Aspects of the Role of Man in Erosion in Rhodesia

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Of all the factors in erosion, man has been the least studied. Soil erosion as distinct from geological erosion is essentially a man-induced process. The anomolous situation whereby the human influences have been largely neglected can partially be explained in terms of the very unreliability of man. It may be a costly and laborious task to set up and maintain erosion plots, but once in operation virtual control is exercised over the natural environment. Rainfall can be accurately measured; soil loss in runoff assessed. This is not so with man; for any rigorous measurement of his activities is fraught with difficulties. He is subject to the many forces of his environment, under which two apparently similar human beings might react in totally different fashion. Ekblaw (1936, 2) writing on the relationship between soil science and geography, touches on the problem:

> Man is the most difficult of all things to relate scientifically to his environment because he possesses as wide a degree of adaptability as plants and animals, greater mobility as a genus than either plants or animals and, in addition, has his peculiar power of volition, of choosing for himself his own course.

The problem remains as to how far it is possible to identify a measure of order within man's activities. If a sound quantitative study is required, not enough order is available, since the sweeping generalizations necessary in a wide geographical study would tend to temper the very important role of the individual. A cursory study of air photographs over adjacent European farms in Rhodesia, for instance, clearly shows the very different erosional situation over similar tracts of land.

It appears, therefore, that any discussion on man and erosion in Rhodesia must necessarily neglect precise cause-effect relationships. This problem has been circumvented in the United States where the 'human factor' has been measured in terms of known conservation measures and the degree to which these have been implemented. The approach adopted by American research workers was conditioned by the framework of the Universal Soil Loss Equation (Smith and Wischmeier, 1962) where it was hoped to reduce the causes of soil erosion down to a number of readily definable and measurable factors. This may be feasible in the United States and indeed has been used with success. Thus, the 'erosion control practice factor' is an attempt at quantifying the benefits of various conservation practices. For example, contour planting (Moldenhauer and Wischmeier, 1960), strip cropping (Hill *et al.*, 1944), ridging or terracing along the contour (Smith and Wischmeier, 1957) have all been assessed in terms of their value in reducing erosion with reference to standardised conditions on the erosion experiment stations in the United States. In addition, a 'cropping management factor' looks at aspects of the cover given to the soil by various crops (Stocking, 1972a). Its definition encompasses measures such as the number of years of planting continuous row crops and the quantity of residues left on the ground after harvesting (Wischmeier, 1960).

This whole approach by the American conservationists is geared to the large cornbelt farms that are highly mechanised and technologically based, where, at the change of a plough, minimum tillage (i.e., least disturbance to the soil) can be practised. The human 'unreliability' factor has largely been eliminated, so much so that agricultural practices are no longer the whim of the individual. The use of such American indices in Rhodesia, however, is dependent upon knowledge of the necessary local control measures and the means to implement them being available. While the knowledge and means is, to a large extent, available amongst European farmers in Rhodesia, it is not so in the African areas. The African farmer cannot yet be expected to understand fully the intricacies of mould board ploughing, let alone suitable crop rotations, detailed soil analyses and optimum fertilizer requirements, all of which are necessary pre-requisites for the successful operation of the American indices. Therefore, one cannot effectively base an assessment of the human factor on the degree to which positive conservation measures are applied. An index must be sought which measures the degree of damage done to soils by the accumulated effects of past and present land use practices. At this stage it is possible to show only the foundations for such an index through contrasts illustrating the significant differences between land tenures and land use systems, the importance of factors such as standards of education or pride of ownership and the availability of means and resources for conservation.

The National Situation

It is at the national level that the broadest generalizations must be applied. There is little data to quote and only the major patterns of man's activities that influence erosion can be brought out. The major emphasis is on the Tribal Trust Lands. It is here that man, strongly backed by natural forces, has created for himself the greatest actual or potential erosional situation.

