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THE MANAGEMENT OF ENVIRONMENTAL DEGRADATION IN SEMI-ARID BOTSWANA

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C O N T E N T S

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THE MANAGEMENT OF EVIRONMENTAL DEGRADATION IN SEMI-ARID BOTSWANA

I INTRODUCTION

Botswana is large (581,730 sq km). sparsely populated (721,00 Total Population)[1], and occupying the centre of the Southern African Sub continent. It is bordered by the Republic of South Africa to the South and South East, by Zimbabwe to the North East, by Zambia and Angola to the North and by Namibia to the West. Only 5% of the land in suitable for arable agriculture and only 2.1% of the land is used as such(2). It is characterized by great variation in mean annual rainfall ranging between 250 and 650 millimetres with most of the land receiving below 450 millimetres of rain.[3] About 84% of the land used to be described as desert[4], but now the whole of Botswana is described as semi-arid it has been suggested that the area that used to be described as desert is really a "thirstland"[5]. The History of Botswana is a history of frequent droughts.[6]

Public management systems for Botswana's semi-arid environment must be so designed as to take into account a combination of severe climatic constraints and person's wasteful, careless and negligent utilization of common pool resources of a delicate ecosystem. Common pool resources are those resources which members of a society own in common and each individual has equal rights of access and utilization. Inadequate and unrealiable rainfall together with high rates of evopotranspiration and pressure of human and animal demands beyond the carrying capacity of the resources result in droughts,

soil erosion, crop failures, human and animal famines, negative vegetation changes, and overgrazing.

Public management is one of number of solutions to these environmental problems and this solution will be the focus of this paper. Public management, for this paper, may be defined in very general and comprehensive terms. It covers the perception, misperception and non-perception of environment problems, translation of perceptions into policy, and either the allocation of these tasks to existing agencies or the establishment of new agencies to carry out the tasks; and finally,the actual implimentation of the policy.

II GENERAL ELEMENTS OF BOTSWANA'S SEMI-ARID ENVIRONMENT

Public management systems for environmental problems must be based non correct assumptions, facts and concepts about the nature of these problems. It is therefore proposed to discuss in this and the next sections the state of knowledge about Botswana environmental problems before discussing policies (iv below) and agencies (vi below).

The approach used here is to read as much of the existing literature and to synthesize the findings. As one reads more and more about each topic, one is overwhelmed by the abundance of contradictions and inconsistencies and by econsiderable methodological naivity. Most of government search has been based on incorrect sampling procedures and non-generalizable experimental designs[7]. But three distinct definitions and solutions of the environmental problem do emerge backed by methodoligies that render their findings valid and reliable[8]:-

1. Current environmental conditions reflect climate. They are not man-made. But man must understand them as constraints and utilize the environment within the given limits. This view is best represented by the work of Pike[9].

2. Current environmental conditions reflect man's impact on Botswana's environment. They are not climatological in origin. Botswana's environment needs urgent protection from man's misuse of it which has lead to it's degradation during the last 100 to 150 years. This view is best represented by Campbell and Child[10].

3. The above positions are extremes of a continuam on which other authors take intermediate positions.

The most theoretically interesting is the middle one, or the integration position. Here the finding is that the current Botswana environmental conditions are a product of both climate and man and that the direction of causation is reflective. Man's acts degrade the environment; but a degrated environment leads to degraded climate. Or that climate causes conditions such as droughts which degrade the Botswana environment. This view is best represented by Cooke and Vegten.[11]

(a) <u>The view that current Botswana Environemtnal conditions are given by nature and specifically by climate (Pike)</u>

There are two statements made by Pike which make his position clear.

> "Over the Western half of the sub continent and Botswana, winds tend to be northely or north-westerly in both seasons circulating outwards from the high pressure centre; their <u>continental origin condemns</u> the greater part of the interior and most of Botswana to aridity"[12].

Pike's second statement is:-

> "Whilst many changes, particularly of an <u>apparent</u> cyclic nature have been detected, none of these has been shown to continue for any length of time. There have been many assertions that the sub continent is becomming drier but this <u>subjective</u> observation is very often <u>confused with degradation of the land by man</u>"[13].

But climatological determinism does not require a rejection of a cyclic trend. These cycles, or oscillations, can be regarded as deviations off a constant mean in the long run[14]. Such a dynamic equilibrium need not correlate with environmenta degradation. Campbell uses this very point to ingeniously cast climatological determinism in the shape of a devels advocate by showing that at Mafeking rainfall has flactuated above and below a constant annual mean for the period 1890 - 1970[15].

Pike has argued that the Kalahari sands do not allow rain water to percolate to deeper layers.

> "aeolitian deposit, up to 120 metres or more, in thickness and of such fine grain that the rainfall is held in the few feet below the surface until evaporation and transpiration have dissipated it"[16].

> "Where the thickness of the sand exceeds 10 metres, the rainfall of the area is too low to penetrate below the root zone of the plant cover and no recharge to the ground water takes place. But water held in the upper layer is enough to support plant life against long spells of droughts and accounts for the cover of bush and grass deep into the Kalahari desert"[17].

Thus according to Pike type of vegetation reflects naturally given factors rather than the man's impact on the ecosystem. Botswana is subject to three rainfall patterns: the Southern periphery of the Inter Tropical convergence zone touches a small area of Northern Botswana giving it mean annual rainfall ranging between 650 mm and 450 mm. In the South East, the Limpopo water shed receives rain brought from the Indian Ocean. Here mean annual rainfall ranges between 350 and 400 milimitres. In both cases the border regions are receiving left over rain of two major rainbearing air masses. The rest of the country receives mean annual rain ranging between 250 and 350 milimitres characterized by extreme variability (50% - 80% coefficient of variation).

According to Pike on the basis of rainfall only the Northern and the Eastern areas are suitable for agriculture. However, on the basis of soils, only the South East combines rainfall and soils suitable for dry land farming.

> "Combining these data with soils data it can be shown, therefore, that arable dryland agriculture can only be practised without extreme risk in an area of approximately 45,000 sq. km. in the Southern Eastern region in a belt extending from Ramatlabama through Shoshong to Molepolole and Kanye: A further smaller

> area of 5,000 sq km is also shown to the North-West of Francistown."......
>
> "In summary, therefore, it may be said that less than 5% of Botswana may be considered as potentially arable and even here the risk of crop failure may be put at approximately 4 in 10 years."[18]

Implicit in Pike's analysis is that if arable agriculture were extended beyond the suitable areas there would be increasing crop failures as well as disruption of the ecological balance. He is silent on whether cropping in unsuitable areas has in <u>fact</u> taken place.

Pike attributes Botswana's aridity to a long term (30 - 70 years) shift in the position of the Inter Tropical convergence zone on the basis of a theory developed by Lamb[19].

> "He /<u>Lamb</u>/ further [illegible] evidence to show that such a shift possibly occured in 1960 and this had the effect of shifting the westerly depression belt of the Northern and Southern hemispheres nearer to the equator and this restricting the oscillations of the inter-tropical convergence zone to within narrow limits.....If this theory is upheld, and we have no way of knowing whether it would be or not, it would seem that Botswana lies within a region that may expect to receive less rainfall in the future than the period ended in 1960 and that this period may continue for any period between 30 and 70 years. The evidence from Botswana clearly shows that there has been an overall decline in rainfall amount since 1960 and if rainfall were to stabilise at a new, lower value, the need for more efficient utilization of pastures and improved practices in dry land agriculture would become an urgent priority in the face or rising human and cattle population."[20]

Again for Pike, the need for conservation is still futuristic and contingent on climatic changes.

(b) <u>The view that current Botswana Environmental Conditions are man-made</u>

Campbell and Child[21] accept the view that changes in climate may result in changes of the flora and fauna of an ecosystem.

But they take the position that such changes are long term; whereas the changes they observe in Botswana are recent, and have taken place in the last 100 to 150 years.

> "Moreau pointed out that such conditions /Long term cyclic changes in temperature/ were probably not peculiar to this period and formed part of a series of irregular warm and cool cycles within lesser periods of flacutation operating within them and leading to gradual changes in the flora and its dependent fauna."[22]

> "It should be emphasized, however, that even the most rapid of these changes was a very gradual process and the significant modification of the environment in Botswana during the last 100 to 150 years, described below, can not be explained by this phenomenon."

