Anthropogenic Sedimentological Changes during the Holocene in Southern Africa

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STRIAE

Heine, K., 1987 06 24: Anthropogenic sedimentological changes during the Holocene in Southern Africa. In Anthropogenic sedimentological changes during the Holocene (L. Starkel, Ed.). *Striae*, Vol. 26, 41—50 pp. Uppsala. ISBN 91-7388-058-2. ISSN 0345-0074.

For southern Africa this paper describes briefly the erosion and sedimentation processes. The data reviewed indicate that only very few records concerning Holocene anthropogenic sedimentation exist. Man's impact on the soil environment is felt and registered in form of increasing sedimentation rates in reservoirs and dams of the South African streams over the last c. 100 years. Especially in the Bantu areas, due to population pressure, rates of soil erosion and sedimentation are extremely high and may even increase in future.

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General geographic and climatic characteristic

Southern Africa is certainly not a naturally bounded area, so that there are several possibilities for delineating it and for concepts about its extent (Wellington, 1955). For this article the northern boundary of the area to be discussed is identical with the northern border of SWA/Namibia, Botswana and the northeastern and eastern border of the Republic of South Africa and Swaziland. The territories covered by the countries mentioned and Lesotho stretches from latitude 17° to 35° S and from longitude 12° to 33° E. The total area covered is 2,7 million km^2.

In terms of physiography, southern Africa may be divided into two broad divisions, separated by the Great Escarpment. This can be traced from the Limpopo southward through the eastern Transvaal, the border between Natal and the Orange Free State and Lesotho, and finally through the southern Cape Province and into South West Africa northward to the Angolan border (Fig. 1). Above the escarpment lies a series of tablelands, with the Kalahari basin at their core. Below the escarpment, in the south-western Cape Province, lie folded mountain belts with ranges parallel to both southern and western coasts, and elsewhere a series of terraces or steps descends to the coastal plains, which in many places are not extensive (Christopher, 1976; King, 1963). According to King (1963) southern Africa may be sub-divided into a number of provinces or regions each of relatively uniform physiography. The criteria employed in distinguishing these provinces (Fig. 1) have been: geomorphologic history, geological structure, climate, location and altitude; of these the geomorphologic history is the most important (King, 1963).

Topographical detail of any major geomorphic region differs locally according to rock constitution (Gondwana-type sedimentary rocks, late Palaeozoic to mid-Mesozoic sandstones and shales, huge emissions of basalt), to the denudational processes operative from place to place from late-Mesozoic to present day (Early and middle Cretaceous post-Gondwana landscape, late-Cretaceous to mid-Tertiary extreme planation, Miocene surface, Pliocene valleys and basin plains and coastal plains round much of southern Africa, Quaternary deep river valleys, coastal dissection, tectonic arches and rift valleys), to the amount of local uplift (several tectonic movements during Cretaceous to recent time), and to effects due to Quaternary climatic changes (King, 1978).

The climates of southern Africa are strongly influenced by the position of the area in relation to the pressure and wind systems of the southern hemisphere (Jackson and Tyson, 1971). From the equator to about 20° S isohyets of mean annual rainfall generally run east-west; the rainfall increases towards the equator. South fo 20° S the isohyets have a north-south trend,