The pattern of African population in Rhodesia has been documented by Kay (1972). The African population density map derived from Kay's study (Kay and Wheeler, 1971) clearly shows a strong clustering of population in the rural areas to the north, east and south of Salisbury. Equally high densities — up to 60 persons per square kilometre — are shown to the north of Mtoko and generally in a wide arc coincident with the south-eastern Middleveld, stretching in the north from the edges of the Zambezi Escarpment, through Mtoko, Rusape and the densely-settled TTLs of the Sabi-Gutu-Buhera-Bikita-Chibi area. In contrast, the areas to the north-west are sparsely-populated. The large TTLs of Gokwe and Nkai have local densities rising to 30 p.p. sq. km., but in general the density is of the order of 0-10 p.p. sq. km. Moreover, it should be noted that in this relatively undeveloped area, endowed with potentially good natural resources, the increase in population is over ten per cent per annum. Population density, while not directly affecting erosion, must be taken in context as a major contributing factor in erosion. A high density of population on land that at the present stage of technology is incapable of supporting such a population unless large and ever-increasing areas are brought under the plough, and which is settled in an area where the natural incidence of erosion is potentially very great, must be conducive to erosion. This situation is perhaps best exemplified in parts of the south-eastern Middleveld where slopes are steep (Stocking, 1972b), vegetation is poor due to the unreliable rainfall and the pressure of population on the land is accentuated by the paucity of areas suitable for cultivation and settlement.

An associated problem and one that has important consequences on erosion is the concept of land carrying capacity. In a classic study of man-land relationships in Africa, Allan (1949, p. 1) states that:

> Any area of land will support in perpetuity only a limited number of people. An absolute limit is imposed by soil and climatic factors in so far as these are beyond human control, and a practical limit is set by the way in which the land is used.

Allan was directly concerned with critical populations for particular land-use systems. An excess of population above a critical limit, without a compensating change in the system of land usage must promote what he calls 'land degradtion' (Allan 1949, p. 1; and 1965, p. 291). The estimation of land carrying capacity in Rhodesia presents almost insuperable practical problems. It can be stated from the obvious fact that serious erosion has occurred, that the carrying capacity of the tribal areas is low under present systems of land usage, and that the critical population density has been exceeded in most areas.

Populations of cattle, goats and donkeys are also contributory agents to the erosion process. Holleman (1951, 358) writing of the subsistence economy of the Shona tribes in the Sabi area, notes that although cultivation is by far the most important means of subsistence 'a sizeable number of cattle and smaller livestock is found, mostly of a poor to mediocre quality'. Though cattle bring in more money to the tribal areas than sales of crops, they play little part in the national economy of Rhodesia, being mostly maintained for marriage and draught purposes. In this latter capacity, cattle are vital to the cultivation of fairly extensive areas, especially in the absence of many adult men. Here a twofold problem arises for the cultivator: that of keeping enough cattle for ploughing and enough land under crops to feed the family. Also, individual wealth is often gauged by numbers of livestock and there is a consequent tendency to keep the maximum number possible, a figure limited by periodic drought, lack of grazing and attempts at administrative control. The Ndebele have a stronger pastoral tradition and chose to settle in the drier southern and western parts of the country. These people remain largely pastoral, although any movement towards commercial cultivation would be thwarted by unreliable rainfall (Kuper *et al.*, 1954; Johnson, 1964). In 1962 there were some 2 090 000 head of cattle, 650 000 goats, sheep and pigs and 65 000 donkeys in the tribal areas* (Kay, 1970, p. 80). Assuming that four of the small livestock are equivalent to one cattle unit, there are approximately 0,13 cattle units per hectare of African land. While this does not appear to be an unduly high density, it must be remembered that many areas are totally unsuited to any form of grazing and in others, notably the Middleveld again, carrying capacity of the extensive grazings is one cow to every 4-12 ha., dependent on rainfall (Department of Native Agriculture, 1962, p. 98). It should also be noted that the overall density of 0,13 does not take into account arable land or land unsuitable for agricultural practices. Therefore, it can be deduced that high densities of livestock are apparent in some areas. Kay (1970) shows how the situation in Rhodesia has deteriorated between 1961 and 1965. In 1961 in the communally occupied African areas as a whole it was estimated that the total stock as a percentage of carrying capacity was 97 per cent. Certain provinces, in particular Manicaland and Matabeleland South were overstocked. By 1965 the situation had worsened considerably and the African areas as a whole were seen to be overstocked (114 per cent). Furthermore the problem is bound to be more serious locally especially in those TTLs with high human population densities. Sister Mary Aquina (1964) quotes a good local example from the southern tip of Chilimanzi TTL near Gwelo. Due to reallocation of lands in 1965, a large number of tribesmen and their cattle were forced to move into this area. The cattle population was suddenly swollen to one beast per 2 ha on land that requires at least 6 ha per unit. In contrast to Northern Chilimanzi, the southern portion is very seriously eroded. Naturally, these local areas are at the moment the foci for erosion. In the African areas the choice for such a focus is often merely an accident of history. In the European areas, it is to the individual farmer one has to turn. Before considering the question of erosion at this detailed scale it is worth while to look into some of the regional or intra-regional patterns that occur.

