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Looking Into The Past: Interpretations of vegetation change in Western Namibia based on matched photography.

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Abstract

This article describes the use of matched photography as a methodology for interpreting environmental change. It provides an overview of one aspect of the author's current research into property relations and options for land tenure reform within the communal areas of Western Namibia. Photographs from four sites raise questions about the history of vegetation change in communal settlements, communal rangeland, commercial farm land and ephemeral rivers in western Namibia.

Repeat photography provides high quality information about vegetation change within a limited area. It can be used in conjunction with other methods of vegetation sampling, analysis of rainfall records, satellite imagery, aerial photography, livestock records, historical accounts and anthropological research in order to construct a broader interpretation of environmental dynamics. This methodology has more general applications in Namibia today and can be used by both students and professionals in research and development programmes dealing with desertification, rangeland management and environmental education.

Interpretations of the matched photographs presented in this article indicate that vegetation changes have occurred but these cannot be solely attributed to human-induced processes of degradation, especially in the communal areas studied. This evidence suggests that assumptions about land degradation need to be carefully examined before they are incorporated into policies related to land reform, agrarian reform and natural resource use.

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Introduction

Environmental issues have become increasingly important in Namibian policy formation and development initiatives. Considerable emphasis is presently being placed on the goal of achieving sustainable development through policy reform which aims to reverse negative human impacts on renewable resources. This objective informs many government activities including economic planning, agricultural policy, land reform, tourism and population policy (National Agricultural Policy, 1995; Outline of a National Land Policy, May 1996). Policies are increasingly justified on the basis of their ability to link social and economic problems to environmental issues; the perceived need to reverse processes of land degradation and desertification has become a doctrine underpinning current development ideology. However, many uncertainties surround our knowledge of ecosystem functioning, especially in dynamic low-rainfall environments. Our limited understanding of ecological processes involving environmental change as a result of human impacts, should lend some caution to the impulse of planners to make policy on unsubstantiated assumptions about land degradation and desertification.

Our ability to understand the causes of land degradation is dependent on an historical record of how the physical environment has actually changed over climatic cycles and through the impact of growing population pressure, accelerated natural resource use and intensified livestock farming. Namibia has few long-term sources of environmental monitoring from which to draw in order to verify physical change in the environment. What is more, even where such data is available, the analysis of causal change is subject to debate: constructing ecological models, determining appropriate rangeland management practices and creating policies which address social and economic development are complex, inter-related and ongoing.

Land degradation in this semi-arid environment is commonly ascribed to inappropriate 'traditional' land tenure and land use systems coupled to population growth and sedentarization. These factors (among others) are said to result in unsustainable natural resource use leading to a depletion of grazing resources, soil erosion, bush encroachment and irreversible loss of productivity (Seely, *et al.*, 1995). This emphasis on policy reform regarding land tenure has serious implications if applied without regard to fundamental environmental and social differences which exist in Namibia's various communal areas. The Namibian Programme to Combat Desertification (NAPCOD) has recently produced a document stating that many instances of land degradation can be attributed to "the fact that rural communities do not have secure, exclusive tenure over natural resources (1996: iii). That land degradation is assumed to be taking place as a matter of fact and that land tenure reform is necessary to reverse this trend is highly probable in many communal areas, but both of these assumptions lack evidence in the communal areas of former Damaraland.

There is a danger in applying theory without evidential proof: previous consultancy surveys in Damaraland such as that carried out by Loxton, Hunting & Associates (1974) have assumed that severe deterioration of the veld was taking place as a result of mismanagement and called for the development of a land use plan based on a one-off 'snap-shot' survey. Their recommendations were based on prevailing commercial range management theory which took little account of the realities of either communal practice or firm evidence of environmental degradation. The Ministry of Lands, Resettlement and Rehabilitation is presently carrying out a similar exercise in Kunene Region with the aim of developing a land use plan based on more comprehensive social, economic and environmental research. However, it too lacks the historic dimension necessary to interpreting both the extent and causes of environmental change. Since there are no long-term ecological studies of the impact which both commercial and communal farming has had on the environment of former Damaraland, I found matched photography a particularly useful means of looking into the past.

The subject of this paper has arisen out of my research into communal livestock farming in former Damaraland. Its focus is necessarily confined to the vegetation types and the specific land-use history of one part of Western Namibia. The ultimate aim of my study is to provide an integrated analysis of communal farming within the Erongo and Southern Kunene Regions, especially in regard to property relations, land tenure and proposed communal land tenure reform. This preliminary report has two purposes: first, to describe and evaluate the methodology of using matched photos and secondly, to describe my observations of historical and current vegetation patterns at four sites, in the light of current presumptions about degradation that are influencing policy reform.

Methodology

Matched photography has been used in at least 450 studies world-wide, many of which were conducted in semi-arid environments. Well-known studies include "The changing mile" (Hastings & Turner, 1965) and "A legacy of change" (Bahre, 1991) from the Sonoran Desert in the USA; and from Africa, "Photographic documentation of vegetational changes in Africa over a third of a century" (Shantz & Turner, 1958) and Hoffman and Cowling's study (1990) of vegetation change in the Karoo. The methodology described in this article is derived from Rogers, *et al.*, (1984), Hoffman & Cowling (1990), Hoffman, *et al.*, (1995) and from M. Timm Hoffman (pers. comm.).

This methodology is available to anyone with a basic knowledge of cameras and a modicum of common sense. As a means of provoking relevant questions about environmental change in a specific location it is a powerful tool in providing high quality comparative information directly through an image without having to resort to statistical analysis and specialised expert knowledge. When comparing images from two separate time periods one is immediately aware of significant changes in the density of vegetation, species composition and often important information regarding species' morphology. Questions arising from a comparison of matched photos can then be related to histories of environmental variables such as rainfall, fire, wildlife and human impacts such as farming activities and resource use thus building a profile of likely causes of environmental change. Other more sophisticated methodologies of vegetation sampling and analysis should also be employed and fed back into the research process in order to revise and construct theories of ecological dynamics more generally. (see Sullivan, 1997)

The sites described in this article were chosen from my collection of 45 matched archival photos which illustrate the study area; the original images were found in the Namibian National Archives, in old copies of the SWA Farmer, SWA Annual and The Blue Books (*see* Union of South Africa). While these four matches are representative of the trends observed in the collection as a whole, overall site selection was necessarily arbitrary and limited. The time spans between matched photos are also variable making comparisons between sites that much more complex. Ideally, matched photographic studies should model the site sample criteria to specific long term research aims and vegetation sampling methods. Unfortunately for Namibian researchers, it is only recently that fixed point repeat photography has been built into long-term vegetation studies in Namibia (within the Department of Forestry) and the results of these will only become available in future decades.

