregular flow of our rivers is one of the great stumbling blocks in the way of extending irrigation works on a large scale. The ever increasing soil erosion is not only increasing the irregularity of our rivers, but it also rushes down sand, mud, stones, etc., whereby the length, or the useful life, of expensive dams or reservoirs is so greatly reduced, that irrigation schemes are frequently made economically impossible.

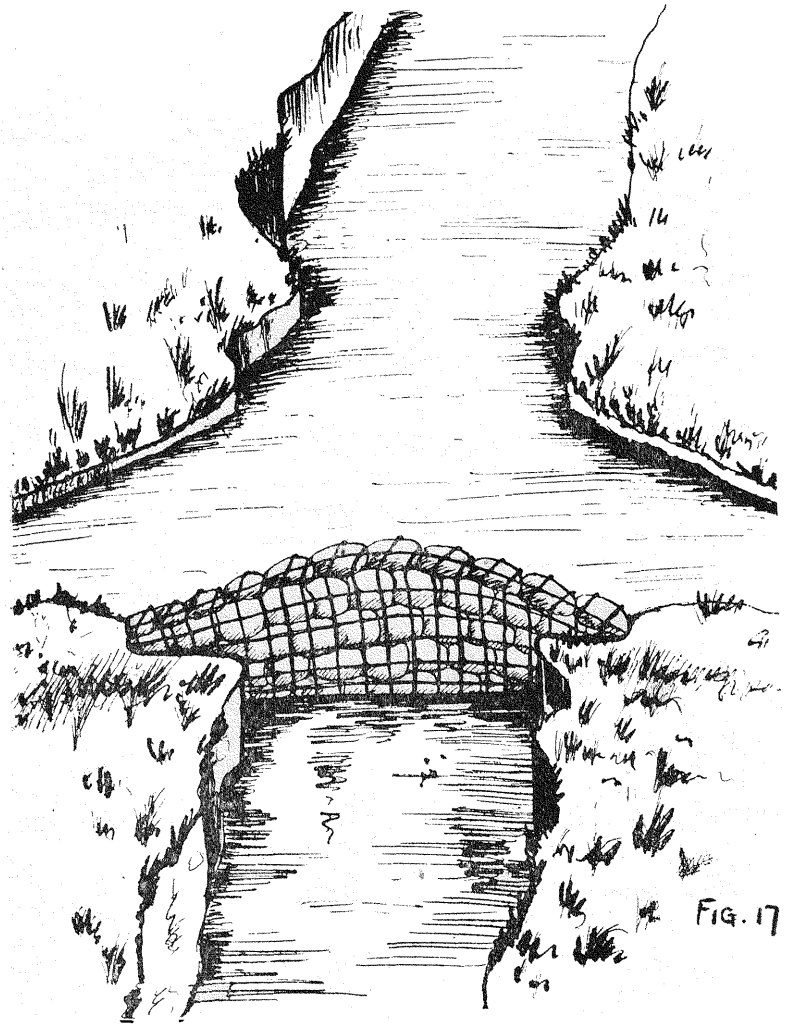
70. *The severe periodical drought* has been in the past and still is, one of the South African farmer's bitterest enemies. According to our Agricultural census the Union's loss in live-stock and crops through drought, during the year 1918-19, amounted to over £16,000,000 and 1918-19 was neither the severest nor the only drought through which the South African farmer had to pass.

71. In order therefore, to protect ourselves against these severe droughts, irrigation works are, among other measures, most essential, but if we permit matters to drift—"ad libitum" —to such an extent as to make irrigation schemes well nigh impossible, then it requires no prophet to predict our future.

72. The following is a short summary of some of the principal evils caused by soil erosion, viz:—

(a) The removal of our best soils and valuable plant food materials.

(b) The destruction of our vegetal covering.



A stone wall enclosed in a net of galvanised wire built across a main donga with canals on either side leading the flood water onto level veld
(See Paragraphs 102, 103 and 137.)

(c) Decrease in the carrying capacity of our veld.
(d) Decrease in the productivity of our cultivated lands and in the yields of wool, meat, fruit, crops, etc.
(e) Decrease in the number of people who could live on the land and increase of poor whites and poor natives flocking to towns and cities.
(f) Decrease in the revenue of the country.
(g) Silting-up of expensive irrigation works.
(h) Sinking of the subterranean water table causing the dying out of even deep-rooted trees and valuable shrubs and drying up of springs, bore holes and rivers.