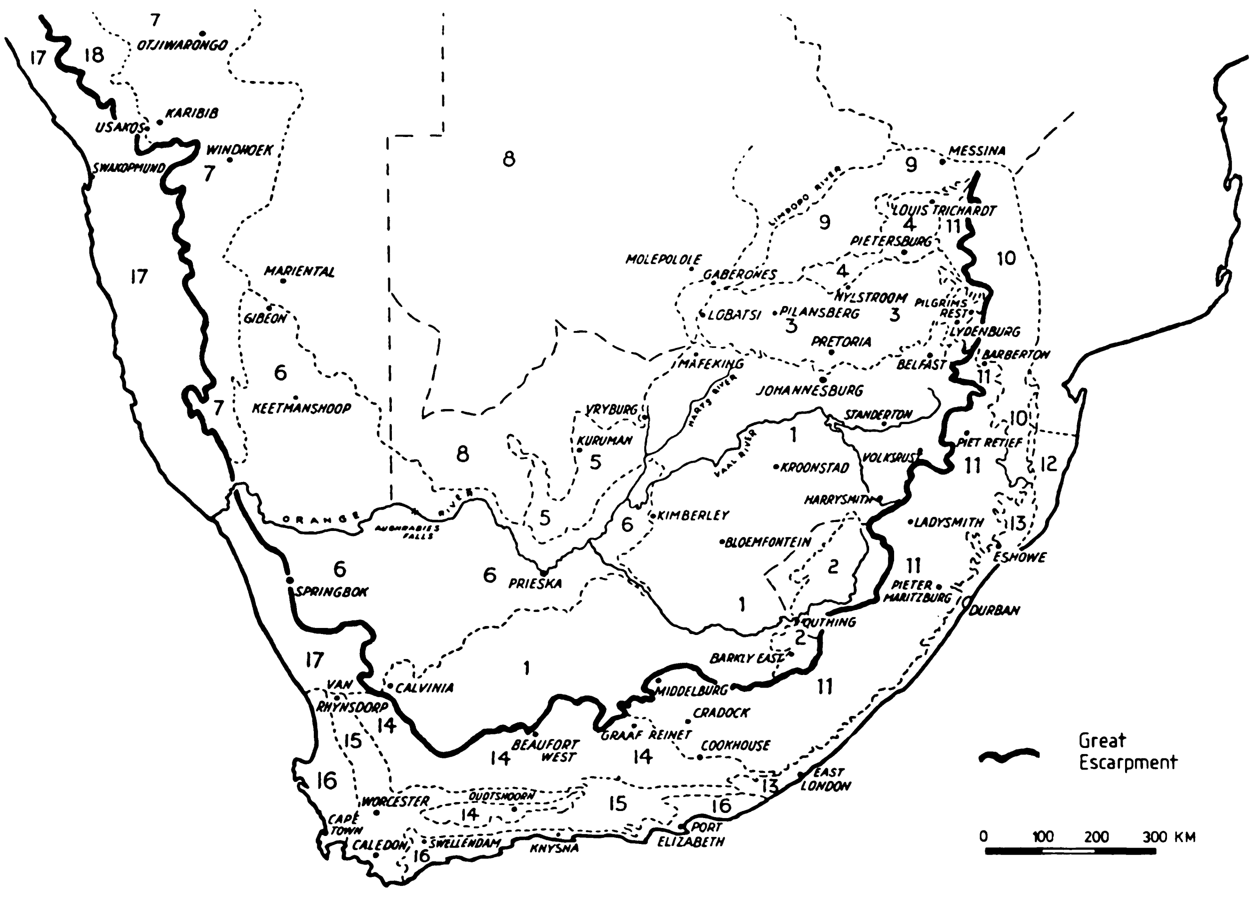

Fig. 1. Geomorphologic provinces of Southern Africa (after King, 1963).
1. Highveld, 2. Basuto Highlands, 3. Central Transvaal (Bushveld) Basin, 4. Northern Transvaal Province, 5. Kaap Plateau, 6. Cape Middle Veld, 7. Damaraland, 8. Kalahari, 9. Limpopo Valley, 10. Lowveld, 11. Eastern Uplands, 12. Zululand Coastal Plain, 13. Eastern Coastal Belt, 14. The Karoo, 15. Cape Folded Belt, 16. Southern Coast, 17. Namib, 18. Kaokoveld.

such that the 400 mm-isohyet almost bisects southern Africa, dividing it into a wetter eastern section and a drier western section (Jackson and Tyson, 1971). The east-west contrast in climate is emphasized by the warm southward-flowing Agulhas Current in the Indian Ocean and the cool northward-flowing Benguela Current in the west. An exception to the prevailing aridity of the Namib desert is to be found in the limited area of Mediterranean climate of the south-western Cape (Jackson and Tyson, 1971; Fig. 1). Southern Africa's rainfall is explained in terms of prevailing vertical temperature gradients (stability or instability) and weather systems likely to produce convergence and the ascent of air rather than in terms of prevailing winds and rigid precipitation types (Tyson, 1969).

The response of vegetation to climate in southern Africa is both direct and indirect; direct through the role that the factors of radiation, temperature and moisture play on the growth and development of the vegetation, and indirect through the influence of climatic factors on soil conditions, competing botanic associations or cultural practices (Schulze and McGee, 1978).

Environmental changes since the late Pleistocene

Little evidence of southern African climatic change is available for the Holocene. Deacon et al. (1984) suggest that in southern Africa climatic shifts during the last 10,000 years were not as marked as those of the late Pleistocene, but the warmest temperatures occurred between about 7000 and 5000 yr BP when it was generally drier in the interior and moister along the Cape coast. At about 3000 yr BP conditions were generally wetter than at present and the temperatures were possibly lower to the north and probably higher than at present to the south around 3000 yr BP (Tyson, 1986). At 2000 yr BP the situation was apparently unaltered. One thousand years ago conditions were possibly wetter than at present north of latitude 30° S and drier in the southern Cape. The drying of the Lake Ngami occurred within the last 2000 years, with final stages of desiccation taking place within the last 200 years; generally, palaeoclimatic information of the last millennium is sparse and insufficient

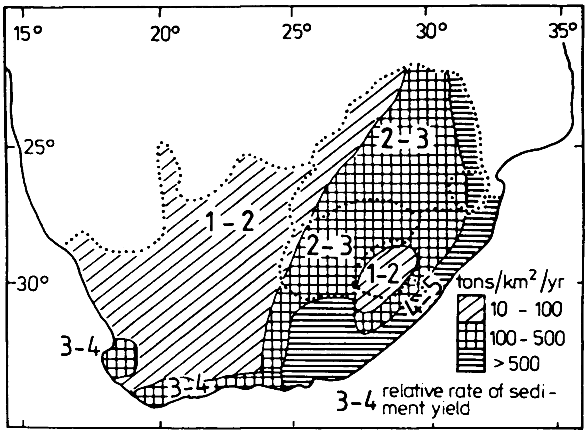

Fig. 2. Relative rate of sediment yield in South Africa, 1 = very low, 2 = low, 3 = moderate, 4 = high, 5 = very high (after Jansson, 1982). Some sediment yield values from the groups, in tons/km^2/yr.: 1: 12, 16, 28, 36; 2: 73, 81; 2—3: 121, 137, 161; 3: 202, 202, 242, 242, 242, 242, 242; 4: 484; 4—5: 645, 1209; 5: 1612.

to allow any firm conclusions to be drawn (Tyson, 1986).

That desert and semi-desert conditions are encroaching towards the northern and easterns parts of South Africa, and that Karoo vegetation ist replacing grassland and in turn is being replaced by dryland woody species has been suggested by many authors (Tyson, 1978; Acocks, 1953). Various reasons have been advanced to explain this phenomenon, viz. that progressive climatic desiccation has taken place, that man's activity in general and bad farming in particular have caused deterioration and allowed invasion of Karoo species to take place, or that the general ecological balance of marginal areas is so delicate as to be easily, or possibly semi-permanently, reversed in extended dry spells, and so allowing serious soil erosion (Tyson, 1978; Walter and Breckle, 1984). According to Tyson (1978, 1986) the absence of clear evidence for steadily declining rainfall shows that desertification in South Africa cannot have been the result of a progressive drying up of the country since the turn of the last century. Tyson (1978) demonstrates the oscillatory character of southern African rainfall; predominant oscillation in the summer rainfall region is a quasi 20-year wave. In neither case any evidence of progressive trends of either a positive or negative nature exists. The causal link between extended dry spells and changing environments must be studied carefully; only when this has been done it will be possible to reconsider the complex interaction between man, his activities, and his environment (Tyson, 1978).