Methods of Producing Matched Photographs

Locating the exact camera position from an archival photograph can be time consuming, but provided there are at least two identifiable landscape features such as rocks, hills, buildings or trees present, surprising site accuracy can be obtained through common sense triangulation. It is often useful to determine the time of day and season in which the archival photo was made in order to obtain a more accurate match, but this is not crucial. Once the exact position of the original photo station has been determined it should be permanently marked with a cairn of stones or metal stake and its co-ordinates recorded with a Global Positioning System although accurate co-ordinates can be derived from 1:50 000 topographic maps. A sturdy tripod is essential for establishing the exact camera position and recording the camera height. By determining the centre of the original photo it is possible to align the centre of the image in the camera view finder to correspond with the original; a zoom lens is useful in replicating the original frame.

Standardised data sheets should be drawn up to record date, time, position, grid reference, location maps, source and date of original photo, veld type and subject, soil types, geological features, landscape description and notes on major changes. A record of camera type, film type, focal length, f-stop, shutter speed and exact time helps when it comes to processing, documentation and storage of images. It is prudent to 'bracket' exposures by taking several frames of the same image while varying the lens aperture: film is cheap compared to the expense and time required to revisit sites in case of mistakes in film development. After photographs of the main image have been taken, the camera can be rotated first 30° and then 60° to the right and to the left, thus producing a panoramic record of the site.

Three cameras were used during this study in order to minimise the risk of spoiled film and to record images in black and white, colour transparencies and colour prints. The cameras used during this study comprised: a Pentax MX with a 28-80mm lens using FP4 Plus (ASA 125) black and white film (a medium format camera is preferable but not essential); an Olympus OM10 with a 35-70mm lens using Fujichrome slide film (ASA 100); and an Olympus 35mm automatic loaded with colour film.

The process of replicating an exact match is finally accomplished in the dark room during the process of enlargement by projecting the negative image of the match onto the archival photo until prominent features from both photos can be accurately aligned. The archival photo is then replaced by unexposed photo paper and a print made of the matched image. Mounting matched photos onto an A4 card facilitates a rapid comparison; standard 5x7 inch enlargements were used in this study although there is some advantage to using 8x10 inch photos for greater depth of detail.

Photo Site Survey Methodology

Photo site areas typically covered from 5 to 50 hectares. Where site exhibited more than one distinct land form, soil type, biotic or management influence (drainage channels, sandy river beds, river banks, rocky slopes, rocky pediments etc.), regions based on these distinctions were defined. These regions were then surveyed by walking into the field of the image, recording each species encountered and making a subjective judgement of percentage species cover by region. While the focus of this research was primarily on woody vegetation, dominant grasses and as many ephemeral species as possible were also recorded.

A second more detailed survey was then conducted using the matched photos. By numbering individual trees and shrubs in both images it is possible to compare the matches in detail by defining three classes of individual trees and shrubs: those present in both photos; recruits and those no longer present. Numbered individuals are then identified by species and notes on observed recruitment, age or senescence recorded.

A photograph records a relatively small pie-shaped slice of landscape and while the information it contains is of very high quality, it is necessarily limited in interpreting broader trends in the environment. What is seen adjacent to or outside of the photo image is sometimes at variance with changes observed inside the frame of the image. For instance, it might be observed that the mortality and recruitment of a particular species was markedly different in adjacent areas due to changes in alluvial drainage channels: this variation could be quantified by walking transects through the respective regions and recording height classes and senescence. Where a fence line is adjacent to a site, it might (if the management history is known) be used as a control to record differences in species cover, size, recruitment etc. By identifying individual trees or shrubs present in both images, it is also possible to gain insight into species morphology: it is a revelation to discover that a particular Boscia foetida hardly changed over an interval of 100 years; to identify an *Acacia reficiens* as a young recruit in 1930 and find it partially senescent in 1995, or to observe an area completely devoid of trees in 1876 now almost obscured by *Faidherbia albida* and *Acacia tortilis*, or to see the die-back exhibited by an *Acacia erioloba* and subsequent regrowth over a short climatic cycle of 35 years. Such clues as to species life history, coupled with climatic and land use history are crucial to understanding ecosystem dynamics.

On its own, matched photography provides important historical insights but a detailed analysis and interpretation of vegetation change is only as good as the information brought to bear from other sources such as controlled vegetation sampling, rainfall data, satellite imagery, traveller's records and histories of land use. As a non-specialist, combining historical evidence in this way enabled me to pose questions about environmental dynamics. My conclusions in this regard are at present tentative and the analysis of my field data is at a preliminary stage. This article is limited to describing the usefulness of matched photography as a research tool. I also hope that by putting some of this photographic evidence into the public domain I will encourage a reappraisal of the extent and causes of environmental degradation in this part of Namibia, with all the implications this has for development policy and land tenure reform.

Matched photographs from four sites

For the purposes of this article, four matched photographs have been selected from a total of 45 surveyed sites used in my study. These illustrate four major site categories and include: 1) open savanna transition rangeland; 2) communal settlements; 3) ephemeral rivers; 4) commercial farms (see Figure 1). I have been able to collect a number of archival photos for locations such as Sesfontein, Brandberg, Spitzkoppe, Karibib and Otjimbingwe. These clusters of images often span several decades and have been taken from different angles in varying habitats, making it possible to construct a detailed pattern of change over time and space. The matched photographs presented here were chosen on criterion of image clarity, accuracy of site matches and their general representativeness of changes observed in various site categories.

Spitzkoppe

The photo station in Figures 2a and 2b is located 12 km south-east of Gross Spitzkoppe in an area defined as Semi-desert and Savanna Transition by Giess (1971) and as part of the Nama Karoo Biome by Irish (1994). Rainfall is approximately 100mm per year with a coefficient of variation in excess of 60%.

