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The use of dambos in small scale rural development

INTRODUCTION

Dambos (or vleis) are treeless headwater depressions with groundwater close to the surface. They are found throughout the plateau savannas of the tropics and have a core area in central southern Africa. Similar features are recorded for Tanzania, Northern Nigeria and parts of Latin America. Previous studies of dambos have investigated their geomorphology, hydrology and vegetation (refs. 1-4). With the exception of Russell's (ref. 5) work in Malawi, little research has been carried out into their potential role in rural development. Their use for small-scale irrigation in Zimbabwe was discouraged during the colonial period because of the threat of soil erosion. However, attention has recently been drawn in the scientific press to the underused potential of these small water sources (ref. 6). As a result, the Overseas Development Administration (ODA) of the British Government are funding a project run jointly by the Water and Waste Engineering for Developing Countries (WEDC) group at Loughborough University of Technology and the Department of Civil Engineering, University of Zimbabwe. The fieldwork commenced in 1984 in Zimbabawe. It is intended that some comparative studies will also be carried out in neighbouring countries.

BACKGROUND

Large scale irrigation projects which seek to redress the growing imbalance between population and food supply have a restricted potential in many African countries in view of the shortage of suitable land in the vicinity of adequate, exploitable water sources. However, limited amounts of water appropriate for small scale irrigation may often be found in dambos. In Zimbabwe these features occupy a substantial proportion of the highveld. They are saturated with water in the wet season while during the dry season the water table drops to a metre or so below the surface. This annual fluctuation is most apparent at the upper dambo margins where the vegetation changes from grass to shrubs.

While the unrestricted development of dambos could pose a severe threat of erosion and perhaps even alter the precarious ecological balance on their margins in particular, cultivation may be encouraged with appropriate conservation practices. Although these areas are unsuitable for any single large-scale project, collectively they constitute a valuable asset in the development of indigenous agriculture.

Small-scale irrigation development has many advantages over large-scale projects. For example, the current capital development costs for sprinkler and flood irrigation systems in Zimbabwe range from $2,000 to $6,000/ha (Z$0.6 = £) depending on conditions. In comparison, small-scale developments using handpumps can be implemented for less than $500/ha - and hand-watered gardens for a good deal less.

Potential sites for large-scale irrigation developments often do not occur in areas with high population densities and may require relocation of would-be cultivators. Conversely, rural settlements are normally sited close to small water sources which could be exploited, thus bringing irrigation directly to the people. Existing extension staff could be trained to implement and advise upon the most appropriate low cost technology associated with small scale irrigation, eliminating the need for large consultancy and management contracts. In addition, the risk factor would be spread over a large number of mutually exclusive projects, instead of being carried by a single large project heavily dependent on management inputs.

The main constraint on small-scale irrigation is that it is normally necessary to lift relatively large quantities of water to an elevation high enough for it to command the areas to be irrigated. A number of handpumps capable of delivering sufficient water to irrigate up to one hectare have been developed. The pumps have the advantage of being cheap and rely on a renewable energy resource, namely manpower. In general they are limited to operational heads of under 6m.

In Zimbabwe, large areas of vegetable gardens are irrigated by hand, in spite of the substantial logistical problems. Typically, water is drawn from a shallow wide-body well (in reality just a hole in the ground) tapping a dambo or perched water table. Water is then carried to adjacent vegetable plots in 1-20 litre containers. Given an adequate supply of water and assuming a reasonable standard of cultivation, a plot of 1,000m^2 of irrigated vegetables would ensure a more than adequate supply for a Zimbabwean family of between six and eight. Hence a one hectare block, if cultivated by an extended family or on a communal basis could cater for 60-80 people.

However, a 1,000m^2 family plot will require a gross of 3-7.5m^3 /water /day depending on the time of year. This represents 35-90 minutes pumping on a handpump delivering 4 litres per stroke at a rate of 20 strokes per minute or a total of 150 to 375 roundtrips hand watering with a 20 litre can. While both, especially hand watering, are onerous tasks, they are within the physical capabilities of an average family unit.

