SADCC SOIL AND WATER CONSERVATION

AND

LAND UTILIZATION PROGRAMME

EROSION HAZARD MAPPING:

ZAMBIA

REPORT No. XX

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

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OBJECTIVES

At the outset the aims and objectives of this project for Zambian circumstances were specified as:

(1) Serve as Source Material for the SADCC Regional Map. The country map is intended to provide one of the inputs to a regional map of Southern Africa showing the relative hazards due to erosion and pinpointing those parts of the Region which might require special attention.

(2) Provision of Basic Source Information. The distribution of areas prone to erosion in Zambia will be shown: i.e. this is the vulnerability to erosion, as opposed to actual erosion which is historical.

(3) Planning Land Use and Soil Conservation. Through the parameters used to construct the erosion hazard map -- climate, relief, vegetation, crops, land use -- the type and intensity of potential erosion is identified. This alerts the land use planner to appropriate forms of land use and the soil conservationist to appropriate conservation strategies and measures. Hopefully, this project will assist the identification of sound practices to match the natural and induced dangers of erosion.

(4) Guidance of More Detailed Surveys. Based on the country map, areas especially prone to erosion can be targetted and detailed surveys be designed for sustainable agricultural development.

DATA BASE

Data Sources

For rainfall interception by vegetation, the Vegetation Map of Zambia (1976) at a scale of 1:500,000 and the Land Use Map of Zambia (1976) at 1:750,000 were utilized to give country-wide coverage. This was supplemented with field checks.

Average slope was determined from the 1:50,000 coverage of topographical maps. For the small parts of Zambia where coverage is unavailable, adjacent sheets were used as a guide and field experience helped to obtain what are considered reasonably accurate estimates.

Soil erodibility estimates were made using expert opinion and based on the Soils Map of Zambia (1983).

Rainfall erosivity was based on the Annual Rainfall Map of Zambia (1968), which itself summarises 30 years of records.

All parameter values were assigned to a grid of squares: 4,156 squares to cover the whole land surface of Zambia. The size of squares was approximately 13.5 by 13.5 km, or one quarter of a 1:50,000 map sheet.

Data Reliability

Care was taken throughout the exercise to check for data reliability. Particular attention was paid to rainfall interception by vegetation where the procedure for calculation often produced a result lower than expected. Average slope results were considered accurate to within +/- 1%. Where estimates had to be made because of lack of sufficient source material (mainly in western Zambia and around Lake Bangweulu), erosion hazard was in any case low, and therefore any inaccuarcies should have minimal effect.

Problems with Data

Most of the problems stemmed from rainfall interception by vegetation and average slope. Data collection for these was found especially tedious and time-consuming. Because vegetation had to be compiled from a number of sources and each grid square might have several major land uses, the calculation of interception for the over 4,000 squares was difficult. Similarly, the counting of contour crossings for average slope was conducive to headaches!

Once all parameter values had been assembled, data processing was found to be difficult. In the absence of access to a computer, a programmable Hewlett Packard HP 33E calculator was used, and the main programme was broken down into its component parts for each factor and sub-programmes were run to do the calculations. This entailed considerable extra data manipulation with additional possibility of errors.

Other than these difficulties which were exacerbated by the lack of manpower, no major problems were encountered and the project proceeded smoothly.

THE MAPPING

Mapping proceeded according to the standard format decided at the series of Workshops. Five categories of Erosion Hazard encompassed a range in Erosion Hazard Units from 0 to more than 100, as follows:

EROSION HAZARD CATEGORY	EROSION HAZARD UNITS
1. Very Low	0 - 10
2. Low	11 - 25
3. Average	26 - 50
4. High	51 - 100
5. Very High	> 100

The standard symbols were used to denote sub-factors which proved dominant: slope, s; soil erodibility, e; rainfall erosivity, r; vegetation cover (interception), c. Under Zambian conditions, the ranges for these factors were as follows:

FACTOR	RANGE IN VALUE
slope	0 - 50.5 %
soil erodibility	2 - 6.5 (index value)
rainfall erosivity	13,200 - 30,200 J/m^2
vegetation cover	28 - 90 %

Each factor was also separately assessed in Zambian conditions for its seriousness and rated accordingly:

EROSION HAZARD CATEGORY	SLOPE %	SOIL ERODIBILITY index	RAINFALL EROSIVITY J/m^2	COVER %
1. Very Low	< 3	> 6	< 15,100	> 80
2. Low	3.1 - 5	5.1 - 6	15,100-18,000	61 - 80
3. Average	5.1 -10	4.1 - 5	18,100-23,000	46 - 60
4. High	10.1 -20	3.0 - 4	23,100-28,000	35 - 45
5. Very High	> 20	< 3	> 28,000	< 35

In practice this means that a land unit categorized as "2ec" has a low overall erosion hazard, but that soil erodibility and cover are the main existing contributors to the hazard at 'average' level or above.

