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SOIL AND WATER CONSERVATION

AND

LAND UTILIZATION PROGRAMME

EROSION HAZARD MAPPING:

MALAWI

by

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FOREWORD

This report is one of a series of SADCC country reports on the Erosion Hazard Mapping of the region. It arises from a project initiated in September 1985 in the first phase of the work programme of the SADCC Coordination Unit for Soil and Water Conservation and Land Utilization, based in Lesotho. The aims of the Erosion Hazard Mapping project are:

- define main danger areas for erosion and the principal processes contributing to the hazard;
- assist the design of appropriate conservation strategies;
- give guidance in regional planning, environmental monitoring and land utilization programmes;
- provide an action-learning exercise and training forum for SADCC participants.

Erosion hazard assessment is a technique to express the natural danger of soil erosion over large areas. As such it is an appropriate exercise for the SADCC Coordination Unit which is very much concerned with land degradation problems and the safe utilization of land resources, especially soil. Details of the technique have already been published in Report No.9, "A Methodology for Erosion Hazard Mapping of the SADCC Region", April 1987. Local staff members from SADCC countries have done all the data collection and processing necessary for the national maps.

All participants at the four Erosion Hazard Workshops -- Harare, September 1985; Maseru, March 1986; Mbabane, November 1986; Lusaka, April 1987 -- as well as their departmental heads and junior staff are warmly thanked for their enthusiasm and hard work. Several of the country teams have laboured under severe manpower constraints with competing demands on their time and resources. That this project is nearing completion is a tribute to SADCC cooperative spirit. This country report was compiled from draft reports submitted by the country team under the overall technical supervision of Dr Michael Stocking.

B. Leleka

ACKNOWLEDGEMENTS

We would first like to thank the Malawi Government for allowing us to participate in the Erosion Hazard Mapping series of workshops. Heartfelt thanks are also expressed to the SADCC Coordination Unit for Soil and Water Conservation and Land Utilisation, Maseru, for their full sponsorship which has enabled us to attend the workshops.

This project could not have been carried to completion without the cooperation and contribution of personnel of the Land Husbandry Branch throughout Malawi. What initially felt like a strange far-fetched dream has merged into reality in "The Erosion Hazard Map of Malawi" with the help of these many people.

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OBJECTIVES

The objectives were diverse but all are geared towards safe-guarding land resources and making them of greater benefit to humankind:

(1) Map areas of different erosion hazard potential on a five-point semi-quantitative scale.

(2) Identify and quantify the main causes of soil erosion in the various parts of the country.

(3) Assist in formulating strategies in order to control soil erosion.

(4) Provide decision-makers and development planners with information on the degree of erosion hazard in an area so that planning can proceed on agricultural and development activities that will conserve the environment from land degradation.

(5) Produce a map to be used as an extension tool, enabling Land Husbandry Officers in Agricultural Development Divisions working jointly with extension staff and Adaptive Research Teams to devise appropriate farming systems and land management practices to suit different areas.

(6) Provide a national input towards the production of a regional Erosion Hazard Map for SADCC countries for

environmental monitoring purposes, planning and land utilisation programmes.

IMPORTANCE OF EROSION HAZARD MAPPING TO MALAWI

Soil erosion is the most important single factor affecting agricultural productivity. Its threat to Malawi's economy cannot be overemphasized because Malawi depends largely on agriculture. In order to safeguard agricultural productivity, Shaxson et al (1977) produced guidelines for proper land use and soil conservation. In adopting the US Department of Agriculture's Land Capability Classification system, the erosion danger was considered through the percentage slope value in determining final land class. 12% slope was taken to be the dividing line between arable and non-arable land; and non-erodible and erodible land.