PRESENT CULTIVATION

Figure 1 shows a number of dambo sites which have been investigated. Despite three years of drought (1984), the water table in these dambos was rarely more than 3m below the ground surface and more typically between 1 and 2m. Variation in water level is partly related to substrate which varies from swelling clay to coarse sand. The level of the underlying rock (granitic gneiss) also varies considerably and gives rise to local perched water tables. The upper horizon of the dambo soil is typically black and relatively rich in organic matter.

All the dambo sites under investigation had some cultivation both in winter (July) and summer (December 1984). Typically these were small garden plots (0.2 hect.) with hand methods used to raise the shallow well water. In the case of dambos within 100 kms of Harare and hence with a market for produce, notably Domboshawa in Chinamora district, commercially orientated operations were evident. Cultivated plots extending over an area of 1 - 2 hectares were not uncommon with diesel pumps used to lift water. A common method of providing irrigation water within dambo gardens is by the construction of a small dam involving the excavation of material from below the mean phreatic level to form a bund (1.5-2m high) on the downslope side. Water then collects behind the bund and is released via a simple pipe through the bund itself to irrigate the land downslope. Both in July and December most of these dams were dry due to the drought.

Dambos are used extensively for communal grazing with the result that cultivated gardens must be fenced as a protection. Cattle tend to water at the base of the dambo where a small seasonal stream or open water surface exists. This may rapidly lead to gully erosion extending upstream. Field evidence suggests that uncontrolled cattle grazing on dambo sites pose a greater threat to the delicate ecology of these areas than well-managed cultivation. It has been found in certain areas that the constant passage to and from a water source constitutes an erosion hazard, particularly if the course is a perennial stream.

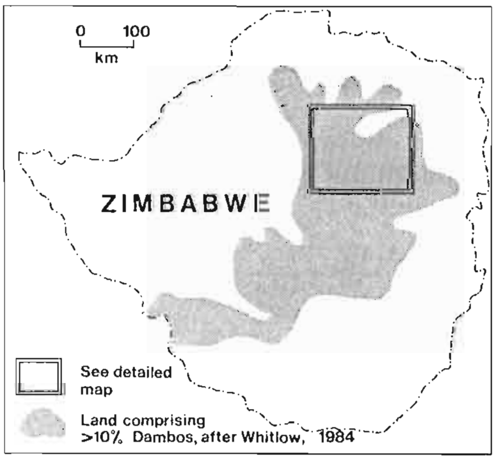

Figure 1a Dambo distribution in Zimbabwe

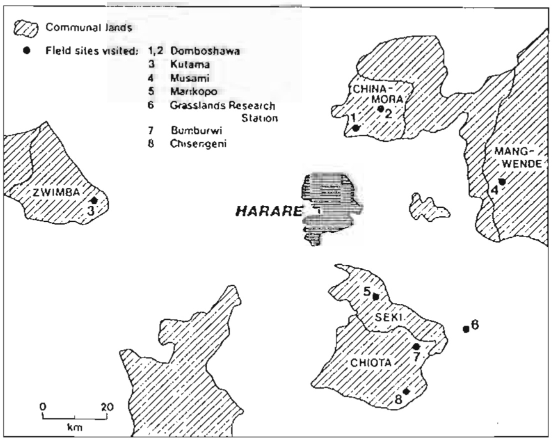

Figure 1b Dambo sites investigated

ENVIRONMENTAL ASPECTS

The hydrology of dambos is complex. Instrumentation is being developed to analyse the parameters of rainfall, evapotranspiration, runoff, infiltration and deep percolation. One objective is to establish the contributions of surface runoff and groundwater flow from the higher adjacent land to the dambo itself. Qualitative evidence suggests that both may be substantial. Work carried out so far indicates that not only is the variation from one dambo to another, but within a single dambo the variation in depth to underlying rock (0 to >3m) complicates the groundwater movement. Figure 2 schematically illustrates the profile of a dambo.