Facies of anthropogenic sediments

The facies of anthropogenic sediments is the result of the combined action of many elements which may be grouped into the major factors of climate, relief, soil, vegetation, and man's activities. The influence of the different elements on the facies of anthropogenic sediments is very complex.

In southern Africa, surface wash and rill formation, gully erosion, local sedimentation at the foot of steep slopes and within gullies (dongas), wind erosion on open spurs, pediments, and planation surfaces, mass-movements on slopes, alluvial gravel, sand, silt and clay accumulation, and transportation of airborn soil dust as well as dune sand movement in deserts and semideserts took place since late Tertiary times together with the hominid evolution. Since there are artifact occurrences in Pleistocene and Holocene alluvial fills (Price Williams et al., 1982), it is nearly impossible to distinguish between facies material of 'natural' sediments and 'anthropogenic' sediments. Although the authors of 'The Rape of the Earth—A World Survey in Soil Erosion' (Jacks and Whyte, 1956) state that a national catastrophe, due to soil erosion, is perhaps more imminent in South Africa than in any other country, rapid rates of accelerated erosion and anthropogenic sedimentation are restricted to recent centuries when population increase has brought about and continues to bring about extensive changes in land use.

Based on sediment yield surveys of reservoirs, Fig. 2 only indicates the relative rate of sediment yield in South Africa (Jansson, 1982). Garland (1982) reports of large tracts of lands that have been rendered unproductive through soil loss and of dams that have become uneconomic through sediment accumulation; Camperdown Dam, built in 1900, had silted completely by 1927, whilst the effective storage capacity of Nagle Dam, Natal, is expected to diminish by 1 % p.a. through sediment deposition. As it is shown by the survey of fiftysix dam sites on various south African rivers the facies of the sediments ranges from sand to clay-rich silt (Rooseboom, 1975; Rooseboom and Harmse, 1979; Le Roux and Roos, 1986). In Lesotho, the erosion within 11 selected areas leads to rapid sedimentation of (a) sandy, infertile materials at the base of the scree slopes and along gently sloping parts of the inter-spur depressions and (b) silty to clayey sediments on the floodplains of major streams and in the reservoirs; some arable floodplain land therefore is lost because of sedimentation (Chakela, 1981). Other results of the erosion and sedimentation are (a) rapid siltation of several of the reservoirs, (b) high sediment loads in the major streams, and (c) development of river terraces (Chakela, 1981).—In Swaziland, too, steep sided gashes (dongas) are very widespread and more than 2670 have been mapped (Fig. 3; Goudie and Price Williams, 1983).—Along the Natal coast the silting of estuaries gives evidence of erosion in the drainage basins of the coastal rivers (Begg, 1978; Hobday, 1976); the silting up of the estuaries is a consequence of the accelerated erosion of the catchments and the absence of extreme floods because of the numerous dams upstream; furthermore, with the blocking of river mouths pronounced accumulation of mud in the immediate vicinity of rivers entering the lagoons is probably due to flocculation of clays in saline water (Hobday, 1976).

Anthropogenic sedimentation in lands above the escparment (Fig. 1) is restricted to recently deposited alluvial soils, generally very sandy, often showing an

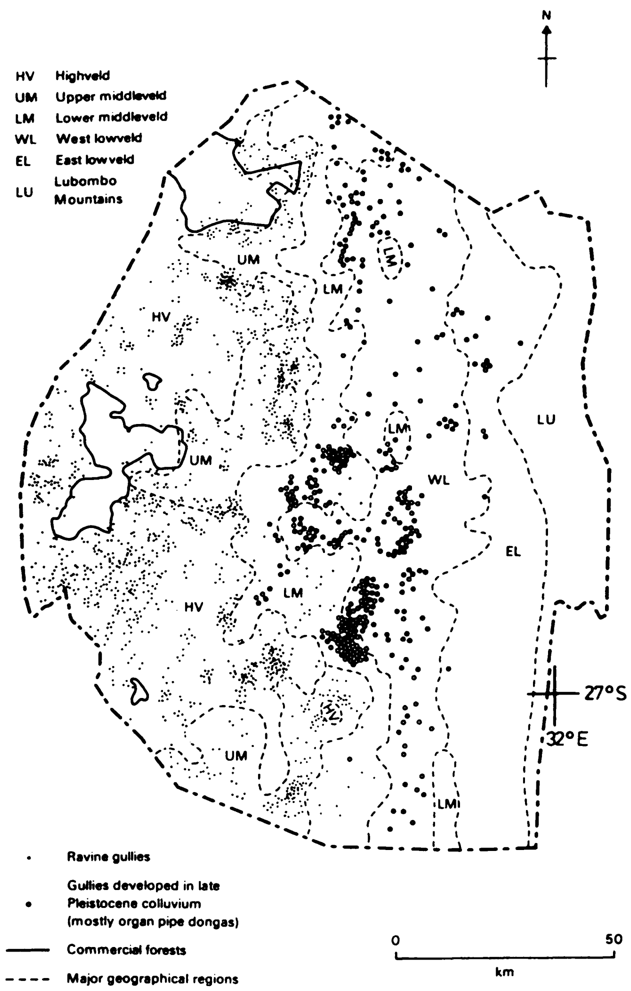

Fig. 3. Occurrence of gullies, Swaziland (after Goudie and Price Williams, 1983).

overlying cap of sandy loams or sandy clays which had been laid down in floods; fine- to medium-grained sands, sometimes even coarse-grained, is derived from different metamorphic or sedimentary rocks and found in surface horizons of small erosion channels, valleys and at the foot of scree slopes. The more arid the region, the more is the sediment yield influenced by factors other than man-made (Stear, 1985). Erosion, transport and accumulation of silt and sand by wind accelerated in the semi-arid to arid regions of southern Africa as a direct cause of the colonization with animal-based and/or agriculture-based livelihood systems. Human and animal pressure led to the well-known features of desertification, such as sand movement, stripping of topsoil and accelerated runoff, gully erosion on slopes and/or sheet erosion or deposition on flat lands in areas with alluvial or residual surfaces, and salinization or alkalinization. Because of the great uniformity of the old planation surfaces, anthropogenic sedimentation rates are low in the interior of southern Africa.