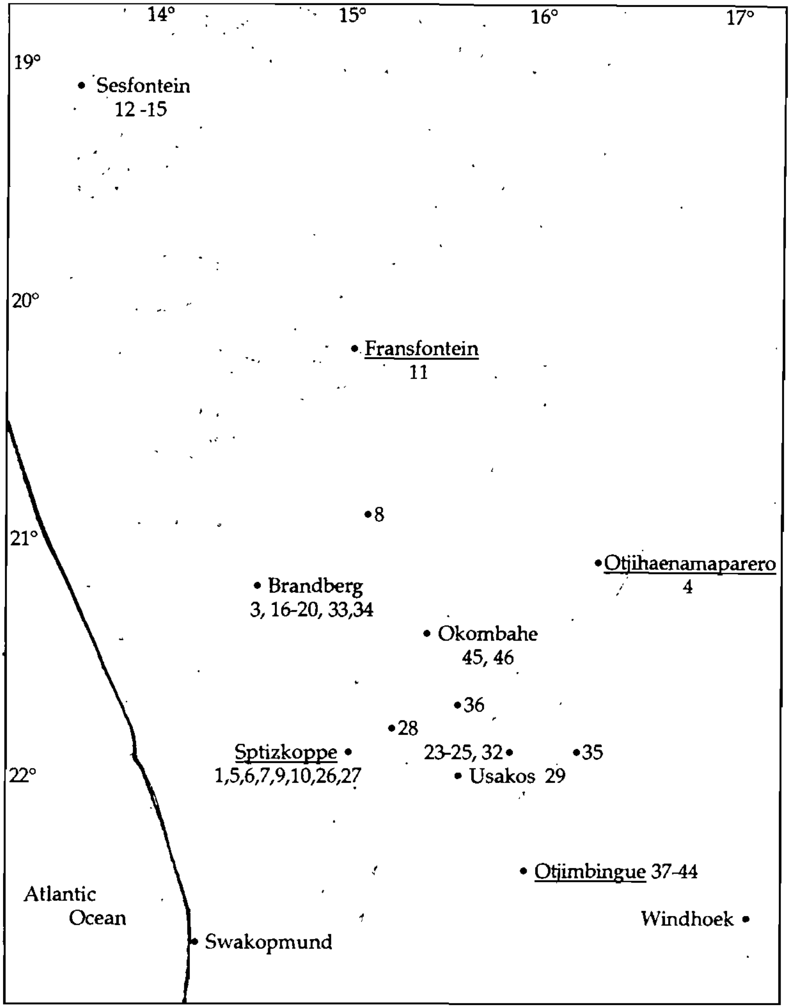

Figure 1: Map of western Namibia showing numbered photo sites of all available matches.

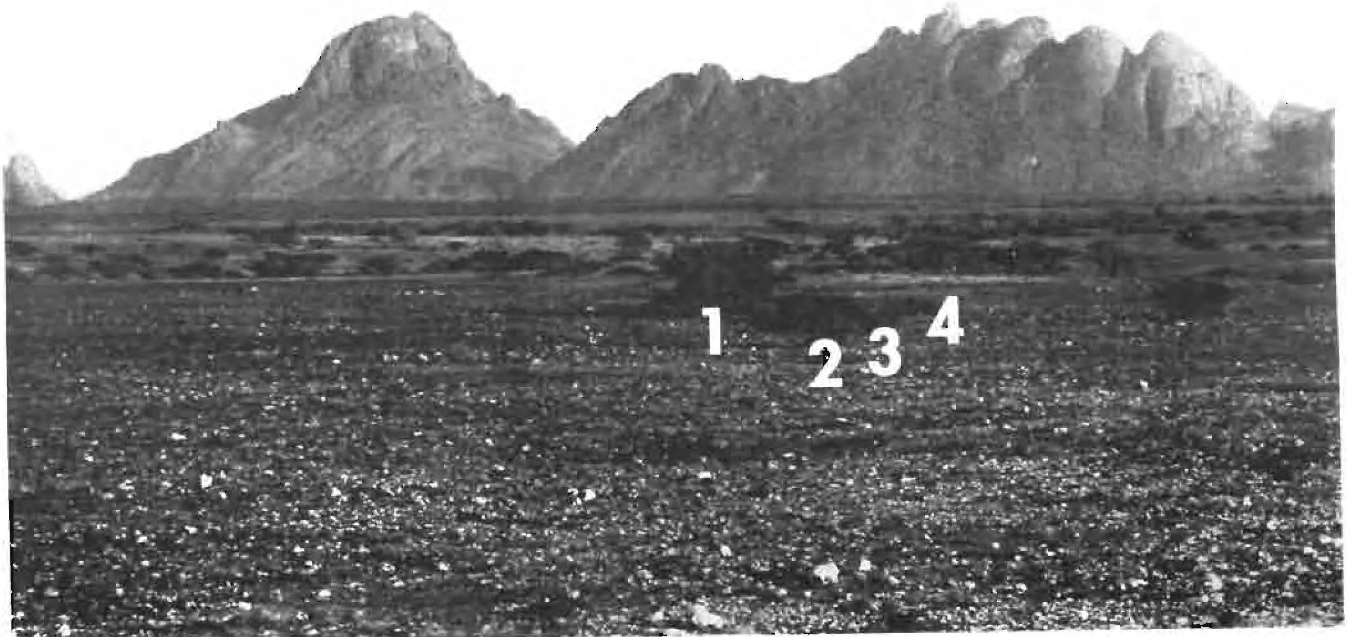

Figure 2a: Looking north-west to Spitzkoppe from Black Range, circa 1930. First published in Blue Book Report 1931. *Acacia reficiens, Boscia foetida*.

Figure 2b: Matched photo (camera position 2 meters higher than Figure 1a in order to obtain clear view). 15° 15' 40" E, 21° 53' 50" S. April 27, 1995; 7:00am. Foreground grasses are dominated by *Stipagrostis uniplumis* (25%), *S. ciliata* (4%), *S. hirtigluma* (3%), *Fingerhuthia africana* (3%), *Stipagrostis obtusa* (1%), other grasses (%) include: *Schmidtia kalihariensis*, *Eragrostis nindensis*, *E. trichophora*, *Aristida adscensionis*, *Triraphis purpurea* and *Enneapogon* sp.. Woody vegetation is primarily *Acacia reficiens* (7%), *Boscia foetida* (%), *Commiphora* sp. (%); other low woody shrubs and ephemerals (% or rare) include: *Maerua parvifolia*, *Monechma* sp., *Petalidium lanatum*, *Hirpicium gorterioides*, *Geigeria* sp., *Zygophyllum* sp., *Chamaesyce glanduligera*.

The two photos demonstrate a significant increase in woody vegetation during the last sixty-five years. Tree and shrub cover is dominated by *Acacia reficiens* ; other woody vegetation includes *Boscia foetida, Commiphora* sp. and *Maerua parvifolia. Acacia tortilis* and *A. erioloba* are both present in larger water courses outside of the frame of the image. The contrast in grass cover is indicative of the response of annual species to extremes of rainfall.

Four individuals from the first photo were positively identified. The largest *Acacia reficiens* (# 1) is now partially senescent and indicates an age of 80 years plus. Another *Acacia reficiens* (# 2) has been coppiced (probably by a communal farmer for use as house or kraal building material) and shows vigorous regrowth. The evenly distributed height-class structure of other *Acacia reficiens* suggests that new recruitment has been rapid and steady since the 1930s. The *Boscia foetida* (# 3) is now about double in size (1 metre high, 1.5 metres across). Individual # 4 is now a mature *Acacia reficiens.*

Presently, the area is communal farm land. Three stock posts to the north, east and south east are situated within 2 to 4 kilometres from the photo site. Prior to 1970, these stock posts were occupied by commercial farmers who settled here in 1940 when Black Range and surrounding farms were first surveyed (Namibian National Archives: LAN 1340).

The absence of grass cover in 1930 illustrates the stochastic nature of this environment which was drought stricken at the time: rainfall in Karibib, Okombahe and Otjimbingwe during the season of 1929-30 was 20 - 30% of long-term averages. During the drought of 1991-92 (rainfall 40% of average) the landscape around Spitzkoppe was similarly denuded of ephemeral grasses and it was commonly assumed by both nature conservators and agricultural advisors that this was a symptom of degradation occurring as a result of poor management and overgrazing. Three years later with a return to long-term rainfall averages, the veld condition exhibited a wide variety of palatable grass species. While there is no way of knowing how the response and species composition of grasses has changed, this at least illustrates that dry periods in the past resulted in denuded landscapes similar to those observed in the recent past.