The Erosion Hazard Map of Zambia appended to this report displays a distinctive pattern. Generally, the areas of eastern Zambia show the highest susceptibility to erosion, while the northern part has a moderate hazard, and the western part a low danger. the following section attempts to explain this pattern.

Distribution of Erosion Hazard

Zambia has a geographical surface area of 752,600 km^2, of which 743,380 km^2 is land surface. The Tables below summarise the distribution of erosion hazard and the dominant factors over Zambia.

EROSION HAZARD CATEGORY	% LAND SURFACE	HECTARES
1. Very Low	67	49,806,460
2. Low	14	10,407,320
3. Average	10	7,433,800
4. High	7	5,203,660
5. Very High	2	1,486,760

FACTOR	CUT-OFF VALUE FOR DOMINANCE	% LAND SURFACE	HECTARES
slope	> 10.1 %	9	6,690,420
soil erodibility	< 4	18	13,306,502
rainfall erosivity	> 23,000 J/m^2	15	11,448,052
vegetation cover	< 45 %	23	17,395,092

Over 81% of Zambia has low erosion hazard, where under present circumstances little danger of erosion can be anticipated. Conversely, some 10% of the country poses potential problems and should be targetted in any conservation planning.

Taking the critical slope for erosion hazard to be 10.1% or more, 9% of the country is susceptible, mainly along the Zambezi and Muchinga escarpments which have high overall erosion hazard. Most of the country (over 60 million hectares) has slopes less than 5%. Some 18% of Zambia is critical with regard to soil erodibility, again mainly in the escarpment zones but also portions in the south western corner of the country which are especially erodible. Because rainfall erosivity is closely related to total rainfall, it is northern Zambia that is most susceptible. Using a cut-off value of 23,000 Joules/m^2, 15% of the country has a serious level of rainfall erosivity. The major influence on vegetation cover is land use and forest resource utilization. There is no clear pattern to poor cover, except that it is poorest closest to the centres of population and also in the drier parts of the country. Over 23% of the country is rated to have an erosion hazard dominated by poor cover.

This analysis of the influence of the various factors shows that a high priority in conservation should be improvement of vegetation cover. Afforestation and the development of rotational cropping, intercrops and agroforestry would seem the best ways of improving the situation. Soil erodibility is the next most serious factor on the system of rating used in this study: proper soil management and maintenance of organic matter is indicated as an urgent priority.

Relationships and Patterns

Notable on the erosion hazard map is those areas where two or more factors are dominant. Most common are combinations of

steep slopes, high erodibility and poor vegetation cover. The areas around Lake Tanganyika and along the escarpments are the prime examples.

The tract of land from Kalomo in the south up to the Copperbelt in the north shows up as having inadequate cover. The country around Petauke, Katete and Chipata in the east is similarly affected. These are largely commercial farming areas and have low overall erosion hazard. Shifting cultivation is common in Northern Province and poor cover sometimes occurs. Clearly, there is a close relationship between land use and cover, and this potentially is the main source of control of erosion in the future.

Areas of steep slope have already been noted to have the highest overall hazards. These are geomorphologically the most unstable land surfaces in Zambia with the escarpments undergoing active erosion. Conversely, deposition is taking place in those areas with lowest erosion hazard: the flood plains and valleys. Areas of particular note are the Kafue flats, Zambezi flood plain, Lukanga Swamps, Bangweulu Swamps, Chambeshi flats and the Luangwa Valley. These receive materials from the surrounding slopes.

USE OF THE MAP

In Zambia, the erosion hazard map will be used both at national and local levels as a source document for planning, administration and decision-making.

At national level it will allow rational planning of

conservation resources and provide an input to policy formulation on conservation issues. At the local level, it will be the guide to the design and targetting of more detailed surveys.

In short, the map can be used as a reference source as well as a working document. Because all the data are available in the Ministry of Agriculture, parts of the data base can be provided for other projects and programmes. Factorial maps could be supplied on request.