Table 1. Huntable bird species, actual numbers and population estimates as determined from 4 water points on Georg-Ferdinandshohe.

Species	Dam 1- ground	Est.	Dam 2- ground	Est.	Dam 3- water trough	Est.	Dam 4- water trough	Est.
Laughing Dove	57	1026	43	774	61	1098	39	702
Cape Turtle Dove	24	432	97	1746	31	558	13	234
Namaqua Dove	19	342	12	216	16	288	0	0
Namaqua Sandgrouse	86	1548	47	846	57	1026	0	0
Double-banded Sandgrouse	7	126	13	234	0	0	0	0
Burchell's Sandgrouse	5	90	0	0	4	72	0	0
Guinea Fowl	113	2034	184	3312	83	1494	61	1098
Red-billed Francolin	18	324	15	270	32	576	0	0
Rock Pigeon	15	270	3	54	6	108	0	0
Red-billed Teal	10	180	8	144	0	0	0	0
Egyptian Goose	10	180	4	72	0	0	0	0

It is evident from the above-mentioned results that most game bird species are associated with the ground dams on the farm Georg-Ferdinandshohe rather than reservoirs with cement troughs. This is probably due to the favoured and more diverse habitats located around such ground dams.

Before determining harvesting quotas for game birds it is suggested that similar baseline information regarding huntable species present as well as potential game bird numbers be determined.

References:
Thomson, R. 1986. On wildlife conservation. United Publishers International, USA. 243pp.

Contact details:
Khosie Shilongo: Ministry of Environment & Tourism, Okaukuejo, PO Box 6, Outjo, khosie-enkali@scientist.com

8. Tree Distribution, Vegetative and Regenerative Growth of Seedlings at Two Selected Sites in the Kuiseb River.

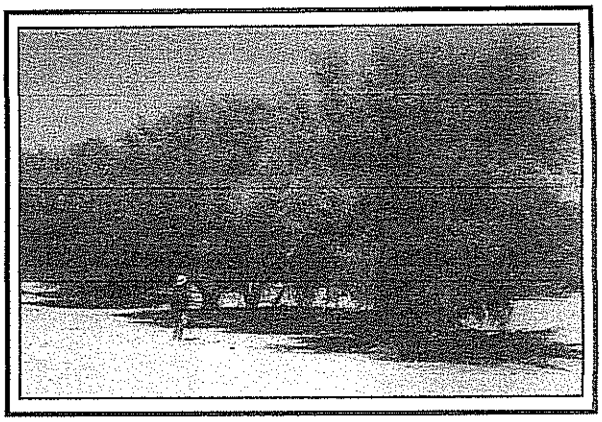
By Martin Kasoana (Polytechnic of Namibia)

Introduction

There are 12 major westward flowing ephemeral rivers crossing the Namib Desert with one of the largest rivers being the Kuiseb River. The Kuiseb River has a catchment area of approximately 14 700km^2 extending from the Khomas Hochland across the Namib to the Atlantic Ocean. The riparian oasis supported by the Kuiseb River divides the gravel plains and the Namib sand sea. This confluence of three ecosystems supports an amazing abundance of life, including many endemic species of fauna and flora (e.g. *Welwitschia mirabilis* and *Acanthosicyos horridus*). There are also significant trees species like *Faidherbia albida*, *Acacia erioloba*, *Ficus sycomorus*, *Salvadora persica* and *Euclea pseudebenus* (Jacobson et al. 1995).

The Gobabeb Training and Research Centre lies at the point where these three key ecosystems i.e. the dune sea, the Kuiseb River and the gravel plains of the Namib converge (Huntley 1985). The Centre lies approximately where the winter and summer rainfall areas merge. Furthermore, the site is on the boundary between the western fogbelt and the inland rainfall areas (Lancaster 1989). Much research has been conducted in terms of its ecology and significance for the Topnaar community living alongside the Kuiseb River. This includes the effect of dams in the Kuiseb (SDP 2000), fog harvesting (Henschel et al. 1998), !Nara resource management and on-going research projects on tenebrionid beetles, etc.