*These are official figures and probably understatements.

The Regional Situation

The term 'region' is used very loosely in this context as adjacent areas that have roughly similar natural environments. The contrast that can be brought out is that between different systems of land use which, in broad terms, is reflected in the map of land tenure. In order to compare and contrast different areas, an aerial photographic method was adopted (Stocking, 1971). Several areas over the country were chosen at random from which a parameter of intensity of erosion, gully lengths, was measured directly from the air photographs. Three of these areas fall very near each other in the Middleveld; Bikita Tribal Trust Land, Nyahunda African Purchase Area and Sabi Valley Intensive Conservation Area. Mean annual rainfall in these three areas is in the range 500-700 mm. The relief, however, is not en-

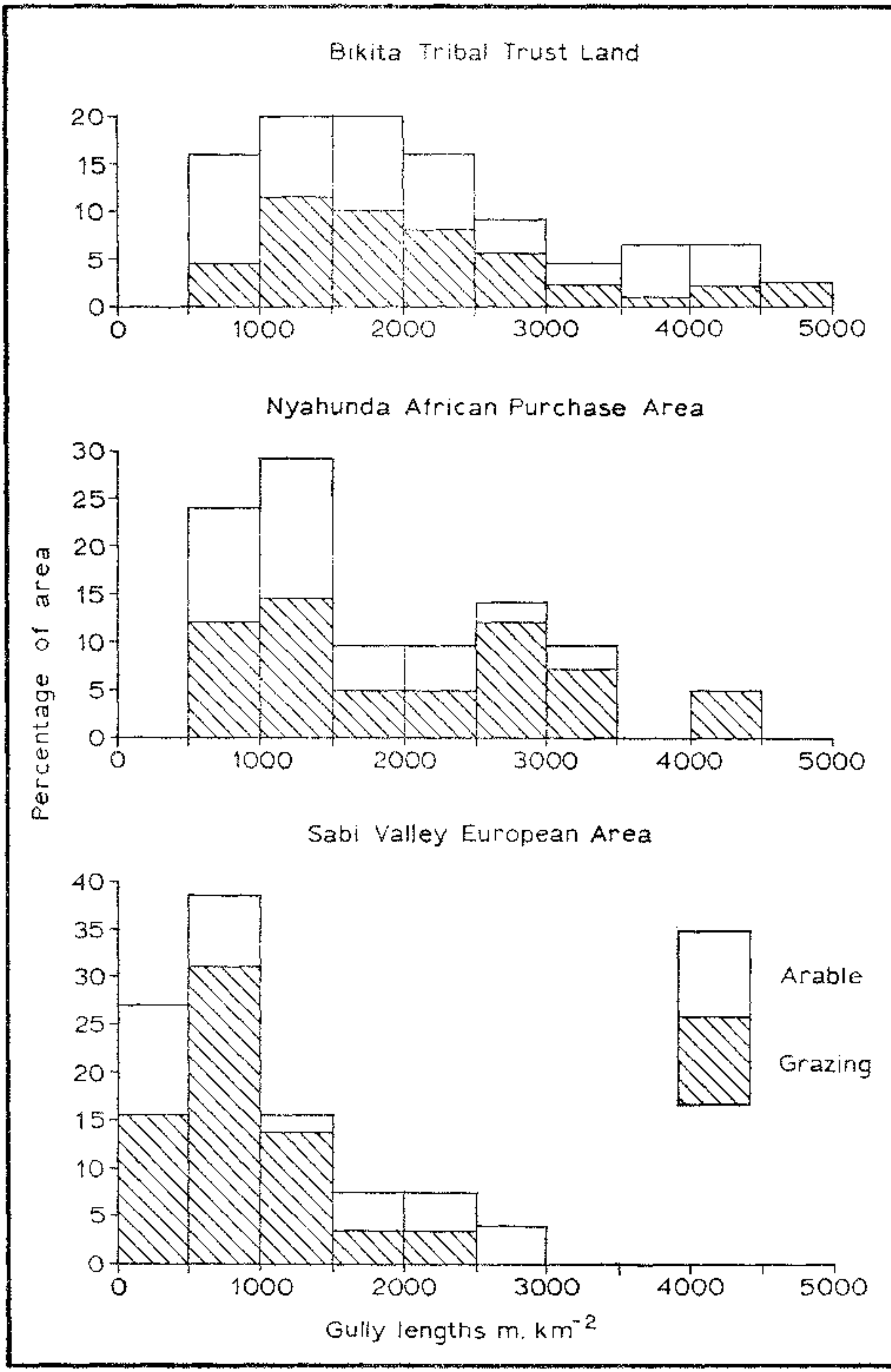

Fig. 1.—Comparison of the frequency of gullies from three types of land tenure.

tirely similar and this should be borne in mind in the discussion below. Bikita is more broken, having a mean average slope of 7,0 degrees in comparison to 4,8 for Nyahunda and 3,2 for Sabi Valley, though the mean for Bikita is increased by a few very high figures (19,4 degrees in one square kilometre, for instance).

Fig. 1 is computed from a twenty per cent sample of each area and illustrates the strong contrasts between the three land tenures. Bikita has a wide spread of erosional categories which can be partially attributed to a greater range in slope values and partially to mismanagement of the land. Erosion occurs with equal severity on grazing and arable land although the very steep slopes on which cultivation is impossible are wholly for grazing. The African Purchase Area shows a slightly different pattern in that most of the area could be classified as moderately eroded, i.e., in the range 500-1 500 metres of gullies per square kilometre. Nyahunda also shows a fairly wide range in erosional categories. It is interesting to note that here again the severe erosion occurs on the steep grazing lands. The European area presents a very different picture. Over a quarter is slightly eroded and no more than fifteen per cent is severely eroded. This fifteen per cent is associated with African squatter and/or farm labourer settlements on the periphery of the I.C.A. Arable land wholly occupies the highest erosional category of 2 500-3 000 m kms^{-2} in an area that is almost totally European ranching.