In later studies, the Land Husbandry Branch mapped slope separately. Slope was computed using the formula:

$$s = 1000\ c/(a \times b)$$

where, s is the slope in degrees; a is the distance between contours in millimetres; b is the denominator of the representative fraction of the map; and c is the vertical interval in metres. The result was a slope map showing four categories: 0-5%, 5-8%, 8-12% and >12%. The map indicated areas of potentially high erosion risk. It was used only to a limited extent in the planning of agricultural development projects. Clearly, its utility was reduced in only considering slope.

The current study is more useful because it combines four factors of erosion: rainfall erosivity, soil erodibility, slope and vegetation. By quantifying the degree of the threat or protection afforded by each factor, it makes comparison a lot easier. Also, by combining the factors to give a final rating score, it enforces the interdependency of factors of erosion while at the same time identifying a dominant factor in any given area. This will make the hazard rating much more useful for planning and conservation purposes. Knowing the main causes contributing to the danger of soil erosion, appropriate packages will be formulated accordingly to address the main causative erosion factors. Conservation can then be more sensitively designed for the field situation.

The general erosion status in Malawi has not yet reached alarming proportions, although it could if appropriate farming systems are not devised and implemented as solutions to steep slope and stream bank cultivation which are now rife throughout the country.

Marginal land is coming under cultivation as a result of increase in population; some localised areas have very high livestock population resulting in overgrazing; clearing of natural vegetation especially on steep areas for new settlement are some of the factors which directly induce as awell as increase soil erosion rates.

DATA BASE

Four variables were used in the exercise: rainfall erosivity, slope, soil erodibility and vegetation cover. In the tropics soil erosion is principally caused by raindrop splash. Shaxson et al (1977) argue that as much as 90% of soil loss is caused by splash, while runoff accounts for only 10%. Because of its wide differences in topography, Malawi receives rainfall from October to April ranging from 635 to over 1500 mm per annum at a variety of intensities. Under these rainfalls, the soil has its own ability to resist detachment; each of Malawi's main soil types was rated accordingly. Much of this destructive energy of falling raindrops is intercepted if there is a good vegetation cover to the soil. The current status of the vegetation gives an indication of its potential to resist erosive forces. Slope also affects soil erosion and it is because of this influence that a threshold slope of 12% has been adopted, above which all land is classified as non-arable in Malawi.

Source of data

Soils and rainfall data were abstracted from the map on Natural Regions and Areas (Brown and Young, 1965; Stobbs, 1970). Although a biotic community map had been produced in 1979, vegetation has since changed considerably. As a result, local knowledge and recent aerial photography, where available, were relied upon. For slope, the 1:50,000 series of topographic maps with contours was used, and slope was computed using Wentworth's method.

Treatment of variables

Malawi receives most of its rainfall as thunderstorms. For calculating rainfall erosivity the formula, E = 18.846 x P, was used. Kinetic energy, E, was then rated from 1 to 5, according to increasing hazard for erosion.

After assembling and summarising all the soil data from the natural regions and areas along with information derived from several recent soil surveys, the major soil units were identified and their erodibilities were assessed. These also were rated from 1 to 5 according to degree of erodibility, 5 being the most hazardous for erosion.

For slope analysis, the 1:50,000 topographic maps were divided into 10 x 10 km grid squares. This size was based on the natural divisions of the 1:1,000,000 base map which was used for final mapping and the fact that it is generally assumed that one raingauge exists in Malawi per 100 km^2. Slope values calculated from Wentworth's formula for average slope were then rated on the scale 1 to 5 in order of increasing threat of soil erosion.

Vegetation cover analysis was largely based on local experience with some aerial photograph interpretation. Much of the natural cover of vegetation no longer exists, and it was necessary to assess the effective cover of crops, rangeland and altered woodland. Cover values were also rated between 1 and 5, with 5 indicating least cover and hence greatest exposure of the soil to raindrop splash and erosion.