> "Furthermore, habitant changes towards more arid characteristics have not proceeded at anything like the same speed, even in areas of Botswana with similar climatic and geomorphological conditions. The most that can be attributed to long term changes in the climate, is that habitats may be becoming slightly more sensitive to misuse, if in fact average temperatures are undergoing gradual increase."[2]

Campbell and Child argue that occassional and accidental natural events such as [illegible] activity may alter habitats. While the reasons for changes in the flow patterns of the Okavango and Kwando system and the drying up of Lake Ngomi are not well known, these changes have

> "Obviously had a marked and fairly rapid influence on the habitats. Nevertheless, it is unlikely that they alone would have resulted in the protracted veld deterioration, which is more likely to have been caused by human activities, as this has occured in many places in Botswana where there is no evidence of such changes /natural events/ having taken place."[24]

Campbells and Child's reconstructed Botswana's environment was characterized by forest vegetation in the South East and by open grasslands extending into the interior. The draige systems have not changed very much in the last 100 to 150 years but a number of springs and wells have since disappeared indecating a lowered water table resulting from over exploitation

of water supplies by man. Both forests and grasslands have suffered encroachment by woody and bushy species. These changes in flora are associated with changes in fauna.[25]

> "This region /The Limpopo drainage system/ shows some of the most advanced veld deterioration in Botswana and sensitive grazing species like roan, sable, tsessebe and even zebra have virtually diappeared as their ranges receded towards the north-east, while those of plains game like gemsbok and hartebeest have tended to contract in the opposite direction. Much of the open grass land has been invaded by scrub and the process which is directly attributable to the mismanagement of the veld by man, is still very active, although Pole Evans warned against its obvious adverse effect on the productivity of the country as long ago as 1931. Summers traces the recession of the range of the tsetse fly down the Limpopo, from about 1870, which would have allowed livestock to graze along sections of the rivers where this was not possible before. The rivers have lost many of their perennial properties and springs, of which there were several in the West of the region like the one at Boatlaname, have dried up. The loss of surface water is sometimes blamed on a reduced rainfall, but this is much more likely to have been caused by the loss of water holding properties of grassland; attendant upon the destruction of the plains country. This would have promoted flash floods and siltation of the river courses, in place of a more regular flow lasting until well after the rains."[26]

Campbell and Child repeatedly attribute veld deterioration and desert encroachment to animal and human pressures on the natural resources. This process began when intertribal warfare brought more and more peoples and livestock into Botswana and with the establishment of peace by the Colonial Administration.

> "From about 1880 onwards changes /damage to the environment/ became more rapid as intertribal warfare was curbed by the British and, as a result, people became more settled and could devote more time to agriculture. The build-up in human and cattle numbers gathered impetus as modern medical and veterinary services penetrated into more and more remote areas." [27]

> "Many reliable perennial waterholes have dried up and the water table has receded further from the surface. Grassland has been replaced by scrubland, or in isolated areas by denuded soils, including mobile sand dunes, and these have led to important changes in the fauna as sensitive grazing species have deminished. Certain species have prospered, but unless the veld can be

properly managed,it is probable that this will be no more than a passing phase in the improverishment of the fauna, as the intrinsic productivity of the environment declines towards zero"28

(c) The view that current Botswana environmental conditions reflect the combined effects of the given climate and man's impact on the environment - the integration position.

The integrationist position may be found in the work of Cooke[29] and that of Van Vegten[30].

"The good rain years the land may have the appearance of a lush savanna, but in very dry years it may have the aspect of a desert. This may have nothing to do with man and his activities. Botswana has alternated between savanna and desert in the past before man can have had any influence on the scene. /Cooke now close to Pike/. But man can adapt and modify /The Environment/"31.

"With controlled grazing, judicious cand controlled burning and other practices he can conserve and improve the quality of grazing on the rangeland. By correct agricultural practices which improve soil structure and reduce bulk density he can reduce run-off and increase infiltration, and so make optimum use of soil moisture. By controlling weeds he can reduce wasteful transpirational loss of moisture. He can in other words alleviate drought susceptability"32

/Cooke is now close to Campbell and Child in this and the next paragraph/.

"Unfortunately he also has a wayward ability to aggravate it."..... "Uncontrolled grazing by excessive numbers of livestock under communal systems of tenure and land-use, and especially the concentration of animals round watering points in common. This exhausts the palatable grasses, and encourages weeds and woody scrubs, tramples the ground and breaks up soil structure, and a slowly spreading zone of wasted land creeps radially outward from the water source. Such zones coalesce and enlarge and create a sort of mottled or spotty deserification."33

In Van Vegten[34] may be found both an integrationist position and a reflective one"..... through dissimilative water production ... a vegetation improves the amount of potentially precipitable atmospheric moisture"[35]. Therefore man induced activities such as distruction of forests, burning of grass, and exposing the soil, may reduce transpiration and rainfall.

".... the amount of water produced by transpiration from especially large forest communities is of a magnitude large enough to form rain clouds almost daily over such communities (the Central African forest belt for instance). The rain resulting from this sustains this community in its turn: it provides the perpetually necessary water, but it also maintains major bodies of open water, like the rivers Nile, Congo and Niger. Less water productive vegetation types may still be able to contribute to such a degree to the moisture content of the atmosphere that their sustenance is at least supported, as well as the flow of major streams like the Zambesi"[36].

"The reflection of solar radiation by Botswana's soils is relatively high. This means that bare soils reflect a large proportion of this radiation, while the balance is absorbed, the infra-red fraction raising the top soil's temperature. Vegetation covered soil, on the contrary, absorbs a large proportion of received solar energy, i.e. its albedo or reflectivity is considerably less. As a result of this vegetation - covered surface attains a higher temperature than bare surface. This thermal depression effect of bare ground results in a decreased lifting of air necessary for precipitation. Consequently drastic albedo increase by vegetation deterioration will reduce local rainfall to some extent (charney, 1975)"[37].

III SOME SPECIFIC ELEMENTS OF BOTSWANA SEMI-ARID ENVIRONMENT.

1. Land Shortage, Land Tenure and Land Use

With a population of 721,000 in an area of 581,730 sq km, Botswana's national average population density must be one of the lowest in the world. Such a statistic is greatly misleading.

The human and animal (now estimated at 3 to 4 million) populations are concentrated in a very small zone (about 5% of the country) to the South-East where pressure to the land has gown beyond its carrying capacity.

Because the rest of the country looks empty and becomes lush and green during wet seasons, and because Botswana live in urban villages, rather than in homesteads scattered in the rural areas, there is a tendency for people to hold the belief that there is in Botswana plenty of empty land awaiting exploitation, misleading mapping showing extensive "unutilized" land perpetuated such beliefs.[39]

It was on the basis of such assumptions that the Tribal Grazing Land Policy[38] was launched. Its aim was to identify this empty land, zone it,and transform it onto commercial, privatized, cattle ranches. The first stage in the implimentation of the policy has involved District land use surveys which have demonstrated that the assumption of plentiful land was wrong.

The general trend has been for human and animal population to expand from the South East into the interior and the Tribal Grazing land Policy will re-enforce this trend by giving it

legality and money. It must, however, be recognized that this interior has supported hunter - gatherer communities (one group, the Bushmen is estimated to be 10,000 strong) and wild life populations that may have reached the limits of carrying capacity for the region.

The Tribal arazing Land Policy will have two negative consequances: one humanistic, the other environmental. Introducing ranches into the interior involves extinguishing and re-allocating land rights from a large number of users to a few large scale private ranch operators[40]. The development of a landed aristocracy[41] has been ocurring on its own against communalist norms; but now it will have legal ricognition.

> "Exclusive rights to the land may be given to the lessee upon signing the lease agreement. All customary rights in the area may be extinguished after the allocation hearing and after people with existing customary rights in the area have been compensated."[42]

This land policy promises to provide a modern example of a land grab along the same lines as alienation of the Kenya Highlands by the British, the Enclosure movement in England, and the privatization of land in Ghanzi District. The allocation hearings cannot be fair because they are controlled civil servants who have vested interest in the success of the policy and because many current users may be powerless to assert their rights.[43] This potential land grab is in confrict with one of Botswana's central objectives - social justice, as well as being in conflict with fundamental human rights.

The current expansion of human and cattle into the interior given the delicate ecological balance of hunter - gatherers and wild life may tip that balance towards overuse and over-exploitation of grazing woodlands, and water.

This is the environmentally negative consequance of the Tribal Grazing Land Policy.

One of the justification of the Tribal Grazing Land Policy is that privatization of communal areas will bring about better land use practices. Such an assumption may be supported by simplistic comparison of levels of development of the freehold areas and the Communal areas.[44] This assumption and the tragedy of the commons[45] models that support it will be critically evaluated in section (iv) below.

2. Trends,Cyles and Droughts

All the works that I have read[46] are in agreement about the existence of long term climatic cycles for Botswana of wet and dry periods of various amplitudes.