Several factors could account for the dramatic increase of *Acacia reficiens.* Extrapolations of rainfall data from adjacent rainfall stations (Usakos, Karibib, Okombahe) provide evidence that a significant increase in long-term rainfall averages did occur in this area during the twentieth century. The average in Karibib for the 30 years prior to 1930 was about 160mm rising to 215mm between 1931 and 1949 and then to 240mm between 1950 and 1980: an increase of 50%. Since 1980 the rainfall average has fallen back to levels recorded during the first 30 years of this century.

It is likely that the sustained increase in rainfall during this century up to 1980 caused the shrub and tree species of the thorn bush savanna to increase in density up to 40 kilometres to the west - photographs of the Karibib area from around 1910 show a woody vegetation density which is similar to the plains surrounding Spitzkoppe today while thornbush density in Karibib has increased significantly during this century. In

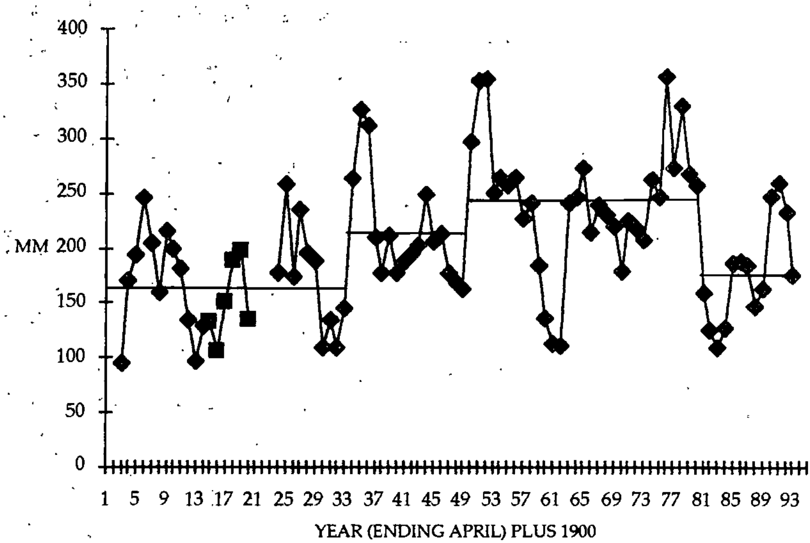

Figure 2: Karibib rainfall: 3 year running mean and periodic long term averages. The rainfall data for 1915 - 1920 are interpolated from Okombahe.

1874, Gerald McKiernan described Usakos as "the beginning of the grass country" on the edge of a treeless "desert tract" (1954: 37). Other photo sites in the vicinity of Spitskoppe, Usakos, Karibib and the Erongo mountains confirm that bush thickening has taken place, however there are also signs of recent extensive die-back of *Acacia* spp. especially in higher, topographically flat areas with few drainage channels, possibly indicating a reversal of the earlier westward recruitment trend. It could also be argued that the increase in *Acacia reficiens* is an indication of overgrazing and consequent bush encroachment occasioned by commercial and communal farmers. Whatever the cause, this increase can hardly be designated as dryland degradation resulting from bush encroachment in the case of Black Range: if anything, the increased shrub density on this western edge of the Savanna Biome indicates an increased production potential in the form of reserve grazing during dry periods when ephemerals are absent.

Fransfontein

The site is within the Mopane Savanna vegetation type (Giess, 1971) and falls within the 200-300mm isohyet band (average 276mm, CV = 36%).

Figure 4a: Namibian National Archives Photo No. 10770. "Fransfontein, P.O.W. lager for British soldiers" 1914-1915.

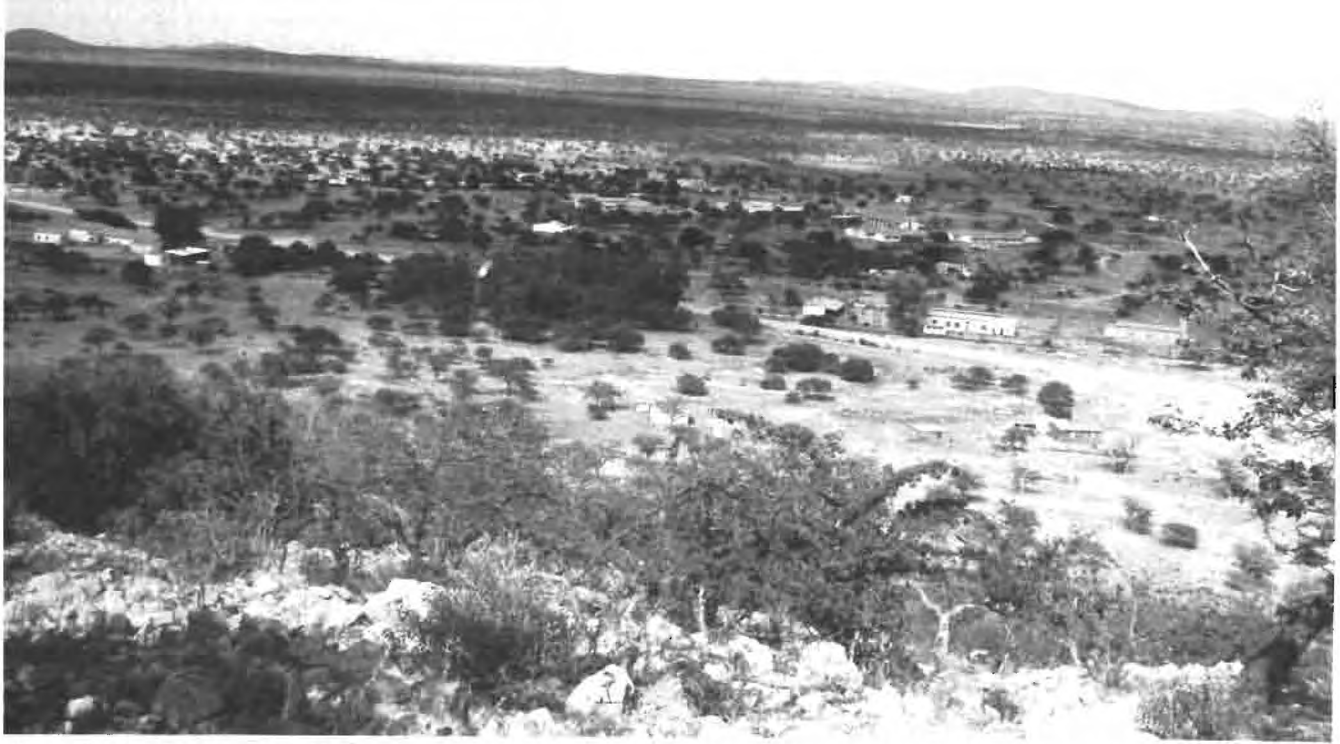

Figure 4b: Matched photo (position exact) taken from hill looking WSW over Fransfontein. 15° 01' 10" E, 21° 12' 25" S; May 2, 1995, 1:40 pm. Hillside: *Terminalia prunioides* (25%), *Colophospermum mopane* (12%), *Grewia tenax* (10%), *Combretum apiculatum* (5%), *Commiphora glaucescens* (1%). Hill-foot to road: *Acacia tortilis* (18%), *Colophospermum mopane* (14%), *Acacia reficiens* (3%), *A. nilotica* (3%). Spring area: *Ficus cordata* (25%), *Acacia tortilis* (15%), *Euclea psuedebenus* (2%). Area of lager: *Acacia tortilis* (12%). *Colophospermum mopane* (10%), *Boscia albitrunca* (1%). Settelment and plains: *Boscia albitrunca*, *B. foetida*, *Colophospermum mopane*, *Maerua* spp., *Acacia tortilis* (not surveyed in detail).