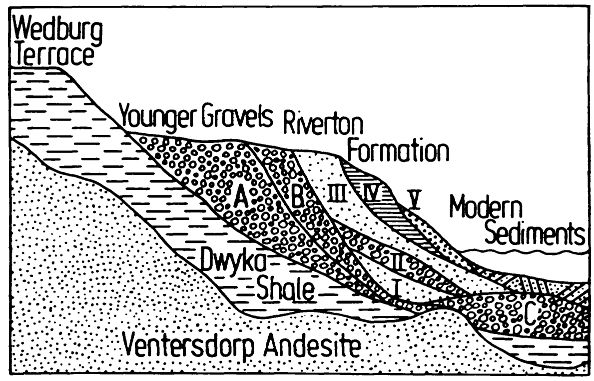

Fig. 4. Schematic cross-section of the Wedburg Terrace, the Younger Gravels and the Riverton Formation (after Helgren, 1977).

Human history and correlative deposits

Due to Quaternary climatic changes, gullies (dongas) have been either incised or re-filled with land waste accordingly with 'wet' or 'dry' periods. Thus over much of southern Africa dongas were incised during the Palaeolithic Age. Towards the end of the Early Stone Age aridity set in and the dongas began to re-fill with land waste. The lowest strata contain the last of the large stone hand axes. Aridity was long continued and the succeeding layers contain developing Middle Stone Age culture. Later, as the climate ameliorated these deposits were trenched by the revived dongas and now afford many interesting archaeological sites (King, 1978). From Swaziland Price Williams et al. (1982) describe the stratigraphy, sediments and archaeological materials of five sedimentary associations of late Quaternary and Holocene age. In the Lower Vaal Basin, later Quaternary environments are revealed by Helgren (1977, 1979). The Riverton Formation spans the later mid-Pleistocene, the late Pleistocene, and the Holocene (Fig. 4) and may be regarded as example for fluvial sequences. Member I appears to contain semi-primary Acheulian artefacts (mid-Pleistocene). Upper levels of Member III contain quantities of undiagnostic artefactual debitage of Middle Stone Age aspect (MSA: ca. 150 000—30 000 yr BP). Member IV and V contain Later Stone Age artefacts. ^{14}C-dates suggest Member IV deposition terminated a little after 8000 yr BP, while accretion of Member V had ceased before 1400 AD; basal Member V is at least 2000 years old. The Riverton Formation is primarily composed of fine-grained alluvium, particularly sandy silts and silty sands, Member V consists of sandy to clayey silts. Members III, IV and V are ubiquitous in tributary gullies (dongas) (Helgren, 1977). Altogether, the sedimentation and relict pedogenesis in the Riverton Formation represents a long and complex interval of fluctuating environmental patterns (Helgren, 1977) that cannot be related to the impact of human activities on terrestrial ecosystems.

The early ancestors of the Khoisan are believed to have inhabited southern Africa during the Later Stone Age. The Bantu-speaking Blacks of southern Africa are the descendants of Iron Age hoe farmers who reached this region in the 11th and 12th centuries; in the northern Transvaal Iron Age datings are as early as the 3rd and 4th centuries. Little is known about the peopling of southern Africa during the Early and Late Iron Age. There exist different theories about the southward migration of the Bantu-speaking agriculturalist-pastoralists. In Zimbabwe evidence for cultivation of cereals has been found between ca. 200 to 1300 AD while terrace farming was probably practised from the 16th to 19th centuries (Seddon, 1968; van Zinderen Bakker, 1980; Mauder, 1980). The chronological pattern which emerges comparing the dates of early agriculture indicates that this innovation in the life of prehistoric man diffused southward probably with the iron-working people who invaded the subcontinent in the Christian era (van Zinderen Bakker, 1980). The colonization of the Whites began in 1652 (arrival in Table Bay), during the 18th century contacts between the White and Bantu led to several clashes, and the migration of the White to the interior of southern Africa, the Great Trek (1834—1852), was a turning point in South African history. Anthropogenic sedimentation due to overgrazing, overcultivation, and wood collection did not seem to have happened until the late 19th century (Christopher, 1976), probably with the exception of the arid southwestern Kalahari where reactivation of dune formation during the past 200 years (Heine, 1981) was caused by serious damage of the natural vegetation cover as consequences of the invasion of cattle herders (Hottentots) to marginal areas from the southern Cape (Vedder, 1973).