> "Thus summer rainfall areas have been affected predominantly by a quasi-twenty-year oscillation in rainfall, the Southern Cape coastal all seasons rainfall belt by a week ten-year oscillation, the mediterranean South-Western Cape by complex fluactuations with periods greater than twenty years. Finally, the arid interior region that experiences aquinoctial rainfall maxima has been affected predominantly by a quasi-biennial oscillation. Of the high frequancy oscillations, the three to four year type are most widespread"[47].

> Tyson shows that "the quasi-twenty-year oscillation of the summer rainfall region is the most pronounced"[48] and "shows a peak at eighteen years which is significant at the one percent level"[49] and has "persisted for about 140 years, if not more"[50].

These climatological cycles may be integrated with human and animal population growth cycles. Campbell has shown that after each drought animal and human population increase rapidly with the improved grazing and arable production associated with improved rainfall[51].

The deamnds on the ecosystem increase beyong carrying capacity until the incremental dynamic results in crash. Human and animal numbers are drastically reduced. Such reductions may be mitigated by the intervention of relief agencies. Grove provides identical analysis based on the Sehel[52] and Child[53], with Botswana in minds, suggests that these population growth curves are exponential which is consistent with population growth models. It may be hypothesized that these cycles (the climatological, and the demographic (animals and humans) coincide.

3. Vegetation changes, overgrazing and carrying capacity

The vegetation changes which have been presented in descriptive terms may be reduced to a theory, but the associated concepts of overgrazing and carrying capacity need to be reduced to quantification.

Van Vegten's theory[54] of defoliation is based on the rate of defoliation in relation to grass biomass productivity. He suggests that grass vegetation developed in association with the emergence of large herds of herbivorous mammals during the early miocene period. Grass Vegetation replaced extensive stretches of forest and shrub vegetation.

> "It is a notable ecological phenomenon that light to moderate grazing, i.e. defoliation, is required to develop and sustain grassland. The physiology of grass growth stimulation by defoliation is still unclear. It appears that grass growth in terms of biomass as well as in terms of build-up of protein, phosphorus and potasium is influenced by defoliation as depicted in fig. 1".[55]

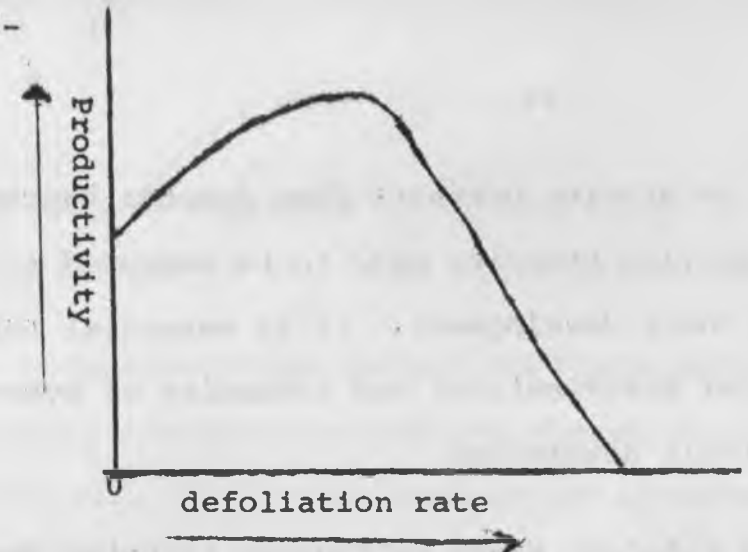


Fig 1. Tentative correlation between grass productivity and defoliation rate.

According to Van Vegten point A on figure 1 represents optimum growth but the exact point for various grass species and different conditions can only determined experimently.

> "To the left of pt. A a decline in productivity is caused by insufficient defoliation. The resulting dead grass material inhibits development of new shoots by occupying the space required for those shoots (suffocation effect). To the right of pt.A a decline in productivity is caused by overdefoliation. Too little photo-synthetic tissue remains to replenish the carbohydrate stores (energy) in the root system and anxiliary tissues. In order to rebuild photo-synthetic tissues the plant has to draw on its partly depleted energy stores, causing progressive depletion and a further drop in biomass production (exhausition effect"56.

Under conditions of overgrazing and undergrazing the grasslands are invaded by forest, or shrub , or both. This process of range deterioration is accerated by illcontrolled burning, exposure and erosion of soils. Grazing animals decline and may be replaced by browsing species. Once range deterioration has taken place recovery is a long term process.[57]

Severe overgrazing and soil erosion are obvious to the eye. Bare soils, muddy rivers, gullies (dongas in Lesotho) are all obvious exmaples of environmental degradation at an advanced stage. A stage that may have been preceded by gradual imperceptable changes.

Conditions such as grazing pressure from demands beyond environmental carrying capacity need to be measured at the early stages of their development. It is essential that occurance (special distribution) and intensity of over-grazing be precisely determined.

Some work in the field of range monitoring is being done by Land utilization division of the Ministry of Agriculture. This work involves sampling botanical composition and frequancy of the vegetation, using experimental, or field, sample units. Range productivity can be determined by 'harvesting' the herbiage produced over a given period, drying and weighting to detemine the yield - biomass. Given these yield figures and the known consumption rates of animals the grazing condition of the range can be determined and as well as the appropriate rates of stocking and carrying capacity.

But van Vegten[58] suggests that these biomass procedures may give inappropriate results. If they are experimental, they do not apply to the field situation; if they are set in the field, they miss out the biomass grazed by the animals during the observation period. He suggests an alternative procedure that disregards the biomass approach. This procedure involves the concept of base cover,"the surface area occupied by the base of the plant from which it breaks through the soil surface. Apart from quantifying the two components, valuable plants and non-valuable plants, this parameter also quantifies the area actually covered by vegetation versus bare soil."[59] Van Vegten, then, develops a Range Coefficient (RC) as basal cover of valuable plants divided by basal cover of non-valuable plants.

It can also be expressed as basical cover of a particular species divided by the basal cover of the rest.

It is to be noted that while both Field and Vegten are developing scientific procedures for monitoring range deterioration and for determining environmentally sound range management procedures, the underlying methodoligical assumptions are in conflict. It may also be noted that present stocking rates and carrying capacities (Table) as calculated by Field are not based on the scientific procedures that he recommends[60] but rather he has based these calculations

TABLE DISTRICT STOCKING RATES[61]

District	Grazingland (1000 km^2)	No.of cattle (1000 hd,)	Stocking Rate (ha/LSU)	Carrying ha/LSU)
Contol	123.3	1045	9.4*	16
North East	1.6	63	2.0*	24
Ngamiland	92.7	308	24.1	9
Chobe	6.7	6	89.3	9
Ghanzi	51.5	64	64.4	21
Kgalagadi	73.2	76	77.0	26
Kweneng	32.2	224	11.5	12
Kgatleng	6.8	174	3.1*	12
South East	0.2	67	0.2*	12
Southern	24.7	268	7.4*	16
TOTAL	412.9	2295	14.4	16

* Overgrazed.

"onrainfall, evapo-transpiration,sand proportions of soils,terrain slope gradient and vegetation density, He assumes a number of lineer regressions between these parameters, which in fact are curred"[62].

Policy makers and farmers may be relying on these calculations unaware of the methodological disagreement. It is impossible to tell the direction of error if any. These figure could overstate, or under state, the degree of over-grazing.

4. Exploitation of water supplies, exhaustion and desertification around watering points

Exploitation of water supplies in semi-arid Botswana is associated with two environmental hazards: one direct, the other indirect. The first hazard is overexploitation of the renewable resource; the second, is increased desertification associated with expanded and spreading watering points. This process of desertification has been described above. In this section analysis centres on environmental problems associated with over exploitation of Botswana's water supplies.

Major sources of water in Botswana in order of magnitude are: (1) Groundwater 33% of water used annually, (2) surface water 29%, (3) sand river extraction 20% and (4) major dams 17%.[63] Currently water utilization is centred on ground water supplies, but the Okavango delta is likely to be the key future source of water after ground water supplies have been developed to the limit. "Some 75 percent of Botswana's human and livestock population are totally o partially dependent on groundwater. Groundwater has already been extensively, but not effectively, developed."[64]

The key environmental water issues for Botswana is whether the renewable groundwater and the Okavango could be, or have been overutilized to the point of bring about imbalance in the

ecosystem. Three types of data are needed the amount of water reserves, the rate of utilization extraction), and the rate of recharge. As in the case of the other specific issues discussed above, the state of knowledge is so limited and contradictory that assertions about this issue cannot be made with a strong degree of scientific confidence. When the facts are not well known it is impossible to reconcile contending sides.