Due to the panoramic quality of the photograph and the complex nature of the site, the site survey was broken into several regions based on topographical features (hill side, hill foot, spring area, settlement area and plains) as well as areas where significant changes were observed ('lager' area and plains adjacent to settlement). The main findings concerning woody vegetation are summarised in Figure 4b. A detailed survey of individual trees between the base of the hill and the road shows a significant increase in spite of an expanding settlement. The total tree and thorn bush population has more than doubled. Approximately 30% of the original population has died and 65% of those alive today have been recruited during the last 80 years. Tree numbers and density have also increased considerably around the fontein where additional recruits of *Ficus cordata* and *Acacia tortilis* have occurred. The pattern of change is even more pronounced in the lager area where the original clump of trees have died and a completely new group of recruits are now growing behind the original position.

The area of mid ground in the photo (hill foot, and plain surrounding the spring including the area of the German lager) shows dynamic recruitment of *Acacia tortilis, A. nilotica, A reficiens* and *Colophospermum mopane*. Parts of the settlement are dominated by mature *C. mopane* but recruits occur in garden enclosures where they are protected from livestock during vulnerable early growth years. Species diversity within the settlement is low but increases dramatically within 500m of the centre becoming consistent with species variety in the larger landscape.

One of the earliest recorded observations of the Fransfontein area was made by Charles Anderson on his abortive trip to the Kunene in 1857. He described the country to the south and east of Fransfontein as "thorn jungles... the bush was in some places so dense that a man on foot could not force a passage through it without having recourse to a hatchet" (Andersson, 1861: 29). Closer to Fransfontein however "the county suddenly changed very much for the better. Both soil and vegetation were now different and our progress for some days was comparatively easy" (1861: 32). It is doubtful that Anderson visited Fransfontein itself, but his diaries portray an area disrupted and depopulated by recent intense raiding between Herero and Nama pastoralists. Andersson vividly describes veld fires which he witnessed during this journey, probably in the vicinity of Kamanjab:

> "...one of the finest illuminations I remember to have seen in Africa. The whole range facing us... exhibited one magnificent blaze of fire, kept vividly alive by a high wind. The flames crossed and chased one another like furies - here rising high above the inflamed substances, as if unsatisfied with their low prey and career - there rushing in snake like folds, as if writhing under some agonising torture - now smouldering for a moment as if gasping for breath, then shooting up into the heavens with redoubled vigour..." (1861:38)

Fransfontein was permanently settled in 1882 by a group of Swartbooi Namas and has been continuously occupied since that time (Vedder, 1966: 466). By the time the photo in Figure 4a was taken, the German colonial authorities had occupied Fransfontein as a military post for 20 years under the terms of a so-called 'protective treaty'. The anthropologist Winifred Hoernlé visited Fransfontein eight years later in February 1923, observing that: "the pasturage round here is very poor; the cattle have eaten off every green stick" (Hoernlé, 1987: 127). She reported a population of 150 people, 400 cattle and 1900 sheep and goats.

The status of Fransfontein as a labour reserve was formalised by the South African administration during the 1920s and it served in this capacity, a small communal enclave surrounded by white commercial farms, until the late 1960s when it was incorporated into the expanded communal area of Damaraland. Today, the village of Fransfontein retains some of its status as a ward centre with schools, a clinic, several shops, churches and a periodic livestock auction. Several hectares of spring-fed gardens which have been under cultivation since the turn of the century are still in use and approximately 1,000 people live within the boundaries of the old reserve (National Planning Commission, 1994). Twenty-one registered farmers live in or near the village keeping upwards of 100 cattle and 600 goats and within the old reserve 190 farmers own 2,500 cattle and over 9,000 goats and sheep (Agricultural Extension, 1994).

The dynamics of vegetation change can partially be attributed to differing species morphologies: the slower growing trees such as *Boscia albitrunca* and *Colophospermum mopane* (Mopane) account for a smaller proportion of recruits than the shorter-lived acacias. Mopane around the settlement is distinctly larger and more mature than they were 80 years ago, which begs the question - why were there not more mature mopane trees in evidence then? Is it due to a more even age structure in the population of mopane at the turn of the century, or does the photo from 1915 show a landscape of young to 'middle-aged' recruits? What effect did the practice of burning the veld have on the species composition, density and recruitment during the 19th century; can we read the results of the cessation of this practice during the colonial period into the present picture?

The matched photos would seem to contradict the stereotypical belief that communal farming and in particular, densely populated communal settlements, cause irreversible environmental degradation. One might have expected to find the matched photograph demonstrating this by showing large areas denuded of tree cover as a result of overutilization and over grazing. Less visible signs of land degradation such as decreased species diversity has undoubtedly occurred but to a surprisingly small extent considering the history of this dense settlement. Other indicators of degradation such as declines grass species diversity and density can only be inferred from controlled vegetation sampling.

Otjimbingwe

Otjimbingwe is within the area defined as Semi-desert and Savanna Transition by Giess (1971) and as part of the Nama Karoo Biome by Irish (1994), and classified in 1914 as rich grazing land comprising grassveld/shrub and grassveld/thorn tree (Schultze, 1914). The rainfall average is 165mm but this has varied from 140mm

Figure 5a: Namibian National Archives Photo No. 9423; "Otjimbingwe" [taken between 1904 and 1914] *Acacia tortilis, Faidherbia albida, Boscia albitrunca, Pechuel-Loeschea lubnitziae.*

Figure 4b: Matched photo (position exact) taken from koppe looking south over Otjimbingwe and Swakop River 16°07'20" E, 22°21'00" S; November 21, 1995, 8:20 AM. Foreground to river: *Acacia tortilis* (3%), *Pechuel-Loeschea lubnitziae* (1%), *Boscia albitrunca* (rare). River: *Prosopis* sp. (28%); *Pheonix reclinata* (18%), *Faidherbia albida*(15%), *Hyphaene petersiana* (7%), *Pechuel-Loeschea lubnitziae* (5%), *Tamarix usneoides* (1%), *Acacia erioloba* (%), *Eucalyptus* sp. (%), *Acacia tortilis* (rare), *Ziziphus mucronata* (rare).

during the German period, to 200mm between 1930 and 1980, falling to 110mm during the last 15 years. The coefficient of variation during these periods has fluctuated between 38 - 66% averaging 45%.