Since the late 19th century, accelerated soil erosion was caused by population pressure, cultivation, and overgrazing by sheep, cattle land goats throughout southern Africa. Despite the obvious practical importance of the problem South Africa has undertaken comparatively little soil erosion research (Garland, 1982). The value of some descriptive research lies in creating awareness of soil erosion, locating the worst affected areas, and establishing the dominant geomorphological processes involved (Garland, 1982; Obst, 1949; Kayser, 1952; Flohr, 1939/43; Bennett, 1945). Under South African climatic conditions, rainwash remove soil particles very rapidly; the gathering of rushing water into streams concentrates the action and gullies (dongas) are cut out. Sheetwash and the rapid and spreading development of dongas has been responsible for the destruction of an appalling amount of farming land (King, 1963). The large quantity of material derived from the landsurface by rill-wash, soil-creep, land-slides etc. is removed in solution, in suspension, and by traction, the removal of material in the Upper Orange-Vaal River catchment having been computed as equal to a lowering of the surface of one foot in 1500 years, and the amount of the Republic of South Africa as Equivalent to 1 foot in 2500 years (during the Cenozoic:1 foot in 20,000 years) (King, 1963). 363 x 10^6 tons/yr of soil material are carried to the rivers in South Africa (Schieber, 1983), and about 50 x 10^6 tons/yr are transported to the sea by the Orange River (King, 1963). In 1919/20 the nine chief rivers of the Republic carried 187 x 10^6 tons of solid material to the sea (King, 1963). Correlative deposition in the stream-beds of the material eroded is sparse and restricted to dam filling and broad valleys such as the Orange River valley downstream from Upington; there the river widens to form a maze of braided streams; silt and sand have been deposited so that semi-permanent islands have been built up in the stream channel (Liebenberg et al., 1976, map 50). During the floods of 1944, 1967 and 1974 large parts of the islands were submerged and fertile silt accumulated. The construction of several big dams in the Orange valley upstream will influence the floods and the silt accumulation.

During the last decades serious soil erosion problems were mainly reduced to areas where traditional methods of cultivation and cattle breeding are still applied, especially so-called homelands and the Black national states (Bophuthatswana, Ciskei, Transkei, Venda, Gazankulu, KwaZulu, Lebowa, Qwaqwa, KwaNdebele, KaNgwane), and Lesotho and Swaziland (Rapp, 1975; Chakela, 1981; Ojany, 1986; Goudie and Price Williams, 1983; see also Prescott, 1961; Stocking, 1980, for Zimbabwe).

Lesotho

The types, rates and extend of soil erosion and sedimentation within different catchments in Lesotho are documented in a valuable study by Chakela (1981). The central and eastern parts of Lesotho consists of high mountain plateaus with peaks about 3500 m.a.s.l.; the western lowland of Lesotho is a fringe of plains and valleys at about 1500—1800 m.a.s.l. The gullies (dongas) would appear to date from the last 100—150 years and did not exist when first missionaries entered the country. Serious concern was expressed about donga erosion in the 1920's in an Interim Report of the S.A. Drought Investigation Commission and in the 1930's in a Government Report (Faber and Imeson, 1982; Rozanov, 1981).

Because of great soil erosion the rates of reservoir sedimentation indicate that most reservoirs have a very short useful life; most of the reservoirs studied by Chakela (1981) are filled within 10 years, and all are filled within 30 years. Reservoir capacity losses are about 4—20 % p.a. Rates of donga growth are slow, up to 100 m in 10 years; these slow rates of gully growth seem to be influenced by reason that most gullies have reached bedrock scarps, water divides or shallow soils; on the other hand, areas liable to donga formation have already been gullied (Chakela, 1981). The evacuation of sediments in dongas must be the result of very extreme runoff events (Faber and Imeson, 1982). In addition to donga erosion, subsurface erosion (piping) plays a great role within the Lesotho and adjacent areas. Gullies and piping have been observed together (Faber and Imeson, 1982; Beckedahl, 1977).

The sediment yield in the Orange River and the small rivers of Lesotho is greatly affected by the land use, both in the main valleys and in the treeless high mountain zones (Rapp, 1975). An ERTS satellite image (Fig. 5) of the boundary zone of Lesotho (right) and South Africa (left) shows three main regions (from left to right): (1) predominantly grey pattern is wheat fields and other vegetation in South Africa, (2) pale zone is overgrazed, eroded and vegetation-poor farmlands in Lesotho, (3) dark zones (right) are mountains and plateaus in