There is some evidence about the amount of water resources and the rate of exploitation (to be reveiwed below) but the bone of contention is whether the groundwater is adequately recharged,or not. Many writers[65] have taken the pessimistic view that groundwater is not being recharged at all, or adequately recharged, and that the water table is falling resulting in the drying up of springs, wells, and even boreholes; other writers[66] have taken a more cautious stand and argue that for the moment groundwater is adequate and is being recharged. The Department of water affairs has estimated that all known water resources in Eastern Botswana "which can be economically developed will have been fully committed by 1985"[67]. The most advanced study of water resources estimated that groundwater recharge is 1% of annual rainfall[68] and localized studies have come up with recharge rates ranging between 1 - 5 percent[69]. The issue of recharge which is the most vital environmentally must be regarded as unresolved and this is a most alarming situation for Botswana.

> "If it is indeed the case that groundwater in the Kalahari sand areas is not being recharged, then Botswana potentially has an extremely serious problem on its hands"70

If the nature of recharge cannot be determined with any degree of confidence, it can nevertheless be asserted that water exploitation has expanded greatly during the last 40 years and this greatly expanded utilization which has indirectly contributed to increased desertification, may be taken as an indirect measure of overutilization of, or pressure on, water supplies.

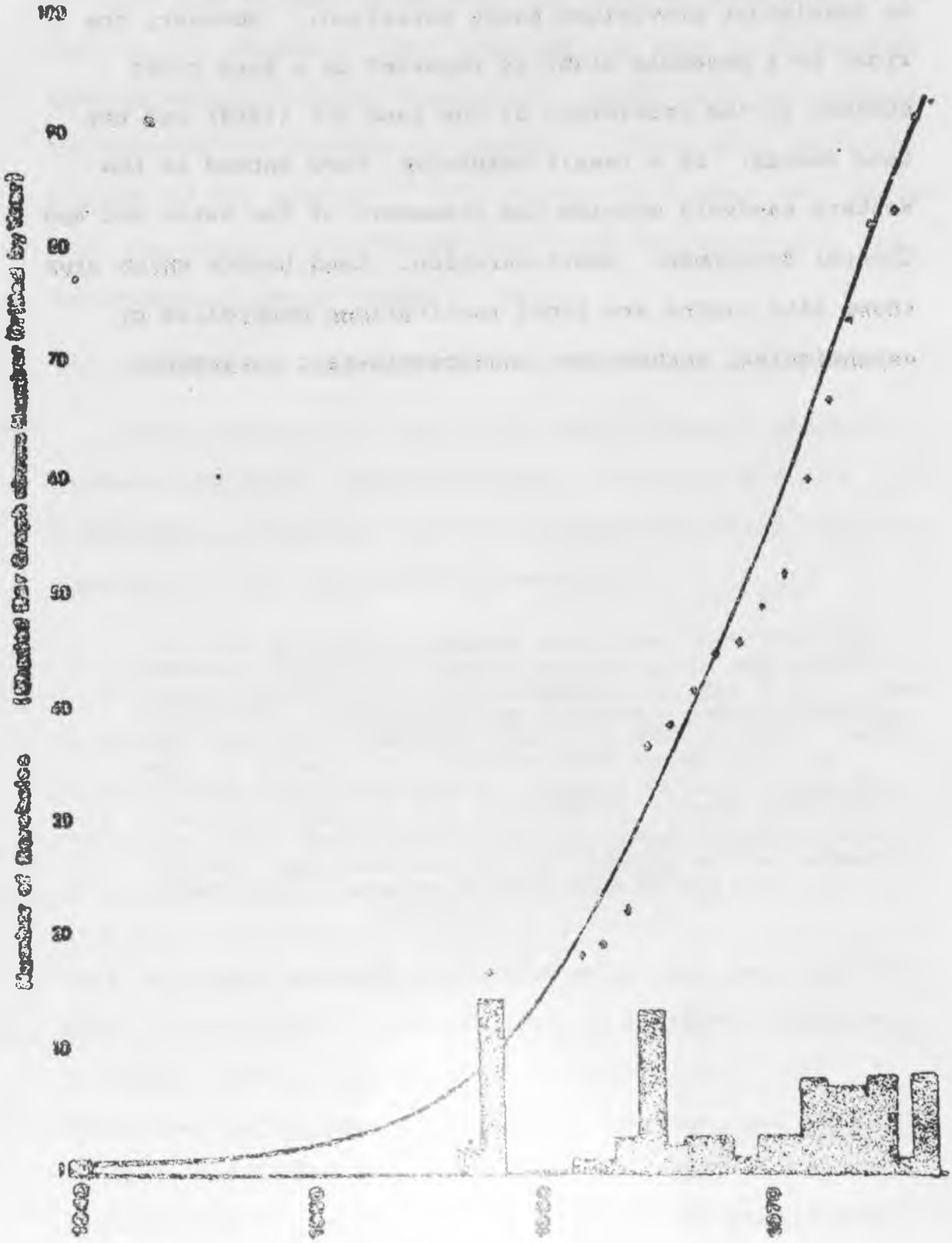
In 1972 it was estimated that "since 1929 approximately 2,500 boreholes have been drilled by the Government and substantially more than that have been drilled by private contractors" [71]. This suggests the total number of boreholes to have been at about 5,500 in 1972. The Geological survey boreholing record shows a decline[72]; where as Hitchcock's study of water exploitation in the Western sandveld shows a very sharp increase.[73]

The Geological survey boreholing record is as follows:

YEAR	1966	1967	1968	1969	1970	1971
NUMBER	80	83	66	52	51	43

The results of Hitchcock's study of water exploitation is represented by a graph.

GROWTH OF BOREHOLES IN THE WESTERN SPRINGVELD. (SOURCE: HITCHCOCK (1978) P. 164



Much of the expansion of boreholes is uncontrolled even when there is a water Act (1967) intended to regulate the exploitation of water supplies. This Act purports to regulate water supplies by granting a water right subject to regulatory provisions being satisfied. However, the right to a borehole sight is regarded as a land right subject to the provisions of the land Act (1968) and the Land Boards. As a result boreholes have spread in the Western sandveld outside the framework of the Water Act and Central Government administration. Land boards which give these site rights are local institutions controlled by expansionist, rather than conservationist, interests.

IV MODELS FOR ENVIRONMENTAL PROBLEMS, POLICIES AND PROGRAMMES IN SEMI-ARID BOTSWANA

Environmental problems may be explained emperically by way of facts and we have shown that the state of knowledge to do this is not adequate. Such problems may also be approached theoretically. Several theoretical models will be examined in terms of the Botswana situation. These are: Hardin's tragedy of the commons"[74] with respect to common pool resources, the concepts of "Public Good", and Externalities, and environmental merit (demerit) goods.

(a) Common Pool Resources and the tregedy of the Commons.

When resources are held and used in common, there is tendency for each actor to engage in bahaviour which maximizes self-interest in the short run but which ruin the resources to the detriment of everyone.

> "....the rational herdsman concludes that the only sensible course for him to persue is to add another animal to his herd. And another..... But this is the conclusion reached by each and every rational herdsman sharing a commons. There is the tragedy. Each man is locked into a system that compels him to increase his herd without limit - in a world that is limited. Ruin is the destination toward which all men rush, each persuing his own best interest in a society that believes in the Freedom of the commons. Freedom in a commons brings ruin to all." 75

This is a very powerful model for explaining over exploitation of common pool resources such as grazing, fisheries, wildlife, forest, water and air in general and conditions on the communal lands of Botswana such as: Overgrazing, herd sizes beyond carrying capacity, severe soil erosion, and low rates of cattle off-take in particular. Although persons tend to be extractive and exploitative of common pool resources in the way predicted by Herdin's

model, there are several qualifications that would make the model more realistic.

Firstly, ruining the commons need not ruin the culprints concerned, It is possible to "kill the goose that lays the eggs"[76] if the proceeds can be transfered to other sectors of the economy with higher rates of return. Though investing in the commons has the highest return at present; the situation will change in future when, diminishing returns set in.

> "The owner of cattle on a cattle post /Botswana rangeland commons/ can expect the number of his animals to grow at 7 or 8% per year, while he sells a futher 8 or 9%. In very crude terms his potential offtake is about 15% per annum. Expressed as a rate of return to investement a traditional cattlepost owner can probably earn an inflation-indexed 9 - 12% on his money. In contrast to this he can only earn an inflation-prone 8% by putting his money on deposit with a building society, or rather less at a commercial bank."77 While the Botswana government is tyring to control exploitative "risk-investment" in housing, "There is no counterpart effort to prevent cattle post owners exploiting the environment and,in effect, succeeding generations "78.

Secondly, Hardins model implies a commons without social structure. Not everyone can add cattle to the Botswana common's even if they have the rights of usage. "45% of Botswana's rural households own no livestock; and 50% of the livestock are owned by 5% of the rural households"[79]. Only those who have cattle can add cattle to the commons. This is a form of the power of power[80]. Hitchcock [81] has shown the norms and rules of cattle transfer among cattle post owners are such as to prevent new entrants. But even among those who own cattle and who could add more and more, they is a limit impossed by managerial resources.