Keech (1968) quotes figures from which a similar comparison can be made. The area concerned is the Tokwe-Selukwe district, east of Gwelo, on the edge of the Highveld at about 1 200 metres (4 000 ft.). Table I shows two Tribal Trust Lands and one European farming area:

Table I

DISTRIBUTION OF EROSION IN THE TOKWE-SELUKWE DISTRICT

Erosional Categories m kms^{-2}	*Percentage of area* Tokwe ICA	Selukwe TTL	Chilimanzi TTL
0	74	0	8
1 - 506	25	25	29
507 - 1181	1	49	41
1182 - 1856	0	25	19
1857 - 3207	0	1	3

numeration of the erosional categories is the result of conversion from the unit of yards of

Source: After Keech (1968); the seemingly odd gullies per 1 600 acres.

The district is clearly less severely eroded than the Sabi area but the contrast between the land tenures is no less apparent.

The Local Situation

It is at the local scale that the activities of man on his soil are most evident. At the regional scale the sum of the effect of many individual farmers was compared to the sum from another group of individuals. The summation necessarily hides the role of the individual, a role that has vital consequences in erosion. A few of the major factors will be considered in the light of our present state of knowledge of the complex interrelations between man and erosion.

Dip Tanks and Watering Places for Cattle

All cattle in tribal areas have to be dipped in communal dipping tanks once a week from September to April and once a fortnight in the four dry months in order to control tick-borne diseases. The hazardous nature of the dipping tank must be seen in the light of the density of tanks and the numbers of cattle using the tanks. From air photo analysis the location of dipping tanks was noted for Mtoko TTL. The density of tanks varied from one per 100 to one per 600 sq. kms. In the northern part of Mtoko TTL and neighbouring parts of Maramba, Uzumba and Pfungwe TTLs, a total area of 650 sq. kms. six dip tanks were found. There is an estimated cattle population in this area of 100 000, each dip tank serving some 17 000 cattle. Moreover, the maximum trekking distance to a tank in Mtoko is twenty kilometres. The cumulative effect of these cattle movements — presumably along the same paths — and the gathering of a large number of cattle at the same points each week must cause a very great erosion hazard.