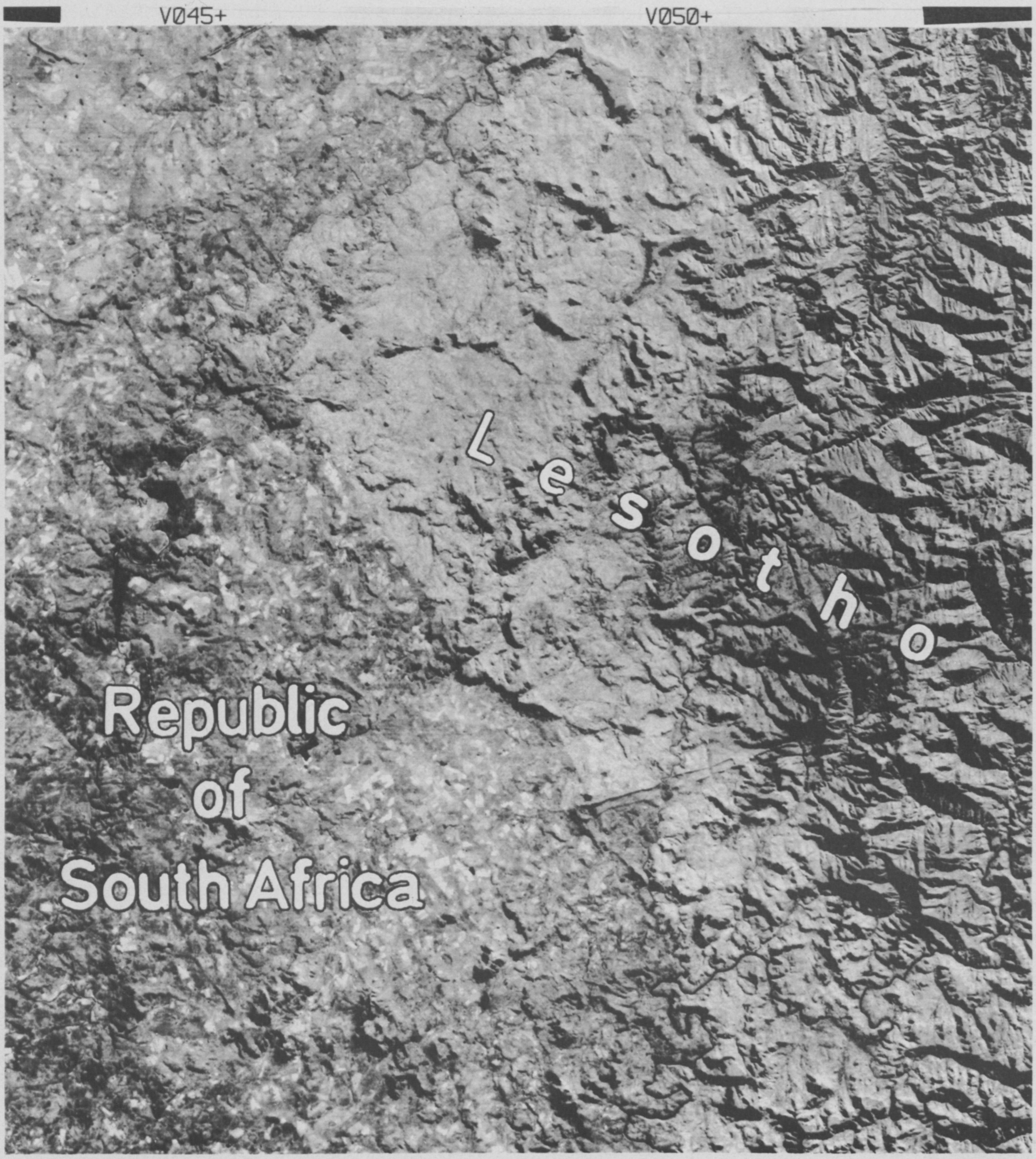

Fig. 5. ERTS satellite image of boundary zone in South Africa (left) and Lesotho (right). Date of ERTS image is June 21, 1979 (see also Rapp, 1975).

Lesotho with pastures; the image clearly demonstrates the countrywide extent of soil erosion in Lesotho as contrasted to the high-economy conservation farming in South Africa (Rapp, 1975).

Swaziland

Another small land-locked state in southern Africa, Swaziland, experiences severe soil erosion, occurring either as sheet removal or by donga erosion (Goudie and Price Williams, 1983). Swaziland has one of the highest stocking rates in Africa; extreme overgrazing and the character of the rainfall (highly seasonal and extreme heavy) are believed to be the prime reasons for the high levels of erosion. Goudie and Price Williams (1983) describe the dongas in Swaziland (Fig. 3) as steep sided gullies; they are widespread, the greatest density, one every 5 km^2, being in the Middleveld. In the upland