Chapter V

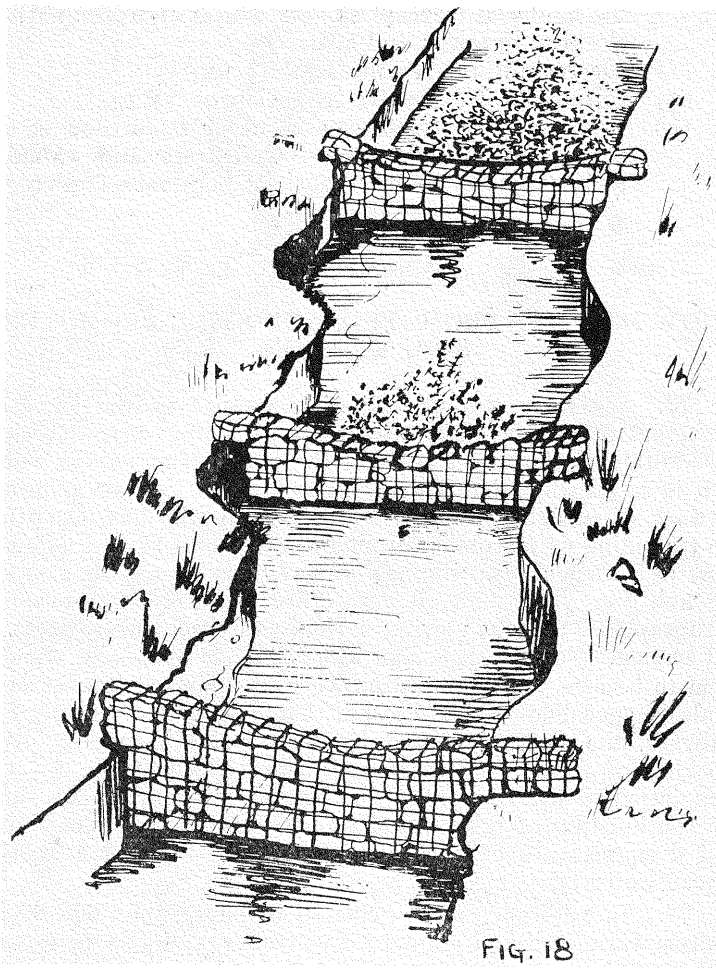
HOW MAN HAS PROMOTED, AND STILL PROMOTES SOIL EROSION.

73. We have throughout this brochure shown what an important rôle is played by man in the promotion of soil erosion. In addition to the wheel rut and the plough furrow for which man is responsible, and which he has allowed to develop into a network of unsightly sloots, it is man also who has permitted the trampling of footpaths through his veld and further allowed these to become sloots; who has been responsible for the slooting of his fine vleis and all the other damage mentioned in Paragraph 72 without moving a finger to check the ravages of soil erosion. Further, it is man who has made roads and allowed them to become yawning chasms with all their tributaries. Man is also responsible for the erosion that has been caused by our railways, the slooting caused by road makers; for the over-stocking of farms; for the over-grazing of our veld; for the denudation or destruction of the vegetal covering of our veld; for the burning of trees, shrubs and grass; for the weakening and disappearance of springs; for the sinking of the subterranean water table, etc.

74. In addition to our remarks in paragraphs 66—68 on the removal of soil and plant food materials, and also mentioned under (a) in paragraph 72, a brief discussion of the remaining items ((b) to (h) Par. 72) is still necessary.

THE DESTRUCTION OF VELD PLANTS AND THE DIMINISHED CARRYING CAPACITY OF THE VELD.

75. The maintenance or improvement of the natural vegetation is of primary importance to animal life. The plants that are suitable for pasture also constitute a proportion of the vegetal covering of the veld, and when this vegetal covering



Stone walls enclosed in wire nets, built across deep donga's to bring about the silting-up of the sloots. (See Paragraphs 132—139.)

(18)

is reduced or destroyed then not only is the available pasturage decreased but the run-off and evaporation of water is *also* thereby increased and the value of the rainfall reduced.

76. It is not intended here to deal with all the causes that have resulted, and are still resulting, in the decrease of the veld flora, but merely to discuss a few of the chief causes for which man is responsible.

77. The kraaling and herding of stock, overgrazing and overstocking of farms and the resultant trampling out of the vegetation may undoubtedly be regarded as the chief cause of the destruction of the vegetal cover of our veld. Herded and kraaled stock usually show a tendency to graze in closer formation than stock that are allowed to range freely. Scarcity of drinking places also causes a concentration of stock with the same disasterous results.