Four distinct regions of vegetation can be described in the matched photos:

1) the immediate foreground which now has fewer trees and shrubs (predominantly *Acacia tortilis* and *Pechuel-Loeschea leubnitziae*) with only one tree (*Boscia albitrunca)* present in both photos (# 1);

2) the flat open area around the church and buildings in 1910 is now colonised by mature *Acacia tortilis* and younger recruits;

3) the river which is now dense with *Prosopis* sp., Date palms (*Phoenix dactylifera*), Fan palms (*Hyphaene petersiana*) and Ana trees (*Faidherbia albida*);

4) the south bank and distant plains supported a matrix of shrubs (2m) and woody perennials (probably *Pechuel-Loeschea lubnitziae*) in 1910 which now appears to have been replaced larger trees and bushes (2m), with significantly fewer woody perennials.

Evidence from earlier photos going as far back as Palgrave's taken in 1876 (Namibian National Archives Photo nos.: 2655 & 2656) show that significant increases in woody vegetation have occurred on the surrounding plains, in the Swakop and Omusema Rivers and in the settlement itself. The sloping plains which flank the rivers show an increase in larger acacia species where low woody shrubs predominated in the past. One photo from 1950 indicates that tree cover on the plains to the south of the Swakop River has decreased slightly since that time possibly due to over-utilization attending settlement expansion during the past 45 years. Riverine vegetation has increased dramatically, due not only to the rapid spread of invasive alien species; photographic evidence shows a general transition from patches of *Tamarix usneoides* to thick stands of *Faidherbia albida, Acacia erioloba* and *A. tortilis* on the river banks. This trend is replicated upstream on the commercial farm of Uitdraai although the increase in riverine tree density here is less pronounced probably due to deeper ground water. The foreground of the matched photo (Figure 5b) is the only example which I have found out of eleven matched photos of Otjimbingwe between the dates of 1876 and 1920, which shows a definite decrease in tree cover within the settlement. This is undoubtedly taking place in other parts of the settlement as a result of building and development but does not in itself support claims of degradation in the wider landscape.

It is often difficult to analyse vegetation change from descriptive historical accounts but the following extracts illuminate two essential features of the Otjimbingwe environment: the Swakop River and the land's dynamic response to low and variable rainfall. In 1852 Francis Galton commented on the perennial surface water in the bed of the Swakop River at Otjimbingwe; a feature which accounts for the existence of Otjimbingwe as a settlement in both pre-colonial and colonial times. "Grass... is also in abundance, for the Swakop, at this place... runs through a wide plain, that shelves for miles down to its bed; and which, though covered in thorn bushes, affords a fair allowance of grass-bearing soil" (Galton, 1853:59). In November 1860, James Chapman noted that "at Otjimbingwe hardly any rain has fallen during the last two years, in consequence of which there is not a blade of grass to be seen, and the bare trees and bushes appear miserably scorched" (Chapman, 1886: 383). Five months later, he described his trek from Otjimbingwe to Gross Barmen as follows:

"The country was still as parched and bare as it was to the west. (Our cattle) could find neither grass nor water, in a country where we have seen grasses and herbs growing in the greatest exuberance when rains favoured the earth in the proper seasons, and where now cattle grubbed with their snouts in the dust for the roots of grasses that had long since been devoured or had crumbled." [But thirty miles from Otjimbingwe] '... the earth, which hitherto had been baked and barren, was here covered with a profusion of green grass, bright flowers and odiforous herbs. The acacias and mimosas, which before showed scanty, drooping, withered foliage... were here expanded by grateful showers to their full freshness and greatest vigour" (1886: 399).

Veld conditions were also recorded by Charles Anderson who lived here during the early 1860's: "Weather very hot. No signs of rain: Otjimbingwe looks like a desert" (February 18, 1860); "A terrific sand-storm passed over us, doing some damage to the store roof" (January 20, 1862). And after a month of rain and improving veld conditions: "A second crop of yellow flowers are appearing" (March 19, 1862) indicating the wide-spread occurrence of *Tribulus* sp., commonly referred to as an indicator of over-grazing (Andersson, 1989). He also describes the Swakop in flood near Gross Barmen:

"The storm did not last above half-an-hour; but this short time was sufficient to convert the whole country into one sheet of water. The noise, moreover, caused by the river and a number of minor mountain streams, as they rolled down their dark, muddy torrents in waves rising often as high as ten feet, was perfectly deafening. Gigantic trees recently uprooted, and others in a state of decay, were carried away with irresistible fury, and tossed about on the foaming billows like so many straws. (1856:100)

Baines' painting of "the Otjimbingwe Volunteer Artillery, 1864" depicts the banks and river bed as almost totally devoid of vegetation, and Palgràves' photos (1876) confirm this. During the second half of the 19th century Otjimbingwe was alternately a dust bowl and a lush prairie land, a settlement without shade situated in what would now undoubtedly be seen as an overgrazed and degraded environment. How, over the course of a century was it able to recover from this 'degraded' state? Was this state a 'natural' one in the first place, or was it man induced? Is it unreasonable to view this change as further confirmation of a general westward shift of the Nama-Karoo biome and subsequent colonisation by pioneer species of the Thornbush Savanna? In spite of increased ground water extraction and the construction of upstream dams, why has non-alien riverine vegetation increased to such an extent? Is there a direct correlation between the decrease in extreme episodic flooding and the dense tree colonisation of the river banks? If so, why did this process take place before the construction of the Swakoppoort Dam?

Otjimbingwe is one of the oldest continuously inhabited settlements in Namibia. It was the centre of mining, cattle trading and missionary activities during the mid to late nineteenth century. Since 1926 when the 'reserve' of Otjimbingwe was proclaimed, it has retained its present form, expanding occasionally through the incorporation of adjoining commercial farms, a communal enclave of about 100,000 hectares - a rural ghetto surrounded by comparatively affluent white farmers. Otjimbingwe has been an active settlement for almost 150 years: the photographic evidence would again seem to contradict the received wisdom that over-utilization occasioned by sedentarization and so-called 'open access' tenure regimes leads to pronounced, irreversible land degradation (Africare, 1994; Interconsult 1994; Ashley, 1994; Corbett & Daniels, 1996). Photos from other long-established communal settlements such as Fransfontein, Okombahe and Sesfontein also confound expectations of how vegetation has changed and this evidence demands that we re-examine our assumptions about human and livestock impacts on this semi-arid environment.

I am not suggesting that complacency should be the order of the day: Otjimbingwe faces tremendous social and economic problems. One of the most obvious environmental changes which has had an immediate impact on the ability of this communal population to sustain itself is the combination of damming, water extraction and low rainfall during the last 15 years leading to a severe depletion of surface water in Otjimbingwe. It is now almost impossible to farm the once productive gardens which lined the Swakop's banks. How has this affected the social-economy of the communal settlement? To what extent will the combined effects of increased poverty and population growth influence the long-term sustainability of finite rangeland resources? Perhaps some of these questions can be answered by studying more recent changes to rangeland vegetation through aerial photography, satellite images and detailed ground surveys comparing adjacent communal and commercial farmland. Further environmental and socio-economic research (see Fuller, 1993) might show that land degradation is a minor factor in the social and economic crisis facing the population of Otjimbingwe today.