Fig. 2 illustrates the incidence of gullying around a cattle dip in Mtoko. The gullying is very noticeable in the immediate vicinity of the dip which is located next to a stream, and on the trail paths radiating from the dip. The dip is badly located, being cradled between very steep and bare kopjes in a narrow valley. The site was obviously chosen as being the most accessible from the surrounding countryside.

Both Wright (1970) in a newspaper article and the Advisory Committee which reported on African Agriculture (Southern Rhodesia, 1962,

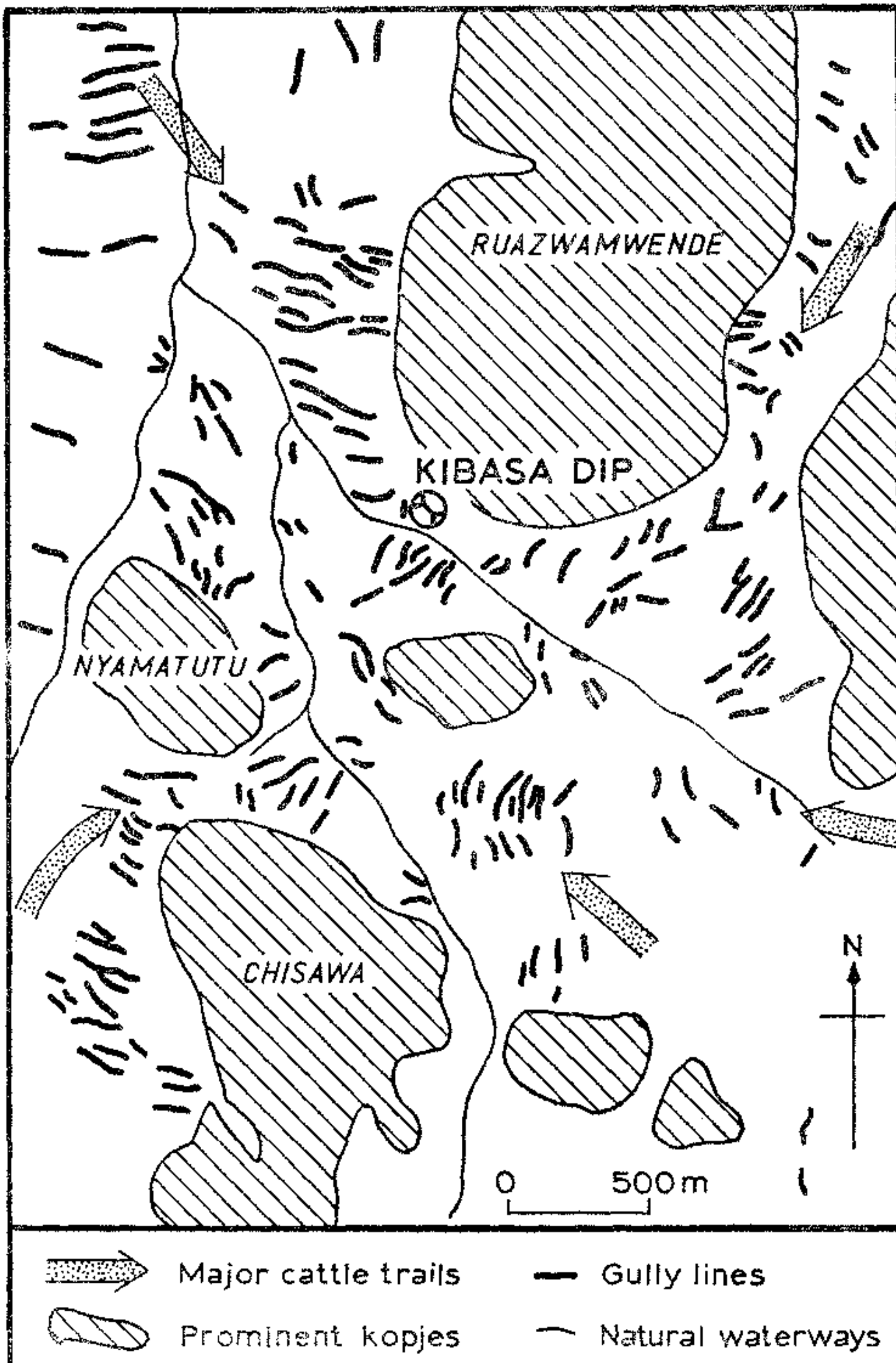

Fig. 2.—Gully erosion around a cattle dip in Mtoko TTL.

p. 182), criticize the present policy of cattle dipping. Wright questions the plunge tank's effectiveness in controlling disease and both suggest the decentralization of tick control by means of spray races and hand spraying using modern tickicides.