The Kuiseb River is a very important ephemeral river as its groundwater source is used by commercial farmers in the upper catchment areas and by communal farmers (Topnaar communities) along the lower river. Wildlife within the Namib Naukluft Park depends on surface water and Walvisbay and Swakopmund municipality obtain water from the Kuiseb River. Because of this reliance it is vital to have an overview of its vegetation. Trees are good indicators of change; therefore a change in their status may indicate fluctuations in underground water levels or climatic change if researched over a long period. Vegetation in the Kuiseb River might possibly be affected negatively by water abstraction (Kramer& Turner 1980). To date there is little detailed information available on the importance of vegetative regrowth, tree distribution and composition on a local scale.



A stand of Faiderbia albida in the Kuiseb River - M. Kasoana

This study investigated some of the topics mentioned above while focusing on *Faidherbia albida* and *Acacia erioloba* due to their importance to the Topnaar community mainly as fodder for their livestock.

Hypothesis

- Tree species distribution, composition, regeneration, and vegetative regrowth will vary according to groundwater levels.

Study site

Two sites were pre-selected by the Gobabeb Training and Research Centre as part of their long-term ecological research programme. One study site is located at Swartbank 45km downstream from Gobabeb and 38km from the coast. At this study site the water table fluctuates from 10-17m due to heavy extraction of underground water for industrial use in Walvisbay and Swakopmund. This fluctuation resulted in the selection of this study site as a place to monitor the effect of water extraction on the vegetation. At this site, 16ha were laid across the river but only 4ha were surveyed as part of a larger survey in future. The second study site was located at Gobabeb (56km from the coast) where 3.5ha were resurveyed as part of a larger survey for the future. The water table varies only gradually around a depth of between 4-6 m. Due to a relatively constant water level at this site, Gobabeb was selected as a study site to compare vegetation with Swartbank where water fluctuates widely.

Objectives

- Determine the composition, structure and distribution of tree species with emphasis on *Acacia erioloba* and *Faidherbia albida* in relation to the water table at two sites.
- Examine vegetative regrowth and seedlings present in relation to the water table at two sites.

Results

Species composition

Table 1 presents the species composition at Gobabeb and Swartbank. At both sites *Acacia erioloba* dominates. There was a highly significant difference in tree species composition between Gobabeb (N=270) and Swartbank (N=221) (Chi-square = 357.55,df = 6, $p < 0.001$)

Table 1. Species composition as determined at Gobabeb and Swartbank.

Tree species	Gobabeb	Swartbank
Acacia erioloba	67%	83.70%
Acathosicyos horridus	0%	4.50%
Euclea pseudebenus	4.10%	0%
Faidherbia albida	23%	4.50%
Nicotiana glauca	0.40%	7%
Salvadora persica	3.30%	0.50%
Tamarisx usneoides	2.20%	0%
Total trees	100%	100%

Stem Circumference Class Structure (SCCS) of *Faidherbia albida* at Swartbank and Gobabeb

Figure 1 & 2 present the stem circumference of *Faidherbia albida* at Swartbank and Gobabeb. The first stem circumference class (0-50 cm) at Swartbank has the highest percentage of individuals. There is two SCCSs missing (201-250 and 501-500cm). At Gobabeb the first four SCCSs have the highest percentage of individuals. One class structure is missing (551-600cm) at Gobabeb. There was a highly significant difference in overall stem circumference structure between Swartbank (N=33) and Gobabeb (N=62) (Chi-square = 143.3040, df = 12, p < 0.001)

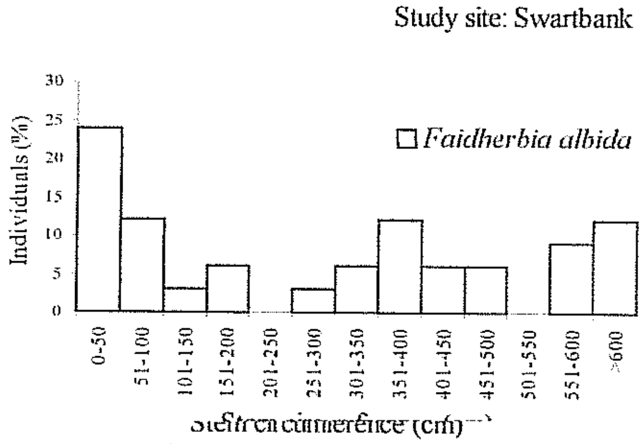


Figure 1. The SCCS of *Faidherbia albida* at Swartbank (N=33).