78. The Drought Investigation Commission made at the time (Sep. 1920—Oct. 1923) a careful analysis of census figures over a period of 56 years. One result of this analysis was the discovery of a decrease in population in the Midlands of the Cape Province. Facts have been adduced, showing that this decrease was due to retrogression of veld, and that those districts were no longer capable of carrying the same number of human beings and live stock that they carried formerly. The decrease in the revenue of the State and the increase in the number of poor whites on the country side are also to a certain extent due to the evils mentioned in the foregoing paragraphs.

79. *The Sinking of the Water Table.* One can always be sure of striking free water if one only goes down deep enough with a well or borehole. Such a well or borehole need not necessarily, to that end, be sunk on a water vein or subterranean spring. Should such an underground vein or spring be struck the supply would naturally be more plentiful and constant than the usual free water found everywhere by going down deep enough. In some places the water will be found relatively close to the surface while in others one would have to go down very deep before it is struck. This underground water level is usually designated "The subterranean water table." Where such a water table is relatively close to the surface it is conceivable that the rivers, springs, pools and vleis of such an area would, even in dry periods, furnish a certain proportion of water, and that those plants, equipped with a deep root system, would flourish even in times of drought.

80. In areas subject to protracted droughts, where sloot formation is almost negligible and the vegetal covering has not been appreciably denuded, the water table is bound to sink to some extent. However, as soon as good rains fall again in

such an area the water table rises and the water in wells and boreholes will mount to its former level. The springs that have become weak or dry will again start running and the abnormal conditions that have supervened during the drought will vanish.

81. In areas, on the other hand, where there is a network of sloots to carry off the rain water almost as fast as it falls, and where the vegetal cover has been destroyed, the fact is self-evident that the rain water will not have much chance of sinking into the ground and the underground water table will sink lower and lower because—apart from the sloots—the surface vegetation in such denuded areas is too sparse to retain the rainwater sufficiently long to enable a proportion thereof to soak into the ground and so reinforce the water and reduce evaporation.

82. Meteorologists assure us that, apart from the climatic changes of bygone ages, there is no proof that the average annual rainfall of South Africa has changed during recent times. There have, of course, been variations of climate from time to time. Good and bad years follow on each other with no apparent regularity; but no general upward or downward tendency in the mean annual rainfall can be traced. Meteorologists suggest, further, that our present rainfall is, as regards its nature and incidence, probably quite different to what it was some 50 or 60 years ago, but that the amount of moisture precipitated by the clouds on the earth is the same now as it was formerly.

83. In the history of the nations that lived on the Earth thousands of years ago mention was made of great floods as well as of great droughts. Even in the Bible we read of a flood in the time of Noah (Gen. 7), and in the time of King Ahab of a three years' drought (1 Kings: 18). We have therefore to assume that since the advent of man on Earth there have always been droughts and floods as well as periods during which conditions were normal. Centuries ago there was, of course, also a certain amount of erosion as a result of the processes described in Par. 52, but the *abnormal* and *unnatural* conditions as well as the many other evils that accompany erosion *are by no means old.* The chief causes of the existing abnormal state of affairs are those that have already been briefly described in the foregoing paragraphs.

84. It is a pity that there are no figures available to show how far or how deep the water table has sunk during the last 50, 60 or 70 years in the denuded, or partially denuded, parts of our country. The fact remains, however, that springs and

other permanent waters, that existed in our land not so long ago, are to-day conspicuous by their absence.

85. Water which falls from the sky upon the earth has four possible courses open to it:—

(1) It may run off the surface and find its way into the water courses.

(2) It may be evaporated from the surface of the soil before it is absorbed or even thereafter, provided it has reached a depth too great for surface tension (capillary action) to draw it to the surface.

(3) It may be taken up by the roots of the vegetation and transpired into the air (excepting the small amount retained by the plant).

(4) It may sink so deeply as to strengthen the underground water.

86. The vegetal covering, referred to in the foregoing paragraphs, serves in the first place as shelter to the surface and also to keep down temperature and to check evaporation. It also, to a certain extent, breaks the moisture-removing power of the wind. Further, the vegetation serves efficiently to curb the run-off, whereby the rain water is retained longer on the surface and is afforded the opportunity to soak into the ground so as to re-inforce the underground water and strengthen springs, etc.