To a lesser extent cattle watering points both on European and tribal land can be dangerous for erosion. In the dry season these watering points are often limited in number and where they are dams or stream beds the vicinity is often steep sided and very susceptible to erosion. The air photographs did indeed show considerable concentration of gullying near natural waterways. Since at these points the water table is nearer the surface, the erosion situation is further aggravated by increased runoff due to water-logged soils.

Basic and Agricultural Education

In order to implement some of the more rudimentary forms of conservation, a cértain basic standard of education must be assumed in the populace. The fact that this assumption cannot always be relied upon is one of the root causes for what the conservationist would call 'lack of co-operation' and the educationist 'inability to grasp simple and logical trains of thought'. The author was invited to view the latter part of a programme for the introduction of a short duration grazing system in Chikowore's Kraal in Msana TTL near Bindura. Here, the District Commissioner and his agricultural staff had battled for six months with a small group of tribal farmers to convince them that they and their future generations would benefit by fencing in paddocks, culling those poor cattle of mixed parentage, and allowing the grassland to recover from excessive grazing. In that this was a pioneer effort, the six months were well spent since the best education for the older chiefs and kraal heads who are without schooling is by example. Even so it would take many years of piecemeal effort to join the pieces and make the TTLs not only economically viable but also adequately conserved.

Rhodesia has on the whole a good record in Africa for primary education; for by 1962 the proportion of the children of school age who have received some education had reached between 85 and 88 per cent (Minister of Native Education). This bodes well for the future, for a population receptive to new ideas and the educational ability to put these ideas into practice is a prime requisite of conservation. However, at present the practice of collateral succession in which all the eldest surviving male descendants of a common forefather are eligible to succeed to the chieftainship (Holleman, 1951), tends to make the leadership of a Shona tribe conservative in the extreme in a population that is conservative anyway. The maintenance of one of the oldest members of the tribe at the head, a man who in all probability has received no education, makes changes in customs, particularly those related to cattle, very difficult.

Agricultural education in Rhodesia has progressed hand-in-hand with primary education. In lower primary schools two hours a week are set aside for gardening and the practical aspects of growing vegetables. Higher up the school the curriculum is extended to field crops and the beneficial effects of manure and fertilizer. It is a common sight in the rainy season to see a tribal school surrounded by high maize of a better standard than crops on adjacent smallholdings. Upper primary schools are supposed to embrace aspects of soil conservation but at this level a shortage of teachers with a knowledge of agriculture leads to a concentration on the more academic subjects to the detriment of practical subjects.

Away from the schools agricultural extension programmes have had some success in the promotion of new ideas in existing farmers. The requisite government legislation was introduced as late as 1951 in the Land Husbandry Act which for the first time* was an attempt to bring compulsion rather than gentle persuasion into agricultural extension programmes. One recommendation that has been slowly put into effect is the registration of African farmers into various categories.

Three categories are recognised: that of Co-operator who is a farmer who uses manure or fertilizer and carries out some form of rotation; a Plotholder who makes records of his cropping programmes and is under tuition by an agricultural demonstrator in order to achieve the higher status of Master Farmer; a Master Farmer, a Plotholder who has reached certain

*The Natural Resources Act of 1941 had set out certain provisions to promote good husbandry and allocation of rights and security of tenure for Africans but no adequate machinery then existed for the implementation of the Act other than for destocking.

Table II

CO-OPERATORS, PLOTHOLDERS AND MASTER FARMERS

Year	*Co-operators*	*Plotholders*	*Master Farmers*	*Total Cultivators*
1948	14 293	2 017	764	213 760
1961	91 381	5 410	10 454	379 860

Source: After Johnson (1964).

minimum standards of crop and animal husbandry laid down by the Department of Agriculture (Johnson, 1964). Progression to the latter status is encouraged by opportunities of land ownership and independence from communal farming on a Purchase Area plot. Table II gives an idea of the increase in numbers of all three categories of African farmer:

However, well over two-thirds of all the cultivators are unwilling or unable to adopt the necessary practices.