Thirdly, if we take a step back to LLoyd's "on the checks to Population"[82] the origin of Hardin's model, we may have a last, but not least, shot at the assumptions and provisions of the model.

> "Why are the cattle on a common so punny and stunted? Why is the common itself so bare-war', and cropped so differently from adjoining inclosures.,/in Botswana Freehold Farms correspond to the inclosures/?" 83.

If the question were posed as why are some or some contries more developed than others, then it would be clear that what is required is a broad theory of development and underdevelopment. Such a theory will be made up of very many variables; psychological, such as the achievement motive[84], or status, depriration and blocked channels of social mobility[85]; economics variables such as capital formation Lloyd's explanation is only a part of the answer.

> "If a person puts more cattle into his own field, the amount of the subsistence which they consume is all deducted from that which was at the command, of his stock; and if, before, there was no more than a sufficiency of pasture, he reaps no benefits from the additional cattle, what is gained in one way being lost in another. But if he puts more cattle on a common, the food which they consume forms a deduction which is shared between all cattle, as well that of others as his own, in proportion to their number, and only a small part of it is taken from his own cattle".[86]

(b) Environmental Public Goods

The logic of common pool resource utilization encourages each participant to avoid external costs, while enjoying the private and social benefits of the resource. This results in the depletion of the resource, but more commonly, the degradation, of the renewable resource: overgrazing, soil erosion, desertification, air and water pollution. Restoration of the range, soil conservation, air and water purification would result in increased welfare for the community. But because persons cannot be excluded from consumption and consumption is nonrival[87], private entrepreneurswill not produce these goods of what could be called

"environobusiness". There is market failure because participants cannot be excluded from enjoying the external benefits arising from solution of these external costs. Each assumes that the others will meet the costs and as a result nothing is done. Each assumes enjoyment of the benefits on the basis of the Free Rider Principle and as a result no one benefits.

If this rational bahaviour is widespread (not localized) the total ecosystem is endengered by more and more, overgrazing, soil erosion and pollusion. Since individuals and the private sector, are not likely to offer a solution, governments generate public policies and programmes to solve these problems and they do so by compulsorily forcing everyone (taxation) to bear the cost and by either implementing the environmental policy directly in the public sector, or indirectly, through the private sector by subsidization. These environmental public goods have something in common with common pool resources: they both involve the principles of externalities and non exclusion from consumption. However, common pool resources are natural; where as public goods are man-made. In the environmental field, public environmental goods arise as a solution to the misuse of common pool resources.

(c) Environmental 'merit (demerit) Goods

Society may want to encourage or discourage, the provision of specific goods, whether these are, or are not, social goods. Through taxation unsuccessful attempts are made to discourage smoking, alcohol and drugs; through subsidies, individual may be encouraged to fence their land,

to mechanize operations, and to engage in risky but socially worthwhile business ventures. The former are demerit goods; while the later are merit goods.
The environmental problems may also be defined in this way; So that through taxation overgrazing, soil erosition, air and water pollution are discouraged as demerit environmental goods; and aforestation, air and water purification, soil conservation, small herd sizes (cattle off-take) are encouraged by subsidization as merit environmental goods. If private citizens could claim 0.5 Rands for every tree they successfully planted, aforestation would be much faster than woodlot programmes undertaken by Agricultural bureaus.

V. ENVIRONMENTAL POLICIES AND PROGRAMMES FOR SEMI-ARID BOTSWANA

Public environmental policies and programmes may be systematically generated by identifying problem areas and by reducing such problem areas to specific factors which re-enforce (or reduce) the problem. Four environment problem areas are identified for Botswana to illustrate the logic. They are based on environmental conditions and the exisisting state of knowledge as described above (section I-IV) and they are selective and in no way purport to exhaust the entire range of problems. The first problem is inadequate and unrealiable rainfall combined with high rates of evepotranspiration resulting in droughts; the second problem is pressure of human and animal demands beyond the carrying capacity of the natural resources; the third problem is man's utilization of resources according to Hardin's "tragedy of the commons" as modified by Fife's "Killing the Goose" that lays the eggs; ;the fourth problem is ineffective and inefficient management responses to the degradation of the environment.

(a) Inadequate and unrealiable rainfall combined with high rates of evapotranspiration resulting in droughts

1. Weather, climate and droughts should be constantly monitored and contigency responses developed and implimented. The success of this will depend on technological advances and changes and on Botswana's ability to give them appropriate organizational setting. Work has already began in this field and the organizational problems which have, and are likely to be

encountered will be indecated in the last section(vi).

2. Farming systems that do not conserve moisture should be discouraged. The necessity for dry land farming research was long recognized and research projects started. Most of this research has taken place under controlled laboratory, or field, situations and there is a need for including sociological, economic, and cultural variable in the research designs. Dryland farming techniques under development are biased in favour of a minority of rich, large scale farmers.[88]

3. Increased soil exposure leading to increased run off, soil erosion, and range deterioration requires soil, range, and water conservation policies and programmes. Although current theories of diffusion of innoration emphasize persuasion in agricultural extension, when the issue concerns environmental protection, compulsory enforcement of soil, range, and water conservation practices may be justified. Much of the terracing that is found on East African mountains is a legacy of enforced colonial convervation measures. Moreover, measures such as aforestation and bush clearance may be encouraged by subsidies in which case the community as a whole is made to meet the cost of environmental protection.

4. Cropping and settling on marginal lands during wet climatic spells should be discouraged by clearly specified policy. Such policies would hopefully constrain the ministry of Agriculture's tendency towards expansionist and conquest approaches to

semi-arid lands. Cropping and herding should be related to the suitability of environmental conditions.

5. Policies should be generated for the proper distribution of rural ground water supplies. The water Act and Land Act should be so ammended that a single agency is responsible for both granting the rights to land water site and the water right itself. The users of the water should be made to pay for any desertification processes set in motion around the water site. Efficient utilization of ground water to compensate for defficient rainfall must be based on scientific understanding of ground water reserves and rates of ground water recharge. Expansion of rural water supplies should not be allowed to induce man and animals to move into marginal areas in numbers beyond the carrying capacity of such areas.

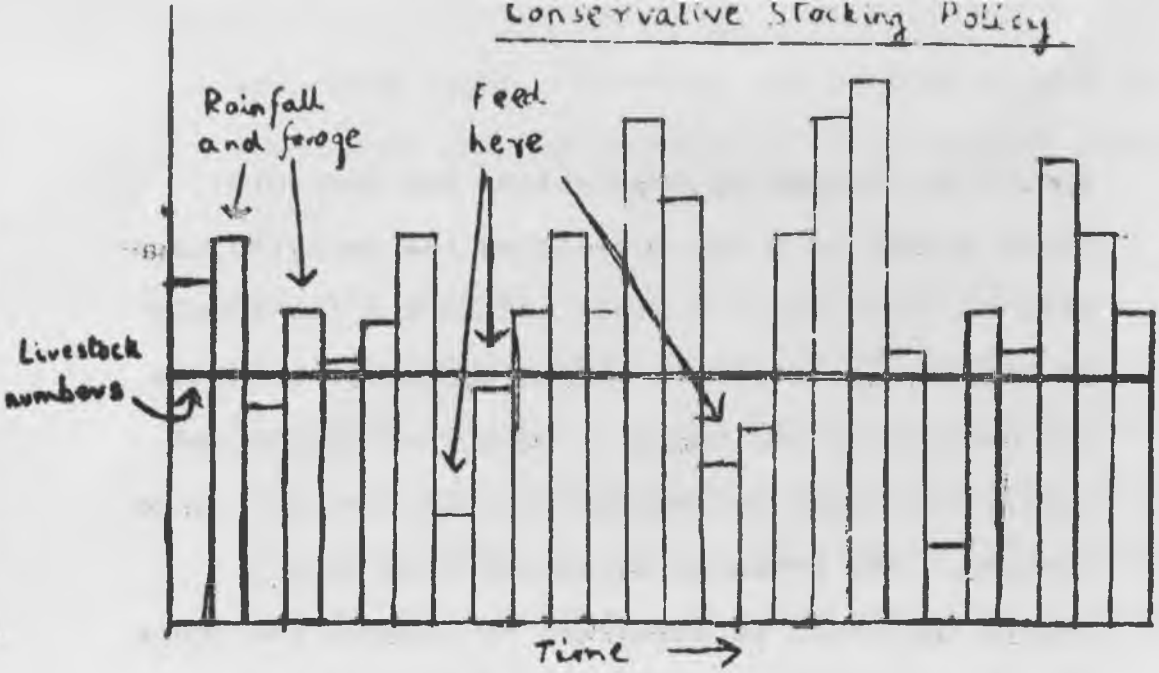
(b) Presure of Human and Animal demands beyond the carrying capacity of the natural resources-