87. Rivulets or spruits and rivers obtain their water respectively from small and large catchment areas. The Orange and Vaal Rivers, for instance, obtain approximately 60% of their water from the districts that abutt on the eastern slopes, namely: Ermelo, Standerton, Wakkerstroom, Vrede Frankfort, Harrismith, Bethlehem, Ficksburg, Ladybrand, Wepener, Rouxville, Aliwal North, Herschel, Barkley East and Basutoland. This catchment area comprises about one-twelfth of the whole of the Union and Basutoland, while the catchment area of a "spruit" may consist, relatively, of only a small tract of land.

88. Plant destruction and sloot formation in such a catchment area will cause an accelerated run-off in addition to all the other evils that accompany soil erosion and veld deterioration. The stream beds that formerly contained clear streams of at least a couple of inches almost throughout the year are now only occasionally in spate with roaring torrents of muddy water that usually run off in a few hours time. Where it was formerly possible, by means of furrows or canals, to divert the water easily and cheaply from the river bed for irrigation purposes it is now necessary to construct expensive dams and protective works.

89. Denudation and deterioration of catchment areas have taken place in many parts of the Union. Against the slopes of the higher plateaux between Pietersburg and Barberton and all along the slopes towards the south and west as far as Worcester the Drought Investigation Commission had, in the course of its investigations over a period of three years, to listen to the same complaint, namely, that in order to provide temporary grazing for a few goats or other stock the steep slopes of mountain ranges, covered at best with only few inches of soil, were burnt off and the natural vegetation destroyed. The effect on streams that have their source in the vicinity, and on which adjacent farms have to rely for their water, is disasterous, because in course of time all the soil is removed from the slopes; the grazing which they afford deteriorates and all the attendant evils, to which we have already drawn attention, reign supreme to the detriment of the nation.

90. At Worcester evidence was sumbitted to the Drought Commission, showing that the Irrigation Board of Nuy (near Worcester) had gone to the expense of purchasing 10,200 morgen of mountain veld falling within their catchment area, in order to secure the right to protect this area against veld-burning, trampling, erosion, etc.

91. *Veldburning* is a very deeply rooted practice in South Africa and as such is extremely difficult to root out. The natural dying down and the decay of grass return to the soil those substances that the plant has withdrawn therefrom and at the same time may enrich the soil with nitrogenous matter derived from the air (see paragraph 43).

92. Veld burning destroys a great deal of the useful covering of the soil and facilitates evaporation, the extent of which is far more serious than most people seem to be able to realise. This destruction of the vegetal covering further causes an increased and accelerated run-off, and since the amount of water absorbed depends very largely upon the time of contact between the water and the soil, it is evident that any factor which reduces the time of contact also reduces the absorption.

93. Standing grass, for instance, and especially that standing in an entanglement of its decaying predecessors ("ougras") acts as a more or less efficient obstruction to run-off. Most people must have noticed that when a heavy shower falls in a valley, one side of which has been burned off and the other not, the former side will precipitate a large volume of water into the stream bed while the flow from the latter side will be, comparatively, almost negligible.

94. Although veld burning in South Africa is decreasing, it is still to a large extent regarded as a necessity. The stock farmer may in some cases have a reasonable excuse for resorting to veld burning. This excuse (if such it be) may perhaps be regarded as perfectly sound by a certain type of stock farmer, but what about posterity? Will posterity bless us for leaving them a devastated country? Not personal or material interests but a sense of duty should be the keynote of any nation, and posterity may reasonably expect to inherit a land that will be an asset instead of a burden, so that millions of unborn South African children may one day bless the deeds of their progenitors instead of condemning and cursing them.

95. Plants, like human beings and animals, are continually dying out from one cause or another. The severe droughts that visit our country from time to time constitute one of the chief causes of the dying out, periodically, of an abnormal proportion of our most useful plants, and the question thus arises whether we are doing justice to ourselves and to posterity by permitting the deliberate destruction of the vegetal covering of our veld. W. R. Chapline writes, in effect, in "Soil Erosion a National Menace," that of all the soil erosion for which man is responsible, veld burning is the chief instrument provided by man to assist the elements of Nature in robbing us of our best plants and soil.

96. Without plant life neither man nor beast can exist on the land. From the day on which he makes his appearance on earth man is tended with the greatest solicitude until he is big enough to fend for himself. The hen protects and feeds her chickens, the cow her calf and the ewe her lamb until they are big enough to help themselves. The same happens to almost all animals on earth but the poor little plant, from the time that it has germinated and shoved its head above ground, has to help itself. It has nobody to protect it and it cannot flee when danger threatens. Useful plants are the friends of, and the source of life to man and beast but, they are nevertheless ruthlessly burnt and destroyed in many ways. Man, who thus permits the ruthless destruction of his useful plants by burning or by any other means, endangers not only his own existence but that also of posterity.