For each grid, the four ratings were combined by simply adding them to give a final erosion hazard factor score. To produce a country map, these scores were categorised as follows:

Factor score:	0 - 8	(1)	Low
	9 - 10	(2)	Below average
	11 - 12	(3)	Average
	13 - 14	(4)	Above average
	15 +	(5)	High

In the final mapping these factor scores have, in turn, been related to Erosion Hazard Units (EHU) as computed through the SLEMSA model. EHUs have been used by other SADCC countries but the original factor method was adopted by the Malawi team because of its simplicity and ease of calculation. The final erosion hazard categories are unaffected.

<u>Problems</u>

Although it was possible to derive factor scores for all four parameters, problems were experienced with two of them.

First, the soil clasification for most of the country uses broad categories within which it is difficult to define soil erodibility values with any degree of precision. This problem is exacerbated by the lack of description of textural properties of the soils which is necessary to identify precise F_b values. This means that soil erodibility assessment is not as accurate as might be wished.

Secondly, the vegetation cover parameter was also difficult to assess especially on agricultural land where different crop rotations are grown. Averages of the different crops had to be estimated.

In addition it should also be mentioned that rainfall values were in many cases approximate. Recently the raingauge network in Malawi has been improved towards the goal of having about 1 station per square kilometre, but the rainfall data base upon which this study was based is significantly poorer. Future refinements of this work will have greater accuracy in assessments of mean annual rainfall. The country is also about to embark on nationwide resource surveys where soils and vegetation will be mapped in greater detail: this also should ensure greater accuracy in the future.

The counting of contours was sometimes inaccurate. Given the large number of staff involved, and in some cases the very close drawn contours in mountainous regions, some contours might have been omitted and the slope percentages underestimated.

Finally, because different teams were responsible for the work in their areas, some difficulties were experienced correlating maps produced by adjacent Agricultural Development Divisions at their boundaries. These inaccuracies were reconciled wherever possible.

MAPPING

General observations

Areas of high rainfall generally have highest erosion risk especially where the terrain is broken and the vegetation cover is poor.

High rainfall areas with good natural vegetation or plantation crops such as tea, coffee or bananas have moderate erosion risk regardless of the terrain.

Areas with moderate rainfall but poor vegetation cover also have a high erosion risk.

Patterns of erosion risk

It is interesting to note that certain features such as the lakeshore scarp zone which even to the untrained eye appears to have a high erosion risk also appears as such on the map. Other areas such as the Viphya and Nyika hills, characterised by steep slopes, also have a high erosion hazard.

The Mzimba and Rukura plains, which are areas with gentle to moderate slopes, have on the erosion hazard mapping only a moderate to low risk. The same pattern is also shown in the Central Region plain of Lilongwe, Kasungu and Mchinji where there are gentler slopes and a lower rainfall averaging 1000 mm.

A cross section from the escarpment to the plain on the west shows a pattern with high erosion hazard along the escarpment where slopes are steep, vegetation is minimal and rainfall is high. There is a gradual decline in the risk as one descends the escarpment.

In the Southern Region of the country high altitude areas with high rainfall exhibit high erosion hazard. In the tea plantations, however, the erosion hazard is moderate despite the high rainfall and moderate to steep slopes. This is mostly because of the good ground cover offered by the tea bushes and underlying mulch.

CONCLUSION

Although the national Agro-Ecological Zone map is only in provisional form, there is a well pronounced resemblance between this map and that of erosion hazard, particularly in the north and central regions. In the south there is less similarity, possibly because intensive land use has led to a complete change in vegetation. For example, the tea plantations have through their alteration of vegetation cover nullified the serious erosion hazard caused by steep slopes and high rainfall in these areas.

This erosion hazard exercise has been a worthwhile training tool for professional officers. The expereince gained will be used to revise the map in the future when adequate and more reliable data have been gathered.

The final Erosion Hazard Map of Malawi will be used in the determination of where it is suitable to establish new agricultural enterprises and human settlements. For conservationists, it indicates the priority areas in which to concentrate efforts. The map will also guide planners in deciding what to develop and in which location in the light of the knowledge on erosion hazard.

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