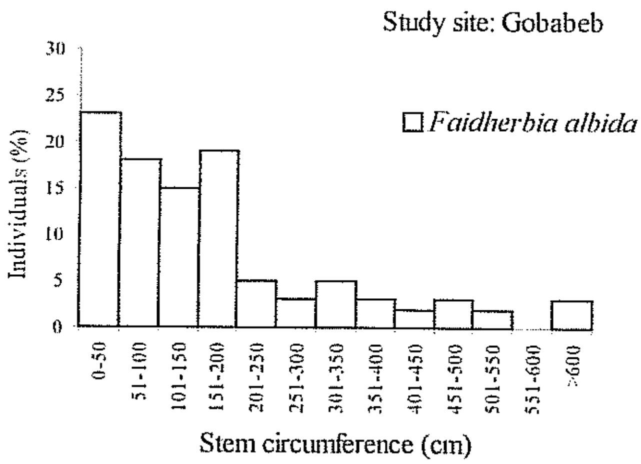


Figure 2. The SCCS of Faidherbia albida at Gobabeb (N=62)

SCCS of *Acacia erioloba* at Gobabeb and Swartbank

At Swartbank *Acacia erioloba* stem circumference is higher in the first four stem circumference classes (Figure 3). From SCCS 401-450, 451-500, 501-550 and >600cm no *Acacia erioloba* was recorded at Swartbank. There was a high significant difference in study species stem circumference of *Acacia erioloba* at Swartbank (N=185) and Gobabeb (N=181) (Chi-square = 24.77387, df = 12, p < 0.016).

Study site: Gobabeb

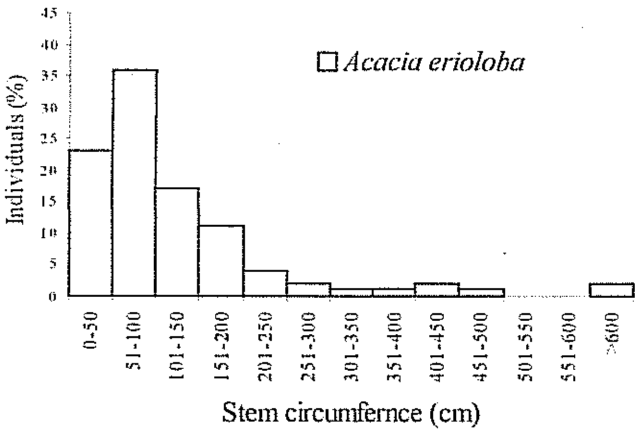


Figure 3. SCCS of *Acacia erioloba* at Gobabeb (N=181)

Study site: Swartbank

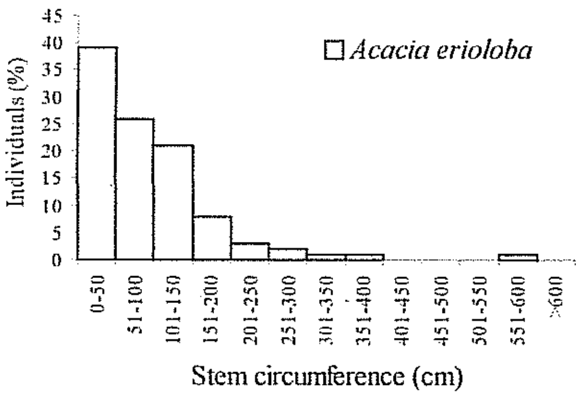


Figure 4. SCCS of *Acacia erioloba* at Swartbank (N=185)

Vitality scores

Figure 5 presents the vitality of *Faidherbia albida* at Swartbank and Gobabeb, respectively. Trees at Swartbank were scored predominantly in ranks 0,2,3&4 while trees at Gobabeb scored mostly from 4-5. *Faidherbia albida* shows highly significant variation between the two sites Gobabeb (N=62) and Swartbank (N=33) (Chi-square = 55.90857, df = 5, $p < 0.001$).