Conservation Facilities and Practice

The Land Husbandry Act not only provided for land and farmer registration but also sought to promote suitable conservation systems. Johnson (1964) shows how up to 1956 the work was slow but after that date the programme was accelerated. He estimates that by 1961 nearly two-thirds of the TTLs had a proper conservation plan. The usual method of conservation is graded ridges and grassed waterways.

On the communal tribal lands, the regular succession of ridges helped to demarcate each cultivator's plot of the 'open field'. This was in fact one of the major objectives of the Land Husbandry Act which attempted to allocate individual rights and security of tenure in arable and grazing areas.

While in theory the Land Husbandry Act should work, in practice it can be very difficult to compel African farmers to conserve the soil. This ties in with the lack of education discussed above. The Lands Inspectorate who are responsible for enforcing the law are poorly staffed and, short of resorting to the courts, they find that contour ridges remain partially dug and the grazing lands still overstocked. In Mtoko TTL gullies on supposedly conserved land were as numerous as those on the more remote and unconserved land. A bad contour ridge channels water to one point and the resulting erosion in an intense storm is worse than if no ridges had been constructed.

Contour ridges are invariably dug by hand on tribal farmland. One reason for the often poor construction is that this task is given over to the women as an extra burden to routine planting, hoeing, harvesting and, last but not least, rearing children. Some of the Purchase Area farmers now employ a locally made ox-drawn contour ridger that completes the work in a fraction of the time. However, these farms are the exception and pride of ownership here is apparent in general farm practice. Contour ridges on communal land have to suffer trampling by cattle and people, especially where a ridge crosses an unofficial footpath.

European farmers use the same basic principles of mechanical conservation. In addition, profit motives encourage the use of fertilizers and higher plant densities which in turn discourage the erosion of soil. Facilities for conservation practice are very much better for the European. The Department of Conservation and Extension provides technical knowledge, contour-pegging teams and general advice on farm planning. The European farmer naturally has greater capital resources to provide for suitable ridgers, fences and the construction of storm waterways and roads. The European is not so constricted by time-honoured customs particularly with regard to possession of cattle. There is a ready appreciation of optimum stocking rates and a willingness to look further into the future than the start of the next rains. In short, the European is more fertile ground for the conservationist. Air photograph analysis has shown that by contrast the land is in far better condition and it is only the rare individual who, through short term greed or occasionally lack of knowledge, encourages the wholesale removal of soil. The inequitable conservation facilities in Rhodesia between African and European is one immediate opening for the betterment of the tribal farmer. Resources are limited but they could well be channelled in the most needed direction with a little reorientation and a change of emphasis to basic conservation education rather than the more specialised knowledge imparted at present to the European farmer.

Conclusion

Severe erosion in Rhodesia is largely a function of man, either directly through his agricultural practices or indirectly through cattle, goat and human populations. Natural or geologic erosion can and does occur through the normal processes of landform evolution. While the forms of this type of erosion are similar to erosion induced by man since the controlling natural energy factors of slope and rainfall are the same, man has succeeded in compressing the time scale so that accelerated soil erosion can be over one thousand times more severe than natural erosion in unit time. Feodoroff (1965, 150) quotes rates of accelerated erosion in the order of 560 000 kilogrammes per hectare, which contrasts with rates of natural erosion in an 'average' environment of 45 kilogrammes per hectare (Young, 1969, 852).

Man is, therefore, the significant key to the processes of accelerated soil erosion but unfortunately he is the least studied of the several factors. At the present time, observation and occasional measurement where statistics and facilities permit are the only available means for study of man's important role in erosion in Rhodesia. Attempts at quantifying man-erosion studies are frustrated by the very lack of order in man's activities, although if and when the agricultural economy of the whole country expands, a situation may be envisaged where precise measurement is possible along American lines.

At three scales, the national, regional and local, significant differences and patterns in erosion can be found in Rhodesia. Possibly the major differences lie between the land tenures of the two main racial groups. Differences within these two groups must be based at the moment on population densities in the case of the tribal areas and overall farming types for European areas. Game parks, National and Unreserved Lands form a special problem. In recent unpublished reports some game reserves, notably Wankie, have suffered severe erosion around or near watering points. However, in the main, these areas must be considered as being low in erosion hazard, along with the extensive European ranching areas.

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