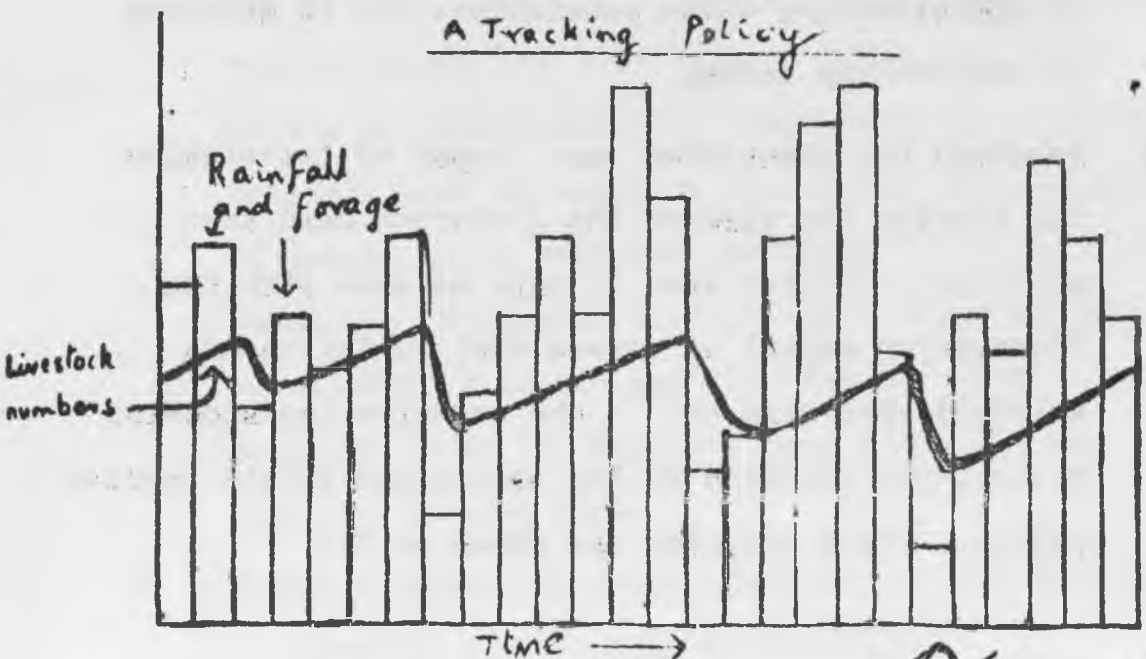
1. Expanded and improved health services result in high birth rates, low mortality rates, but poorly fed large populations (both human and animal). Nutritional serveillance of both persons and animals, and population growth control and regulation are essential policy measures for keeping carrying capacity in balance with natural resources.

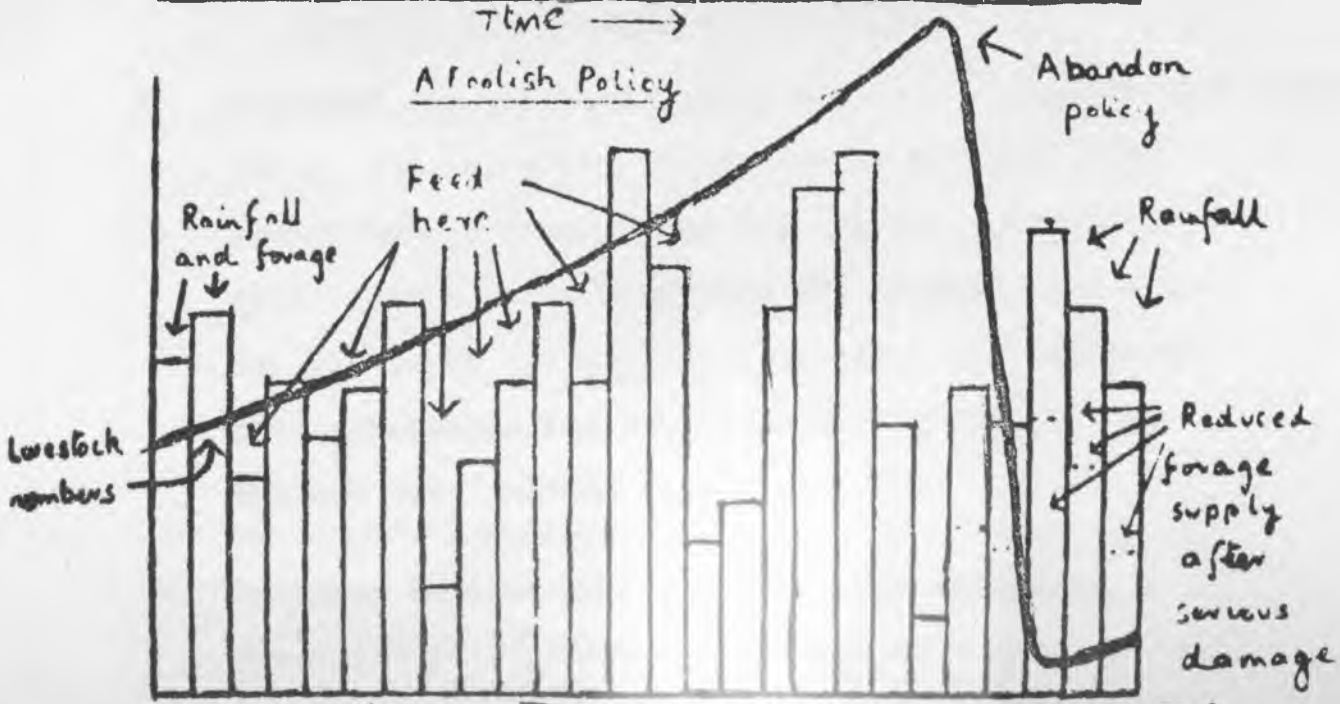
2. Cultural beliefs and altitudes that encourage accumulation of cattle for security, power, and prestige and result in increased herd size and low off-take of poorly maintained cattle

should be changed by regulations and controls. There should be a law specifying the carrying capacity of given grazing areas and such a law should be vigorously enforced. There should be a cattle tax payable on the basis of number of cattle and cattle tax rates increasing with increasing cattle numbers. The revenues collected from this cattle tax would be earmarked to finance the costs of administering these regulations and of measures to improve the range.

3. Sandford has identified two types of "strategies for keeping the size of the livestock herd that utilizes a grazing area in safe balance with the fluctuating amount of forage that variations in rainfall give rise to:[89] the conservative stocking policy, the tracking policy as opposed to the foolish policy. These policies are shown on Fig.







Source: Sandford Dealing with Drought 1:39

"The first is to follow a conservative stocking policy which keeps the number of livestock using the grazing area at a constant level and one well below the capacity of the environment to maintain in all except a very few years of poor rainfall. In those occassional years one can either use forage cut and conserved from previous good years to make up the deficit, or one can import modest amounts of feedstuff from outside. The other sensible policy is to allow the number of livestock to flactuate up and down with flactuations in the productivity of the environment. If it is to succeed without damaging the environment, this second (tracking) policy must be organized so that livestock numbers fall quickly (either by sales or by mortality) with declines in forage production, and so that they do not grow quicker after the end of a prologed drought than the vegetation itself recovers."90

"What is not a sensible policy is to let numbers grow unchecked in the good years and then to try to keep the excess stock on the range by feeding conserved or purchased feed in the bad years. This is a foolish policy both because it allows no opportunity for the range to recover under light grazing pressure after a drought and because, in the long run, such a policy is unviable. The growing herd will require all the forage for its current maintainance even in good years, so that no surplus will be available to conserve (as hay) over into bad years. The cost of purchasing enough food from outside will be come enormous, and consequently the policy will have to be abandoned, and in the subsequent crash the range productivity will be seriously damaged and the herd will virtually disappear."91

Increased effort is needed to move away from the current foolish policy to either of the two sensible policies. The tracking policy would demand a higher level of managerial ability than the conservative policy.

Sandford has identified three[92] stategies for managing livestock during a drought: do nothing policy, the keep policy, and the sell policy. To do nothing, or to keep cattle on the range, are both environmentally and economically wrong. The best strategy is the sell policy and is consistent with the conservative and tracking policies already discussed.

4. Policy and programmes are needed to solve the problem of inadequate marketing and processing systems that result in low off-take. Such programmes are an essential element in the conservative and the tracking policies identified above.

(c) Man's utilization of resources according to the logic of Hardin's"tragedy of the commons" and Fife's "Killing the Goose" that lays the eggs.