Otjihaenamaparerö

The matched photographs from Figures 6a and 6b depict Thornbush Savanna (Giess, 1971) located approximately 65 kilometres north-east of Omaruru. Rainfall averages 375mm per year with a CV of 37% (nearest station: Kalkfeld 1940-1993).

The area has been privately owned and continuously farmed on a commercial basis during the twentieth century, primarily for cattle. The site provides a case study of the dynamics of vegetation response to various commercial management practices: land disturbance has varied from intensive cultivation and grazing to relatively undisturbed hill grazing. Unfortunately the detailed record of land management is not available to this analysis and although this site falls outside the focus of my study area, it is valuable here as an example of how photographic evidence can elucidate the processes of recolonisation of disturbed ground and also raises the question of 'bush encroachment' related to commercial cattle farming.

The photo from 1910 shows a landscape sparsely populated by regularly spaced low trees interspersed with more mature *Acacia erioloba*. There are now clear signs of bush thickening in all areas apart from the hill foreground which is largely unchanged. The large trees situated in the mid-ground, between the photo station and the house (# 1,2,3 & 4) are individuals or groups of *Acacia erioloba*. Most of these have survived into the present; new recruits of this species are rare.

Region C was probably cultivated most intensively judging by evidence of terracing and irrigation channels; *Acacia tortilis* is dominant with significantly lesser densities of *A. hebeclada* and *A. mellifera*. Region B was probably used for rainfed fodder crops such as Lucerne and possibly *Cenchrus cilliaris*. It is now equally dominated by older *Acacia tortilis* and *A. hebeclada*. These two cultivated areas contrast sharply with Region D which carries a high percentage of *Acacia mellifera* and significantly lower densities of *Acacia tortilis* and *A. hebeclada*; the area around the farm house is now dominated by *Prosopis* sp. There is a strong inverse correlation between disturbance and species diversity in all regions. Region E was not surveyed but the photographic evidence suggests that significant increases in shrub and tree density have occurred.

All regions show a similar percentage of vegetation cover (49-58%), but the species composition in the most heavily disturbed sites is skewed in favour of larger *Acacia* species. It would appear that *Acacia tortilis* is the first to colonise followed by *A. hebeclada* and then *A. mellifera*. Low deciduous shrubs such as *Catophractes alexandri* and *Monechma cleomiodes* have not colonised the cultivated areas, but are significant components of the grazed community in Region D.

The issue of bush encroachment in Namibia is usually discussed in relation to commercial ranching where production losses due to the replacement of perennial grasses by shrubs (such as *Acacia mellifera*) have reduced the carrying capacity of the land and hence its productive potential. It is claimed that 10 million hectares in the commercial farming area have been affected by bush infestation reducing output by 30% compared with 40-50 years ago (NAPCOD, 1996). The causes of bush thickening are ascribed to the complex interaction between grazing management, climate, vegetation dynamics, frequency of fire and the exclusion of browsing animals (Bester, 1993).

Although it is beyond the scope of this article to summarise the extensive research literature related to the process of bush encroachment, some studies in Ethiopian rangelands suggest that bush thickening constitutes a beneficial stage in a 60 to 100 year cycle of grazing induced vegetation change where pastoralists are forced to abandon over-grazed sites, providing an opportunity for these sites to recover through replenishment of soil fertility (Coppock, 1993). This process is possibly one of the defining characteristics of the Thornbush Savanna, making it fundamentally different from the Savanna Transition further to the west. Historical accounts suggest that this cyclic process was already in evidence during the 19th century in parts of the

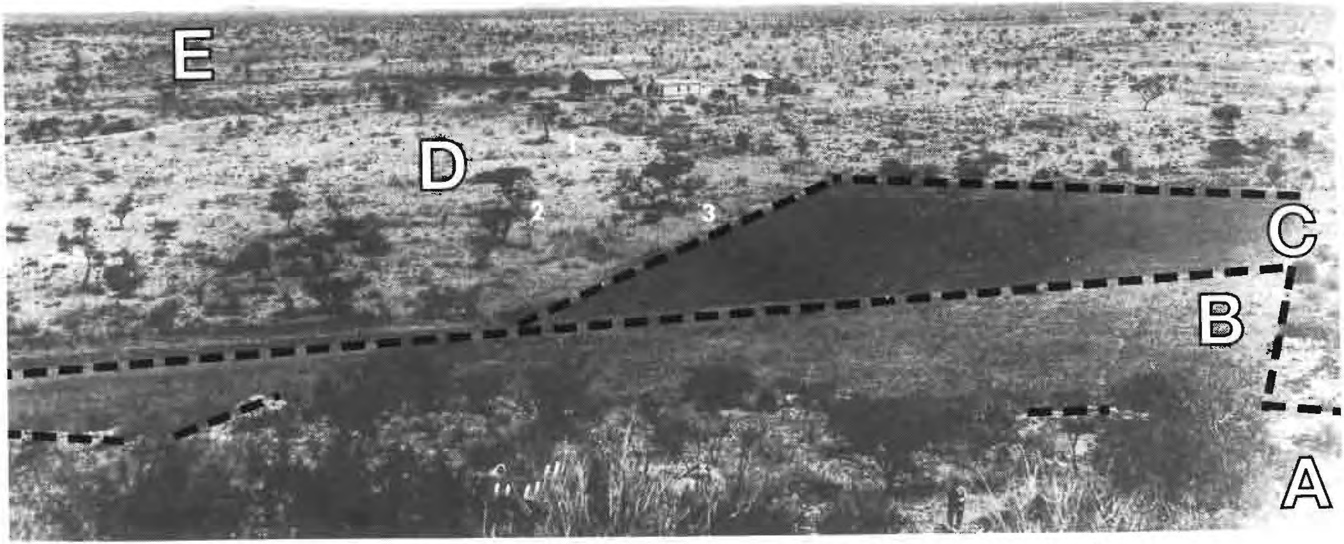

Figure 6a: Namibian National Archives Photo No. 1485. "Otjihaenamaparero Farm, Owned by Muhlenbruch, Omaruru District". Circa 1910.

Figure 6b: Matched photo (camera position 8 metres in front of original photo station) taken from hill looking NW over Otjihaenamaparero farm post. 16° 23' 25" E, 21° 02' 25" S. July 4, 1994 2:45 PM. Foreground (hill): *Dombeya rotundifolia* (8%), *Croton gratissimus* (7%), *Catophratctes alexandri* (7%), *Acacia mellifera* (6%), *Rhus marlothii* (5%), *Commiphora* sp. (3%), *Lycium/Phaeoptilum* sp. (2%). Mid-ground: *Acacia hebeclada*: (Region B = 20%, C = 12%, D = 6%); *Acacia tortilis*: (B = 20%, C = 18%, D = 5%); *A. mellifera*: (B = 3%, C= 12%, D = 20%); *Ziziphus mucronata*: (B = 4%, C = 1%, D = 1%); *Catophractes alexandri*: (C = 7%) *Acacia erioloba*: (C = rare, D = %); *Prosopis* sp.: (B,C = rare, D = 1%).