It has been argued (ref. 7) that dambo utilisation is harmful since the evapotranspiration from cultivated vegetables and crops in the dry season is much larger than that which could occur from natural grass vegetation (which is also sometimes burnt in the dry season). This then detracts from the 'sponge effect' of the dambo by which water is released slowly to downstream watercourses. The extent to which this is true will depend upon the intensity of cultivation. It has also been argued that cultivation leads to degradation and erosion since the soil is washed out of the dambo as silt. This in turn detrimentally affects the downstream watercourses while leaving the dambo itself gullied and degraded (ref. 8). Good water and land management is needed to avoid this.

Nutrients used by crops from the organic upper horizon of hydromorphic dambo soils must be replaced by manure and fertiliser; if not, breakdown of the fragile soil structure will result with subsequent abandonment of the land. However, good agricultural practice including contour furrowing can ensure that these soils remain fertile and productive. The evidence suggests that it is gully rather than sheet action which causes erosion as a result of cattle trampling in the seasonally saturated ground. Overgrazing leads to a reduction in vegetation cover and compaction of the soil surface, which lowers infiltration capacities. The resulting increase in surface runoff causes headward extension of the gully formation and hence dambo desiccation.

SOCIAL BENEFITS

Current legislation in Zimbabwe severely restricts cultivation on wetlands (which include dambos) and within 30m of a water course. These restrictions have their origins in laws passed in 1927 and 1952 when the colonial government was concerned to prevent streambank erosion and reductions in streamflow. A tradition extending over centuries of dambo cultivation as part of indigenous agricultural patterns was thereby interrupted, evidence for which remains in the remnants of former field systems. Information from recent aerial photographs suggests, however, that in spite of the legal restrictions, cultivation has greatly increased since independence with substantial social and economic benefits to the communities involved. These include the nutritional value of the vegetable crops grown which enhance the staple diet based on maize, notably during the dry season when, with simple technology, irrigated cultivation is possible. In sites close to population concentrations, and to Harare in particular, the market value of vegetable production can be considerable providing an important additional source of income to rural households (in some cases Z$ 5-600 per month).

In contrast to large scale, centrally managed agricultural schemes, dambo cultivation does not conflict with traditional agricultural practices and social

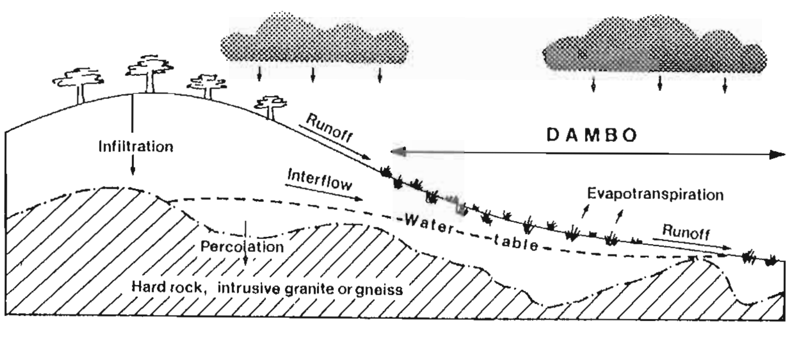

Figure 2 Schematic diagram showing dambo hydrology

organisation. However, irrigation practices are often wasteful in terms of water use while little assistance is provided by government extension services. Irrigation technology is also at present highly labour intensive and inefficient in terms of labour effort. If attempts are to be made to reconcile the advantages of dambo use with the possible social and environmental conflicts which may arise from an increase in the area under cultivation, questions concerning access to land and water resources and to the use of labour must be better understood.

CONCLUSION

Considerable benefits can accrue to rural populations by utilising dambos for small scale cultivation, based on irrigation, particularly during the dry season. However, the environmental and social forces conditioning their use must be clearly understood and evaluated in order that ground rules may be drawn up to ensure that the land remains fertile and degradation does not take place.

ACKNOWLEDGEMENTS

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