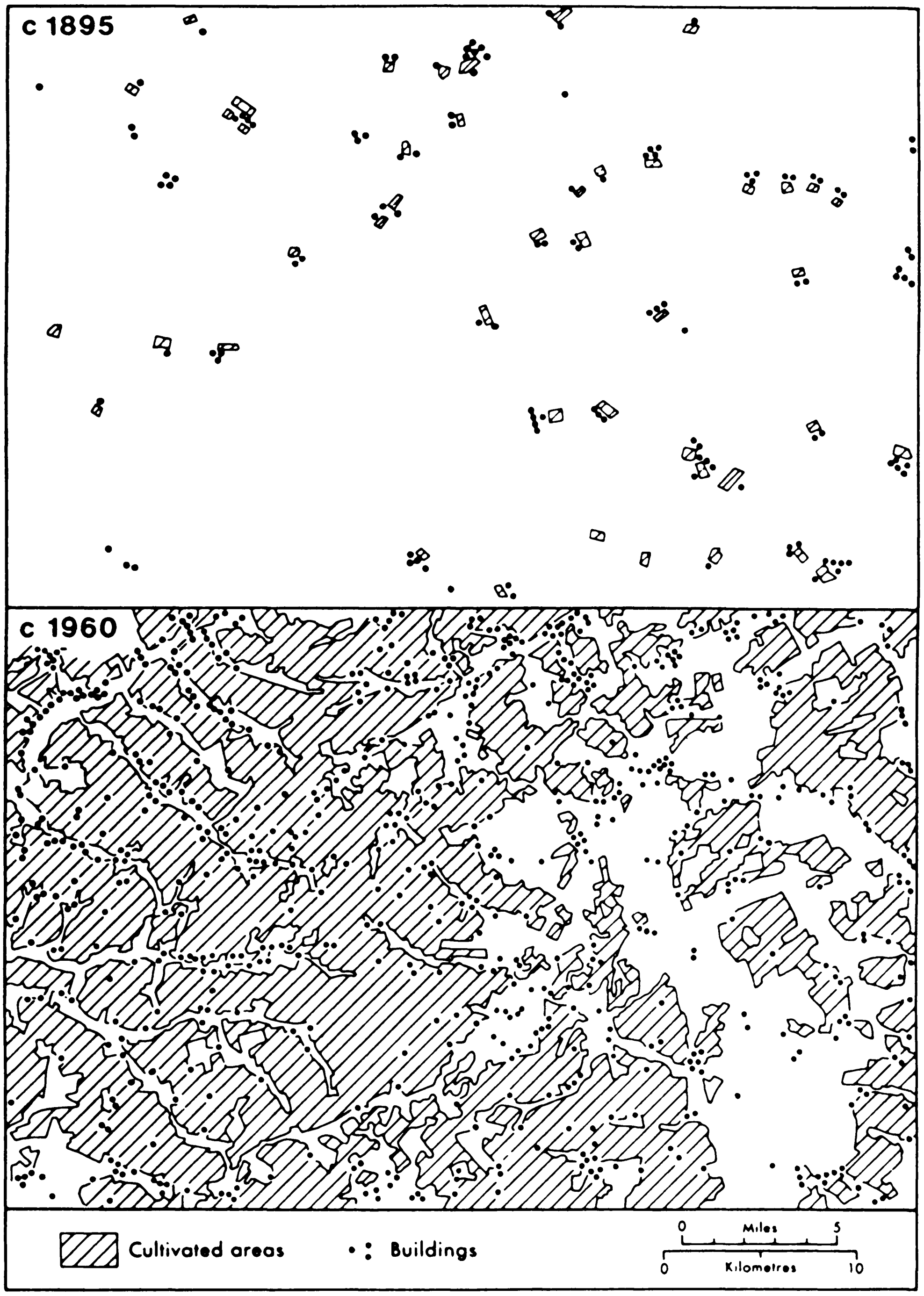

Fig. 6. Land use in part of Potchefstroom District c. 1895 and c. 1960 (after Christopher, 1976).

granite country, the dongas form very deep ravines, often cutting into the bedrock itself. In the Middleveld, the dongas tend to be broader badland type dongas; these are developed in slope wash colluvium which mantle the gentle valley slopes (Goudie and Price Williams, 1983; Price Williams et al., 1982).

Republic of South Africa

In vast regions of the South African summer rainfall areas soil erosion by water must be regarded as a typical feature of the landscape like in Lesotho and Swaziland. Its origins coincide in time with the beginning of intensive agricultural production (Christopher, 1976), so that Schieber (1983) assumes that man and his activities have accelerated and increases soil erosion and sedimentation (Fig. 6). Fig. 7 provides a map of land use, erosion and sedimentation at the farm site 'Die Hoek', near Burgersdorp, south of the Orange River. Bedrock with a shallow waste mantle is found in stream divide areas; sheet wash and occasional rill and gully erosion is typical. Near the main stream channels rill erosion and

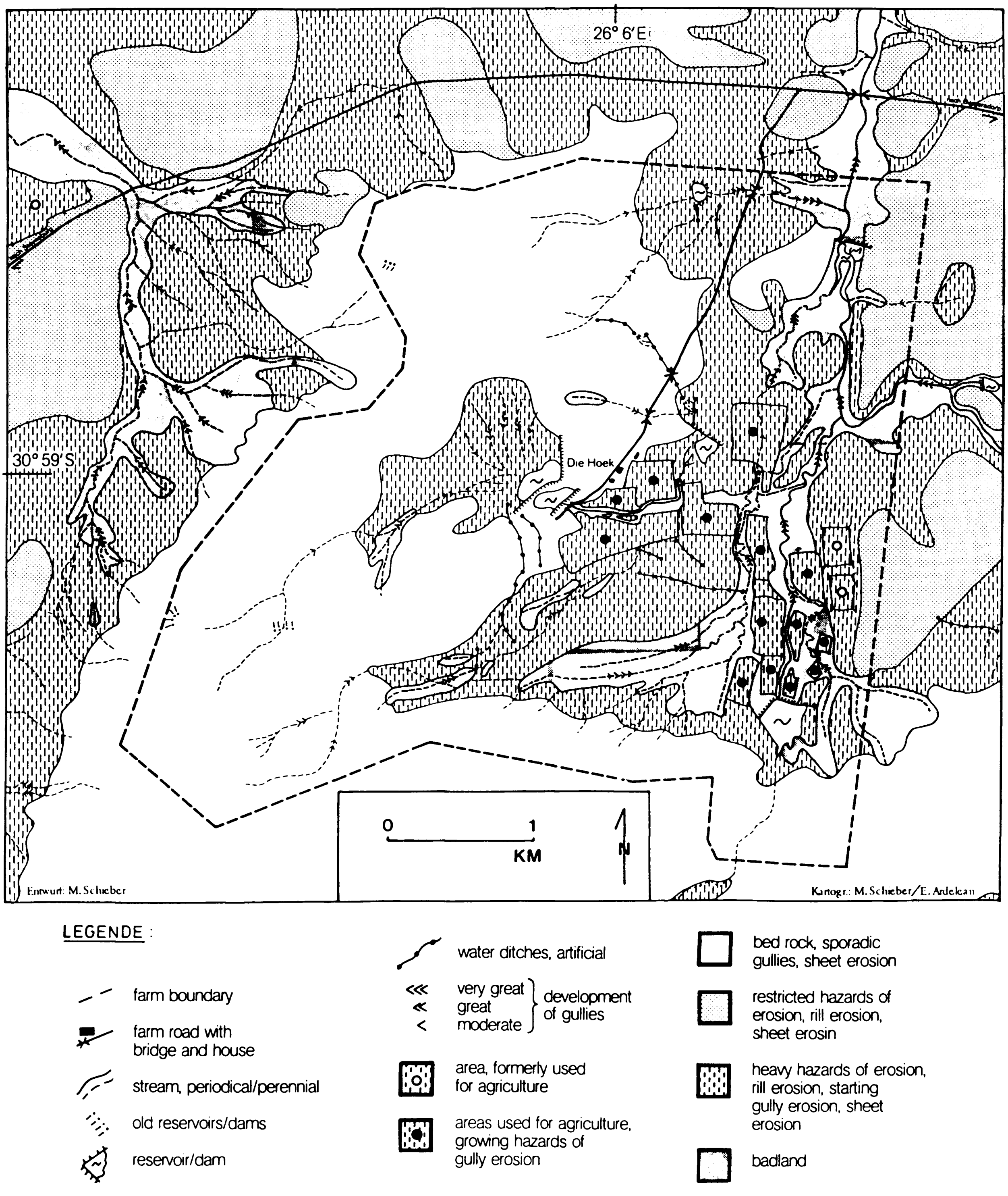

Fig. 7. Erosion and sedimentation in the Burgersdorp area, Cape Province (after Schieber, 1983).

gully formation led to badland development. Between these badlands and the upper pediments and slopes a great variety of different erosional features developed (Schieber, 1983). Correlative deposition of eroded material is restricted to the dams.