Omaruru and Otjiwarongo Regions as a result of the combined impact of pastoralists' livestock and large populations of wild ungulates. Historical accounts show that while the Thornbush Savanna has thickened considerably, parts of this area were even then so dense with *Acacia* as to make travelling a very arduous business.

In 1853 Andersson and Galton passed to the east of Mount Etjo on their journey north to Waterberg, remarking on the abundance of game and the presence of scattered pastoral Herero camps. From a vantage point 40 kilometres east of Otjihaenamaparero, Galton observed that to the north and west "the country appeared as one unbounded plain, only covered by brushwood" (1856: 150). "There seemed to be no grass whatever upon it ; but it was studded over with low bushes, while eastward the ground was covered with trees and grass" (Galton, 1853:149). Galton's map designates the area immediately around "Otjinna ma parero" as 'broken and rugged ground' and tinted yellow to denote 'desert or barren ground'.

Andersson, describing the river east of Omaruru in 1857 "found the country pretty well stocked with giraffes, zebras, gnus, koodoos &c., and had some very decent shooting" (1861: 72). He also mentions the presence of elephants. Gerald McKiernan travelled between Omaruru and Outjo in 1874 on a route 35 kilometres to the west of Otjihaenamaparero and described it as difficult to traverse because of dense thorn bush indicating that tree density was much thicker to the west of Otjihaenamaparero. He describes the Omaruru area as:

> "rough and in part mountainous, covered by a dense growth of mimosas, acacias and other thorn bearing trees and shrubs. The soil is stony and sandy but produces a crop of grasses in the rainy season equal to that of the prairies of America and furnishes pasturage for the numerous herds of the Damara (Herero)" (McKiernan, 1954: 43).

As with Andersson's and Galton's accounts, there is no way of knowing just how thick the bush was at that time nor how many cattle and wildlife browsed there. By the time that McKiernan described the area, its wildlife had been decimated and pastoralism was soon to give way to intensive cattle ranching which has remained the dominant land use during the present century.

The evidence of the Otjihaenamaparero matched photos confirm what is generally known about trends in vegetation change in the commercial cattle areas of Namibia. They also provide additional insights about recruitment patterns in heavily disturbed sites, but the full implications of this information will perhaps only be realised within a larger study where a variety of similar sites can be brought together within a comparative research methodology. It seems likely that long-term selective grazing pressure by cattle managed on a commercial basis is the main cause of the general thickening of the veld but other factors such as climate, soil types and the history of stocking management must be analysed in order to determine the dynamics of bush thickening at Otjihaenamaparero.

It is indicative of commercial ranching systems generally that stocking densities on this farm have remained stable during the last decade in spite of several years of below average rainfall. Rainfall records from Kalkfeld and Omaruru do not show such pronounced long-term fluctuations in rainfall averages as they do further to the west: in comparison to these lower rainfall areas where fluctuations in 30 to 50-year rainfall averages are as high as 50%, the rainfall variation in the region of Otjihaenamaparero during the same cycles is between 15 and 20%. Disentangling the effects of human and climatic impacts on the vegetation is here both more complex and more relevant than in the more stochastic ecosystems to the west. This fact raises the question of interpreting vegetation change through the use of ecological models which differentiate between stable and unstable systems.

Theoretical considerations

These four sets of matched photos are a small but representative sample which elicit relevant questions about environmental change. Change is accounted for by a combination of factors including climate, vegetation type and human impacts involving different management regimes and resource use. It is only by contextualising the photos within the historical evidence of these influences that we can begin to understand the causes of change. But ultimately, these too must be set within wider theoretical models of rangeland ecology. New paradigms of rangeland management are emerging as a result of a reappraisal of the relevance of concepts such as 'vegetation succession' and 'carrying capacity' in arid and semi-arid areas, in particular by focusing on the differences between so-called 'equilibrium' and 'non-equilibrium' environments (Behnke, Scoones & Kerven, 1993; Scoones, 1994).

The distinction between these two ideal types of environment are often blurred as one type graduates into another. Other models of vegetation change such as 'state and transition' (Westoby, *et al.*, 1989; Milton & Hoffman, 1994) or 'pulses of migration' (Dean, *et al.*, 1995) are variations which fit within this general paradigm. This is not the place to elaborate on ecological theory but the interpretation of the photos would not be complete without setting them within the context of such current debates and the implications these have on the concepts of rangeland management.

Hardin's 'tragedy of the commons' (Hardin, 1968) is not a model which sits easily with the evidence from Otjimbingwe, Spitzkoppe, Okombahe, Fransfontein and Sesfontein. These communal areas are often discussed as if they were 'open access regimes' lacking internal traditional controls or external bureaucratic regulation. All of the communal settlements illustrated by the matched photographs are typified by large fluctuations of both human and livestock populations due to cycles of drought. Sedentarisation in these western communal areas is perhaps more fluid and complex than is generally assumed. Commercial cattle farming on the other hand is typified by highly stable livestock populations. This has enormous implications in interpreting change across the gradations of non-equilibrium ecosystems illustrated in the matched photographs. There are also subtle but significant differences in the climate and vegetation communities of present day communal and commercial areas in Western Namibia: it is misleading to lump these areas together within a disequilibrium model. Clearer conceptual distinctions within this model which take account of differences in climate, the dynamics of particular vegetation communities and farming systems are needed in order to develop appropriate land management policies.

Recent policy rhetoric has tended to identify communal land tenure as a major cause of desertification (NAPCOD, 1996; National Agricultural Policy, 1995). There is little evidence to support this argument in the western semi-arid communal areas such as Otjimbingwe and former Damaraland. "Without security of tenure [in communal areas], the incentive and opportunity to manage renewable natural resources in a sustainable manner is significantly reduced" (NAPCOD, 1996: 17) reiterates a legitimate concern amongst rural planners but perhaps misses the point in the case of these western arid and semi-arid areas. Communal farmers in western Namibia already enjoy security of tenure; what is needed is a recognition and strengthening of an existing informal and flexible system of tenure and land management which shows few signs degrading this environment.

Conclusions

Matched photography is one of the most direct means available to a wide variety of Namibian researchers for verifying vegetation change over a long time scale. As a research methodology it is relevant to scientists, historians and development planners, all of whom must work together in the politics of creating a prosperous future for the people of Namibia. It is hoped that this brief article will inspire other researchers to look into the past through archival photographs.

In due course, the full set of surveys and images which have made up this present study will be lodged with the National Botanical Research Institute (Namibia) where hopefully they will be augmented by future studies to form a centralised and expanding data bank of Namibia's environmental history.

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