1. There are very high returns to investing by putting more cattle on the range (sandford above). The investor reaps the benefits of the range without bearing the costs of his contribution to the deterioration of the environment. Privatization of land rights should not be perceived as the sole solution to the problem. A policy of the development of the "communal lands" should be guided by a comprehensive model of social change of which land reform is only a necessary, but not sole solution.

2. In the long run only a small proportion of the population should be in the rural areas: the rural areas could be either run as state farms or as large capitalist enterprises (agro-business) This is a matter of political policy for the Batswana to decide. The current direction of policy is toward agriculture run on private capitalist lines. Thus current enclosure policies which produce landlessness are consistent with such a policy. High rates of migration into the urban areas are consistent with such a model of development. The urban areas have been growing at between 15% and 20% almost all of which is attributable to rural out-migration.[93] Those who are responsible for uprooting people from the rural areas

should meet the cost of creating suitable urban environment; by feeding the towns and contributing to industrialization through revenue surpluses generated by activities in the rural areas.

3. Enclosure and privatization of land may help to reduce beliefs that individual restraint will not be rewarding which result in increased herd ..size and low off-take. Through education in environmental problems and the dynamics of the ecosystem, both formal and informal, citezens may internalize norms and rules of conduct which encourage the adoption of principles of environment protection and conservation, such that volunterism replaces enforcement.

(d) <u>Ineffective and inefficient management responses to the degradation of the environment</u>.

1. Unlike private goods environmental public goods have not generated the politics of interest groups. Such concerns are being voiced by environmentally minded bureaucratic elites who tend to be mostly expatriate.

The Botswana society has a voluntary wing concerned with articulating environmental issues and only the Departmenta of Wild life evidances a bias towards environmental degradation operate gradually and imperceptably in the long run and members of a society tend to take their more dramatic effects (donga's in Lesotho) for granted or are myapic about them or are resigned about them. Thus leaders who control the political system may have no interest or awareness of environmental issues. When and if such issues are

translated into policy, they may not be implimented because they have little political backing.

2. Politicians who are in charge of the Public interest may also be participants in common pool resources and are likely to behave according to the logic of the tragedy of the commons. They are the ones who prossess large herds of cattle which denude the range. When it comes to articulating environmental problems they defend their self interest against the public interest. They advocate those policies which enrich them at the expense of the ecosystem and they pressurize those bureaucrats who are not engaged in the same game from implementing environmental policy and enforcing environmental conservation laws.

3. Conservation problems may be translated into policy (often they are not) but the machinery of implimentation may be poor.

4. Accumulation of problems into periodic environmental disasters (drought and famine) have the effect of triggering a flurry of decision-making and institution building which takes on the periodicity that generated them.

VI THE 'STRUCTURAL' ORGANIZATION (AGENCIES OR BUREAUS) OF ENVIRONMENTAL POLICIES AND PROGRAMMES.

There are three principles (patterns) of Public Service structural organization in Botswana: The functional (Ministries and Departments) the territorial (local government tier structure), and project organizational patterns. Successful management of environmental policies and programmes depends on being able to fit such policies in the conflicting interplay of these structural organization principles.

The options seems to be to activate and orient existing structures in the direction of environmentalism or to set up a Ministry of Environmental Management and Protection, or to set up an interministerial Unit concerned with environmental issues. It is the central thesis of this section that assigning environmental policies to existing functional Departments, or to an interministerial committee, does not work well.

(a) Assigning environmental policies and programmes to existing functional Departments.

It is precisely because existing functional departments are not carrying out their environmental obligations that environmental degradation has taken place. Soil conservation belongs to the Ministry of Agriculture where it enjoys lowest priority. The Ministry has defined its mission as increasing in comes of farm house holds by increasing yields and acrage of cash crops. This expansionist attitude may conflict with environmental protection. The Ministry of Agriculture has two divisions dealing with the livestock sector: the Animal Health Division and the Animal Production Division. The environmental protection measures of its Land

Utilization Division have not been able to cope (balance) with the cattle expansionist activities of the other two divisions.

Mining policy provide· for environmental protection as an objective.[94] In actual operation mining is expansionist. The water Act and the Land Act provide for environmental protection; but the Department of water Affairs and Land Boards ignore environmental considerations in implimenting water and land policies; they aim at farming the desert.

Functional departmentalization emphasizes specialization. Once a dominant direction has been set such as expanding yields and acrages, sinking as many boreholes as possible, mining maximum quantity of diamands, eliminating livestock diseases, it takes most of official attention and resources and environmental consideration, which tend to be in conflict with the dominant direction, are ignored. Specialization discourages attention to different aspects of a major departmental activity and leads to inflexible implimentation of programmes.

Moreover, since functional specialization leads to segmentation (fragementation) of government services, environmental concerns are correspondingly segmented. Thus environmental policies large enough to merit an autonomous agency are scattered across the gament of governmental bureaus which largely define their missions in non-environemntal conservation terms and where environmental aspects receive least attention.

This type of fragmentation also may lead to excessive duplication of effort. Notwithstanding defence of redundancy.[95] Land Utilization in the Ministry of Agriculture is involved in monitoring the range, So is Livestock Development Project (I & II) under the direction of the International Livestock Development Centre which is a technical aid agency external to the Botswana Public Service; so is the Department of Wildlife and so is the Botswana University College Research activities.[96] The Ministry of Agriculature is involved in land improvement policies (land use and rights); so is Local Government and Lands; so is the Department of Lands and Surveys; and so is the Attorney-General's Chambers. Since almost all the activities of government impinge on the environment, functional allocation of environmental policy and programmes to existing functional departments lead to excessive fragmentation and duplication.

The structural organization of environmental policies and programmes along functional lines leads to complications. Such complications are compounded by claims of territorial (divisions) organizations. Botswana is in a transition between the dominance of centralization to decentralization. During the stage of centralization the management problem is horizontal, across (or between) functional departments at the centre. During the era of decentralization fragmentation and duplication occur across (or between) territorial jurisdictions. Those are also horizontal. During the period of transition there is vertical confusion; it is not clear whether the focus of an activity is at the centre, or at the periphery.

Those who support decentralization advocate transfer of activities to local government units even if such units are ill equiped and even if the activity would be better done at the centre. Any Agency operating in Botswana must so behave as to keep on good terms with the centralizing and decentralizing forces, to be on good terms with the Ministry of Finance (centralizing) and the Ministry of Local Government and Lands (decentralizing), in the arena of Gaborone Capital (centralizing), and in the erena of the village (decentralizing).

Any failure to reconcile those forces will result in managerial complications. The vicissitutdes of the Bushman Training and Settlement Project[97] exemplify a most general managerial complication in its most intensified form. The Tribal grazing land Policy and the Policy for monitoring Drought have had to be greatly modified because of attempts to reconcile and balance centralizing and decentralizing conceners. This results in compromise policies that enjoy the support of alliance of dominant Social Forces. Environmental provisions plugged in by minority conservationist bureaucratic elements get trimmed out during these battles for bureaucratic balance. Thus enforced stock limits and stock movement which had been a central feature of the Tribal Grazing Land Policy have since been dropped and environmental aspects abandoned in favour of production.

A project is a time bound set of tasks that require the putting together (aggregation) of manpower, raw materials, technology that cut across the structure of functional specialist departments. More and more of government, services are being organized as projects.

Most of the environmental policies and programmes identified above will have to be organized as projects. Successful project management requires a st of circumstances not present in the Public Services.

The Project Director (Manager) is essentially a linking pin role for aggregating a multiplicity of resources located in diverse environments. The emphasis is not on building specialist'walls' 'but on a coordinated procurement of a variety of resources trhough an open door policy. Project management should respond with flexable innovative adaptability to a turbulent and uncertain environment, even if modern techniques of planning and scheduling may be used to control that turbulance. The project manager must have the power to make on the spot decisions about project activity and thus avoid costs of delay and lost opportunities.

When projects are administered within the framework of the existing functional Departments they are condemned to several pitfalls.

The'integrationist' nature of the project is not appreciated by administrators steeped in functional specialization. The reaction of other specialist departments to the project will be conditioned by their rivalry with the specialist department currently providing a home to the project. Moreover civil service norms and regulations will provide the atmosphere in which the project is administered. Responsiveness will be sacrificed tothe requirements of precedent, routine, protocol and due process.

Again the Bushmen Development Project provides a good illustration of a highly integrated set of tasks requiring project management being fragmented and each bit being assigned to defferent functional departments . It is show how difficult it may be to fit an integrated project (even on the basis of preponderance of similar tasks) into functionalist departments.