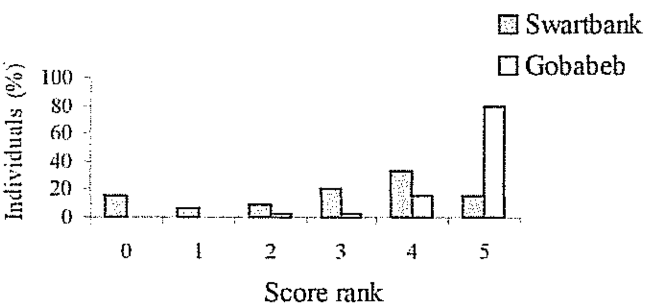


Figure 5. Score rank of individuals *Faidherbia albida* at Swartbank & Gobabeb

Figure 6 presents *Acacia erioloba* score rank at Swartbank and Gobabeb. Most study trees scored 0,3&4 while at Gobabeb it was 1&5. The overall group of *Acacia erioloba* had highly significant difference in terms of their health status between Gobabeb study species (N=181) and Swartbank study *species* (N=185) (Chi-square = 24.99233, df = 5, p < 0.001).

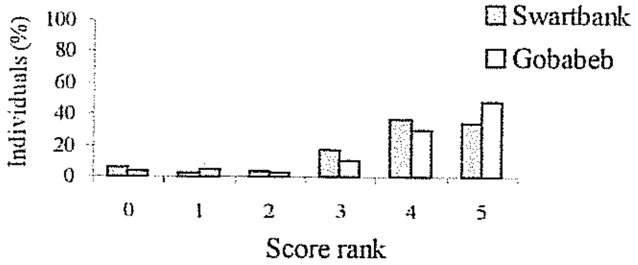


Figure 6. Score rank of individual *Acacia erioloba* at Swartbank & Gobabeb

Height class of *Faidherbia albida*

Figure 7 presents the height class of *Faidherbia albida*. There is a clear difference of *Faidherbia albida* in height class 6-10.9 m at Swartbank and in height class0-5.9, 11-15.9 at Gobabeb. Only at Gobabeb study species were recorded in height class 16-20.9m. *Faidherbia albida* trees shows highly significant difference at Gobabeb (N=62) and Swartbank (N=33)(Chi-square=23.32797,df=3,p<0.001).

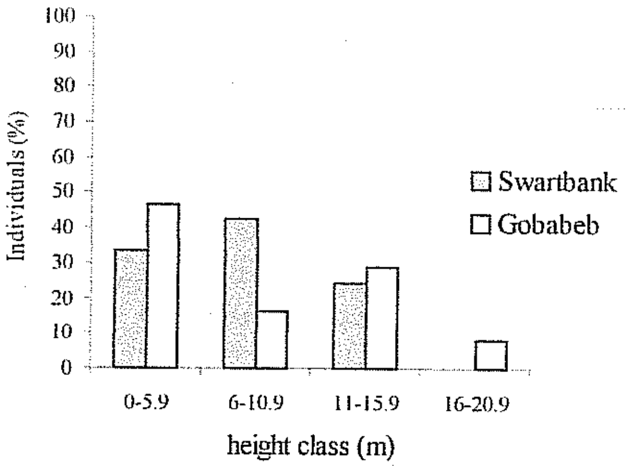


Figure 7. Height classes of Faidherbia albida at Swartbank & Gobabeb.