Apart from the above described anthropogenic sedimentation, sediment yield from open-cast coal mines can be several hundred times greater than from undisturbed areas (Ward et al., 1984). Surface mining activities disturb large tracts of land and produce increased downstream sediment loads. According to Ward et al. (1984) sediment production from surface mined areas can be 100 to 2000 times that from a forested area and more than 10 times that from grazing lands; in addition to being a major source of water pollution, these high sediment loads can result in reduction in the agricultural potential of the area, storage capacity losses in downstream reservoirs, increased flooding due to reduced river channel capacities, and geomorphic changes in stream structure and increased turbidity. Large ponds will generally be required to prevent changes in natural fluvial systems (Wald et al., 1980).

Nowadays, in South Africa anthropogenic erosion and sedimentation processes are strongly correlated to the existence of two landscapes, the 'African landscape' on the one hand, which is highly varied and characterized by an excessive human pressure on land (population increase without alternative source of livelihood other than the land in the traditional sense) with overgrazing from livestock, deforestation for fuelwood, timber of fencing materials, extention of agriculture and uncontrolled settlements in marginal lands, and on the other hand the 'European landscape'; sediment yield in catchments of the 'African landscapes' are extremely high.

SWA/Namibia and Botswana

Nothing is known about anthropogenic sedimentological changes in SWA/Namibia and Botswana. The rivers in SWA/Namibia, normally of very small volume owing to deficient rainfall, provide many astonishing examples of flood action. The Great Fish River has been described as dry one day and as raging torrent several hundred meters wide and ten meter deep the next, producing more changes in erosion and deposition of sediments within a few hours than in several years previously (King, 1963; Stengel, 1964, 1966; see also: Stear, 1985). At such times the proportion of silt is very high. During the flood season of 1934 alone, the Swakop River transported 35 x 10^6 m^3 silt-and-sand, which blocked the mouth, and the coastline advanced more than 1 km into the Atlantic (Stengel, 1964). According to the investigation of silt deposits in the valleys of the Namib rivers, this sand-and-silt transport and accumulation occurred at different phases during the whole late Quaternary and thus cannot be regarded as due to anthropogenic modifications of the natural environment of SWA/Namibia (Heine, in press). Siltation of dams and the construction of 'Sandspeicherdämme' (sand storage dams) (Direktorat für Wasserwesen, undated) are indicators of the extremely high sediment yield of the Namibian dry rivers; yet, anthropogenic sedimentation is not distinguishable.

In the southeastern and eastern regions of Botswana, alluvial fills in the valleys can be observed; redeposited sands, silts, and top soil material form small fluvial terraces. Until now nothing is known about the age and geomorphic processes of these deposits.

Zimbabwe

Even if Zimbabwe should not regarded with respect to anthropogenic sedimentological changes in this review, it is noteworthy that research into runoff erosion from Zimbabwe is of comparatively great interest (Garland, 1982; Stocking, 1972; Elwell, 1984). When examining the factors controlling growth and form of large valley bottom gullies, Stocking (1980) reports that one of the most significant findings is that man played little part in influencing rates of erosion; the erosion is essentially natural and the factors responsible for the erosion reflect this; size of catchment, degree of piping, height of head cut, precipitation. Putting this into general perspective, not all gullies and not all apparently severe erosion is man—induced. In many cases we may be dealing with natural phenomena and natural rates of erosion (Stocking, 1980). Similar conclusions were published from the summer rain areas of eastern South Africa by Kayser (1952).

Anthropogenic sedimentological changes occurred in the Zambezi River channel downstream of Lake Kariba. Probable reasons for the apparently excessive rate of erosion in parts of the bank are the out-of-season flooding, sudden changes in water level due to operations at the Lake Kariba, the silt-free water leaving Lake Kariba and the occurrence of large areas of sandy alluvial soils. Over a distance of about 40 km, about 1030 ha were lost to erosion between 1954 and 1973, whilst 210 ha were redeposited in the form of semipermanent sandbanks (Guy, 1981).

Conclusions on rate and tendency of change

In southern Africa, anthropogenic sedimentological changes are confined to the last century. There are no signs of major deposits of eroded material which is correlative to the pre-European acquisition of the land by the hunter-gatherer of the Khiosan or the Bantu-speaking peoples, respectively. If we define desertification to mean "the changing or transformation of productive land into a desert through soil erosion caused by man" (after Aubreville, cit. Ojany, 1986), then man-induced soil erosion and sedimentation started in southern Africa with the encroachment of the desert ecosystems of the Cape to the East since the mid-19th century. Especially the regions with summer rainfall along the Indian Ocean and below the Great Escarpment (Fig. 1 and 2) were affected by severe soil erosion during the last century. Here, characteristic forms are the dongas. The rates of net erosion vary considerably from area to area and from year to year and cover in Lesotho, for instance, a range of about 100—2000 tons/km^2/yr. These values are indirect indices of the real rates of erosion, because they refer to measurement in reservoirs; large amounts of eroded materials are deposited upstream of the measuring sites (Chakela, 1981). In the arid and semiarid regions the natural processes seem to be little influenced by the activities of man.

Whereas in the 'African landscapes' due to population pressure rates of soil erosion and sedimentation may even increase in future, the tendency is opposite in 'European landscapes' because of soil conservation methods. Silting of dams and river floodplains will continue as long as mismanagement endues.

Acknowledgement.—I thank the Deutsche Forschungsgemeinschaft for financial support.

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