97. In paragraphs 21 and 67 reference has been made to soil erosion that has taken place on a gigantic scale in the United States of America. In other parts of the world, soil erosion has also played a prominent rôle, but in the densely populated and highly civilized countries the evil has long ago been successfully combated, so that under normal conditions comparatively little erosion now takes place. Some overseas

countries are occasionally visited by tremendous floods, which naturally cause much damage and remove a large proportion of rich soil, but such conditions have, so far as soil erosion is concerned to be regarded as abnormal and practically beyond the power of man to rectify or modify. In the U.S.A. and other countries, however, the evil is fought tooth and nail by the population, while the South African people not only permit their valuable soil to be removed from under their feet, but they even assist the powers of Nature in robbing them of their greatest national asset. The time has long since been ripe for the inauguration by the people of South Africa—by individuals as well as communities—of a unanimous and determined campaign against this national calamity. (See Par. 110).

98. The Union of South Africa comprises 472,347 square miles and at present the rural population is approximately 722,000 (Europeans). These occupy 90,658 farms—an area of 97,070,129 morgen—and although the Union is greater in extent than England, Scotland, Ireland, France, Italy and Holland combined, we fall far short of those countries so far as population is concerned.

In accordance with our census figures for 1926 there were only 3.3 Europeans to the square mile in the Union in that year, while (according to Witaker) a small country such as Belgium, which is 40 times smaller than the Union, carries 658 souls to the square mile.

99. From the figure quoted in the preceding paragraph we see that our country is still very sparsely populated and that there is probably still room for millions of Europeans, but when one reads *Par. 78* and realises the damage that has been occasioned by our fathers and ourselves, one is inclined to doubt the possibility of a rapid and extensive increase in the European population of South Africa.

Chapter VI

POSSIBLE REMEDIAL MEASURES.

100. Veld deterioration and soil erosion are not things for which remedies and preventives (as for instance in the case of wireworm in sheep) can be recommended in accordance with kindred or established prescriptions, because the nature and slope of the land, the nature of the sloots and vegetal cover, climatic conditions, etc., vary so much in the different parts of our country, that the problem, in many cases, requires special treatment and that many of its phases should be dealt with

separately. Even on one and the same farm we often find small sloots that are becoming big sloots; big sloots that are becoming still bigger sloots and forming tributaries; wagon tracks, plough furrows, foot paths and old roads that will soon develop into deep dongas. In some cases a bush with a couple of stones piled on it will cause an incipient sloot to silt up, to be soon covered with vegetation and ultimately to disappear altogether, while in other cases, soil, rubble, bush or wire dams may be necessary.

101. The advice that the "birth" of sloots on our farms should be prevented is excellent. Unfortunately, however, there are now already many thousands of sloots in our country and, as has been pointed out in the previous paragraphs, these are rapidly and continually multiplying. It is against this national peril that we as a nation must declare war.

102. A small percentage of farmers spread over the Union, have already for many years fought soil erosion on their own farms, and it is most interesting to see the methods that have been employed and the results that have been obtained by them. On some farms the contour of the land is so favourable that all that the farmer needs to do is to divert the tributary sloots that feed the big ones so that the storm water cannot reach the latter. The banks of the big sloots usually slide in in course of time and the loose soil remains in the bed of the mother sloot as it no longer receives sufficient storm water to take it away. In due course these sloots become overgrown with grass, shrubs or trees and they have ceased to exist as carriers of water and soil.

103. By diverting the branch or tributary sloots which formerly fed the main sloot, the water is turned on to more level parts of the veld where surface erosion and the forming of new sloots is, under normal conditions, impossible. Large tracts of veld are in this manner irrigated with storm water from time to time, with the result that the veld plants on such irrigated parts increase and flourish, and not only provide feed for animals but also form an adequate vegetal covering which is the direct antithesis of vegetal denudation and soil erosion.

104. Although there are many farms in our country where the abovementioned methods might be employed successfully, nothing has as yet been done in the matter by the owners, as a result of which a successful campaign against erosion is rendered more and more difficult and expensive.

105. The conditions favourable for combating soil erosion, referred to in the foregoing paragraph, unfortunately do not obtain on all the farms or in all the districts of our country, because in many instances the sloots are to be found on the