Height class of *Acacia erioloba*

Height classes of *Acacia erioloba* at Swartbank and Gobabeb are presented in Figure 8. Swartbank has a higher proportion in tree height class 0-50cm, while Gobabeb was recorded higher in height class 6-10.9m. Only few trees at Gobabeb were recorded in height class 11-15.9m, with no trees recorded in height class 16-20.9m. There was a highly significant difference in total height classes of *Acacia erioloba* at Gobabeb (N=181) and Swartbank (N=185) (Chi-square = 454.5421, df = 2, p <0.001)

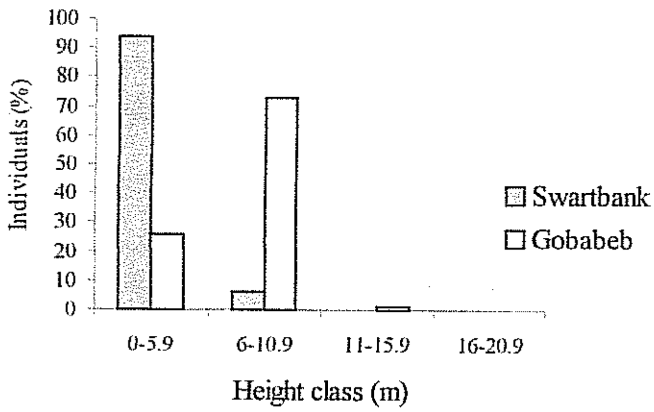


Figure 8. Height classes of *Acacia erioloba* at Swartbank & Gobabeb

Vegetative regrowth and regeneration at Gobabeb & Swartbank
Figures in parenthesis as indicated below represent the total number of trees measured in designated hectares at the two sites.

Table 2. Seedling presence and vegetative regrowth at Gobabeb & Swartbank.

Study sites	Tree species	Vegetative regrowth	Seedling
Gobabeb	*Faidherbia albida*	0	7 (10)
	Acacia erioloba	0	32 (185)
Swartbank	*Faidherbia albida*	5	5 (62)
	Acacia erioloba	0	0 (181)

Discussion

Species composition and their distribution pattern in relation to the water table
Species composition shows that *Acacia erioloba* was the most dominant tree species at Swartbank and Gobabeb. *Acacia erioloba* occurred in dense stands on both sides of the riverbank but rarely in the main flood channels unlike *Faidherbia albida* that was mainly at the edge of the river channel. At Swartbank a similar trend in habitat preference was observed with *Faidherbia albida*. In the main flood channel *Faidherbia albida* occurs as solitary individuals, well spaced along the linear riverbed which can reduce the competition among trees for water and nutrients. The highest numbers of *Faidherbia albida* occurred at Gobabeb at the edge of the main channel. Larger trees of *Faidherbia albida* were observed more commonly upriver towards Sarib compared to downriver towards Swartbank. The river at Swartbank is broad, reducing the impact of flooding on trees, and wider distribution of Faidherbia *albida* (*pers.obs*).

At Swartbank *Faidherbia albida* was found centered around the river channel since it requires more water. *Acacia erioloba*, according to Theron *et al.* (1979) is not only restricted to the floodplains but also occurs on the dunes on either side of the river at Swartbank. The species stands out as solitary individuals with very low vitality. Some limiting factors can be attributed to the lowering of the water table of the Swartbank aquifer for urban use at Walvisbay and Swakopmund. Natural phenomena like heavy floods followed by low flood periods or dry spells also cause the growth of the study species to vary.

Stem circumference class structure for *Acacia erioloba*
At Swartbank the percentage of *Acacia erioloba* was highest in first four SCCS and declined drastically beyond that. This indicates there is no constant continuity in tree recruitment. Gobabeb has few trees with the stem circumference of 0-50cm. Most of these gradually reach the adult stage compared to Swartbank which

had no trees >600cm stem circumference. There was a gap recorded in *Acacia erioloba* stem circumferences in two groups 501-550cm & 551-600cm, but trees with a stem circumference of >600cm at Gobabeb study site were recorded. This absence of *Acacia erioloba* stem circumference structure at Gobabeb (Figure 3) could be a result of old and clustered trees of medium size being uprooted due to the strong floods. It may also indicate periodic recruitment.