> "For our purposes of discussing recent policy of assisting San it is interesting to note that council, while specifying these special projects of assistance, incorporated them under general sectoral headings of their general Plan."99

Helping D'Kar mission school with boarding facilities fell under Education; boreholes fell under water development; actual settlement fell under land development; and helping D'Kar mission school with a small tannery fell under Local Judustry.[100]

(b) Interministerial Committee Organization for Environmental Policy and Programmes

Whenever it has been felt by government that a given policy requires interministerial co-ordination, standing interministerial committees have been organized. The Rural Development Unit (RDU) and the Presidential Commission on Localization are examples. In 1977 arising out Sandford recommendations, an Interministerial Working Party on Drought was formed. Ad hoc interministrial committees are formed to deal with temporary tasks which require the resources of different functional departments. A need for drafting a communal ranching Associations legislation prompted the formation of an ad hoc interministerial committee based in the Ministry of Agriculture.

> "The basic principle behind establishing the RDU was that the concern for rural development cuts across sectoral and Ministerial categories, and therefore because of this, no special executive agency or Ministry should be created to organize it. Coordination and linkages between ministries would however be vital, hence the setting up of this unit under the authority of the Vice President and Minister of Finance and Development Planning."101
>
> ".... The Rural Development Unit has no executive resposibilities. It achieves its results through persuasion advice, and influence. It is therefore not seen to be directly responsible for development in terms of projects and programmes. It only offers a service of advice, ideas and information"102.

The Botswana officials that I have talked to evaluate positively the working of these interministerial committees. But it is important to note special situational circumstance that have affected the performance of these committee. First there is a good personal relationship between the President and the Vice President so that the powers of both offices can be brought to bear on the working of interministerial committees chaired by the Vice-President. Similarly, the previous coordinator of the Rural Development Unit, Ministry of Finance and the Previous head of the Land Division in Ministry of Local Government and Lands, (both men extremely able civil servants have been promoted), were friends and this may have helped eliminate antagonistic competition that would be expected on the basis of structural principles.

Membership of interministerial committees, even of standing ones, is ad hoc. The Status of the official sent to represent a ministry depends on the Ministry's evaluation of the significance of the issues to its own priorities and the pressure of manpower demands within the Ministry, rather than on his expertise, or skill,with respect to the issue under discussion. Very often low level officials are sent and there is very rapid turnover of officials sent.

This leaves considerable control in the hands of the co - ordinator, I am inclined to think that environmental issue which are not the priority of existing ministries would not be adequately expressed and defended.

> "It would be unfair for me to pretend as if though the present arrangement is perfect. One of the greatest problems is to get different Ministires to think in terms of something wider than their own functional subjects. On the other had, rural develo-pent requires a tremendous amount of integration and joint actions. This demands a lot of co-operation from the executive Ministries and Departments. The major short coming of the present set-up is that because RDU has no executive powers, it has to depend on persuasion, advice and influence to be effective in its task"103.

(c) Establishing a Ministry of Environmental Management and Protection.

The implication of the statement of the Rural Development Unit is the need for it to have executive power. This amounts to settting up a Ministry of Rural Development. Current functional departments carry out Planning activities; and personnel Administration activities. But this is no ground for denying the Establishment of Ministries of Planning or Personnel Administration. Similarly, even if different functional departments may have projects of an environmental nature, this in no way eliminates the need for a functional Department, in the area of environmental management and Protection. Kenya and Britain have established such Departments; whereas environmental Degre-dation may be much more acute in Botswana than in these societies.

Once these structural problems of environmental management have been decided attention may be focused on the political economy[104] of environmental management in general and in particularly, the balance between marginal costs of providing environmental protection and the marginal benefits to be derived from such services, and how to guard, the guardians of the Environment.[105]

VII. CONCLUSION

There is emperical evidence that environmental degradation has taken place even though there are important gaps in the evidence i.e. amount of groundwater reserves and rates of recharge. These gaps may be filled by logical inference based on observed conditions both in the past and the present.

This environment degradation may be attributed to increased pressures of human and animal demands beyond the carrying capacity of resources.

A range of policies has been identified. Some of these belong to the portfolios of existing functional ministries which largely ignore them. It is suggested that A Ministry of Environmental Protection is essential for the implimentation of environmentally oriented policies and programmes in a context of rivalries between centralizing functional specialist Departments, decentralizing local government forces, and the requirements of project management.

FOOTNOTES

1. World Bank, World Economic and Social Indecators. Report No. 700/78/01. Washington January, 1978.

2. Field, David I., A Handbook of Basic Ecology for Range Management in Botswana. Gaborone: Ministry of Agriculture, 1978. P. 67

3. Field, Ibid. P. 19

4. On the basis of annual rainfall, it can be classified as desert; but on the basis of vegetation, it is not.

5. Pike, J.G. Rainfall and evaporation in Botswana. Gaborone: UNDP/FAO Technical Document 1, 1971. or Botswana Archives File Sm 132(2) and

6. Sandford, S. Dealing with Drought and Livestock in Botswana. London: Overseas Development Institute, 1977 Appendix B22-B24.

7. Examples are agricultural firm management surveys, Beef Cattle production research, carrying capacity research, and dryland farming innovations research.

8. Representing physical, and Social, Sciences and anthropology.

9. Pike, Rainfall and evaporation. in Botswana.

10. Campbell, A. and Graham Child," The impact of man on the Environment of Botswana," Botswana Notes and Records Vol. 3; 1971 pp. 91 - 110

11. Cooke, H.J. The Problem of Drought in Botswana; Gaborone? N.I.R. Working Paper Np. 17, 1978. and Cooke, H.J.; "Botswana's Present climate and the evidence for past change" Symposium on Drought in Botswana. Gaborone: Botswana Society, 1979 pp. 53 - 58 and Van Vegten, Some Aspects of

African Ecology with special Reference to Botswana. Gaborone: N.I.R.; working Paper No. 26, 1979.

12. Pike, Rainfall and evaporation in Botswana P. 10 emphasis mine.

13. Pike, Ibid. p. 24 emphasis mine.

14. Tyson, P.D. "Southern African Rainfall: Past, present and future" Symposium on Drought in Botswana. pp. 45 - 52.

15. Campbell and Child, Op. cit. p. 91

16. Pike, Op cit. P.5

17. Pike, Ibid

18. Pike, Ibid. p. 22

19. Pike, Ibid. p. 25

20. Pike Ibid.

21. Campbell and Child, op. cit. pp. 91 - 110.

22. Campbell and Child, Ibid. p. 95 Squire brackets Indecate my own inserted wor s.

23. Campbell and Child.Ibid.

24. Campbell and Child Ibid. pp. 95 - 96. emphasis mine.

25. Van Vegten's analysis provides a theory for Campbell and Childs descriptions of Flora and Fauna changes see section III (3) below.

26. Campbell and Child, op cit. p. 101 Emphasis is mine.

27. Campbell and Child, Ibid. p. 108.

28. Campbell and Child, Ibid.

29. Cooke, The Problem of drought in Botswana.

30. Van, Vegten, Some Aspects of African Ecology.

31. Cooke, op. cit. p. 10.

32. Cooke, Ibid. emphasis his

33. Cooke, Ibid. pp. 10 - 11 emphasis his.

34. Van Vegten, op cit.

35. Van Vegten, Ibid. p. 15

36. Van Vegten, Ibid.

37. Van Vegten, Ibid. P. 17 and charney, J.G., "The dynamics of Deserts and Drought in the Sehel" in Quart. J. Roy. Meteo. Society Vol 101, p. 193.

38. Botswana Government, National Policy on Tribal Grazing land. Government paper No. 2 of 1975.

39. Field, op cit. p. 66.

40. About 1000 ranches of about 64 sq. km. each are scheduled for distribution.

41. By sinking boreholds and thereby acquiring exclusive rights to water they are able to control the surrounding range.

42. Daily News: Gaborone. Monday December 31, 1979 No. 247. p. 2. Liz Wily has remarked that compensation is a misnomer for "the provision of basic services (health, education, roads, and water....et.c) which elsewhere in the country were considered basis rights, not privileges to be bargained for". See Liz Wily, official

Policy toward San (Bushman) Hunter - Gatherers in Modern Botswana: 1966 - 1978. Gaborone : N.I.R.; working paper No. 23, 1979 p. 148.

43. Liz Wily, Ibid. pp. 117 - 148.

44. Land in Botswana is legally classified as 71% Tribal land, 23% state land and 6% Freehold land. See Katorobo, J. "The Institutional Structure and Techniques of Rural Development in Botswana with particular reference to land tenure and land use patterns" Law and Rural Development Seminer, Kisunu, Kenya July 18 - 22, 1977 p. 3.

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46. Pike, Cooke, Tyson, Campbell and Child Grove, Van Vegten - already refered too.

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