At Swartbank, *Acacia erioloba* trees are well spaced and the river is broad, reducing the height of floods. The gap in stem circumference between 400-550cm (Figure 4) could be ascribed to the secondary force, the continued abstraction of underground water table for urban use. Therefore floods do not seem to play such an important role in terms of uprooting trees at Swartbank than it does at Gobabeb.

Stem Circumference class structure for *Faidherbia albida*

At Gobabeb the negative decline in stem circumference can primarily be attributed to low rainfall and the preceding drought rather than the secondary factor of water abstraction. There was a clear difference between *Faidherbia albida* at Swartbank and Gobabeb. The percentages of *Faidherbia albida* are high in the first four SCCSs at Gobabeb study site (Figure 2). The decrease in the number of individuals of *Faidherbia albida* and gaps in stem circumference structure at both study sites could be due to the effects of the preceding dry periods. The stem circumference structure at Swartbank is very variable compared to Gobabeb with a well represented SCCS >600 cm.

Vitality (condition) of *Faidherbia albida* and *Acacia erioloba*

Trees at Gobabeb are in better condition than at Swartbank. Figure 5 indicates the vitality comparison of *Faidherbia albida* at the two sites. The highest percentages of trees at Swartbank were scored "4". These were mostly trees with the stem circumference >600cm. The vitality of trees of 0 (mortalities) was recorded on *Faidherbia albida* seedlings due to dehydration at Swartbank. This was supported by Jacobson *et al.* (1995) who observed the die off of the *Faidherbia albida* forest in the lower Kuiseb River from Swartbank to Rooibank. No individuals were scored lower than 2 at the Gobabeb site, while at Swartbank the increase in low scores can be ascribed to both primary (natural death in old trees and the dry spells) and secondary factors (the abstraction of the underground water table). The force of the 2000 flood could have contributed to mortalities of *Acacia erioloba* at Gobabeb, as high velocities of water can uproot clustered trees. Most dead trees observed were either lying horizontally or standing in clusters. The poor vitality of *Faidherbia albida* at Gobabeb could be primarily due to a natural change where trees become old or compete with their nearest neighbouring trees for sunlight and water.

Height class

The success of higher percentages in the first two height classes of *Faidherbia albida* and *Acacia erioloba* can be ascribed to the success of seedling establishment during flood periods. Figure 8 indicates a gap in height class of *Acacia erioloba* that could be linked to the mortalities indicated on the score rank (See Figure 6). Most dead trees recorded were old trees with only few medium sized trees dead.

There was an overall decrease in the percentage of individual height class in both species. *Faidherbia albida* height class had a good continuous trend from one height class to another especially at Gobabeb. At Swartbank the only gap in height class of *Faidherbia albida* was in the last height class (See Figure 7) and this could be supported by the vitality (See Figure 5) that indicates that 6 % of *Faidherbia albida* were dead.

Vegetative regrowth and seedlings in relation to water table at Gobabeb & Swartbank

Interestingly there were a lot of *Acacia erioloba* seedlings at Swartbank compared to Gobabeb (See Table 2) although there was no vegetative regrowth in the hectares surveyed. At Gobabeb *Acacia erioloba* vegetative regrowth and seedlings were not encountered while *Faidherbia albida* seedlings and vegetative regrowth were very low. This was not expected, as the water table is shallower (4-6m) at Gobabeb than at Swartbank. At Swartbank *Acacia erioloba* and *Faidherbia albida* seedlings were very unhealthy. *Faidherbia albida* seedlings away from the edge of channel had poor health scores compared to those close to the river channel. According to Jacobson *et al.* (1995), the higher mortalities of *Faidherbia albida* trees in the lower Kuiseb River from Swartbank to Rooibank are associated with underground water abstraction for Walvisbay and Swakopmund. Although Swartbank has more seedlings compared to Gobabeb, most of the seedlings were poorly ranked in the scoring system. This could be the reason why Swartbank had fewer trees