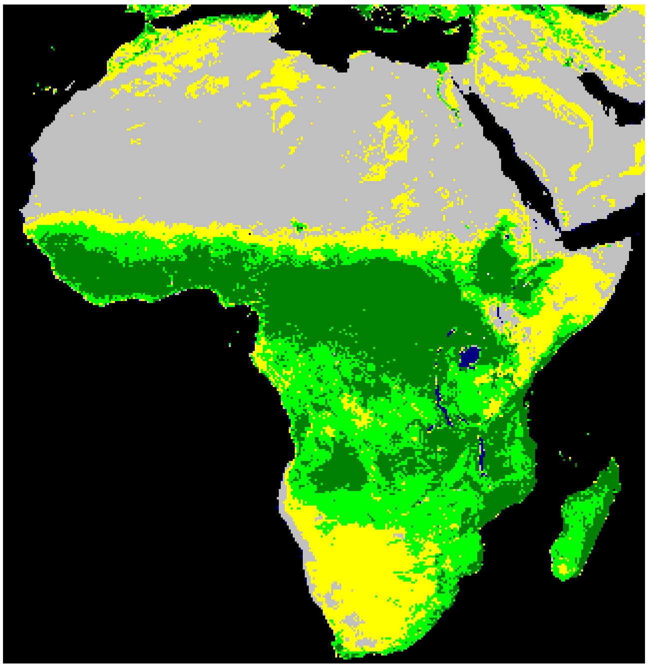
The green grass cover, green biomass and the leaf nitrogen content in relation to NDVI values, Okavango delta, Botswana



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790509-348-070

June 2004

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Summary

Remote sensing techniques such as the ‘Normalized Difference Vegetation Index’ (NDVI), (Lillesand & Kiefer, 2000) have frequently been used to map forage characteristics such as biophysical plant canopy properties (Pinty *et al*. 1993), biomass (Tucker 1979, Elvidge & Lyon 1985, Boelman *et al*. 2003), Leaf Area Index (LAI) (Clevers, 1988,. Van der Meer *et al.* 2001) and leaf nitrogen content (Vleeshouwers & Jongschaap, 2002, Turner *et al.*, 1992 cited in Van Bommel). Van Bommel (2002) measured the NDVI values of Chief’s Island situated in the Okavango delta Botswana in April 2000. Hof (2003) investigated the quality and quantity of the grasses and sedges in the same area. Data about the green grass cover, the amount of biomass, and the leaf nitrogen content are available for April 2001. This gives a good possibility to study the relationship, because both the NDVI values and the actual vegetation data are available for the same area. The aim of the research therefore was to establish a possible link between the quality and the quantity of the grass and sedge sward in April 2001, on Chief’s Island, Okavango Delta, Botswana and the available NDVI values of the same area of April 2000.

No significant relations existed between the NDVI values of Chiefs Island, April 2000, and the green grass cover, the green grass biomass, and the leaf nitrogen content of the grass vegetation of Chiefs Island, April 2001, except for the increasing NDVI values with increasing green grass cover at the woodland. This was probably due to the small range in NDVI values and the inaccuracy of the NDVI values compared to the size of the plots per habitat type and the homogeneity in the surroundings of the plots.

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Introduction

Remote sensing techniques such as the ‘Normalized Difference Vegetation Index’ (NDVI), (Lillesand & Kiefer, 2000) have frequently been used to map forage characteristics such as biophysical plant canopy properties (Pinty *et al*. 1993), biomass (Tucker 1979, Elvidge & Lyon 1985, Boelman *et al*. 2003), Leaf Area Index (LAI) (Clevers 1988,. Van der Meer *et al.* 2001) and leaf nitrogen content (Vleeshouwers & Jongschaap, 2002, Turner *et al.*, 1992 cited in Van Bommel). Total N uptake in winter wheat growth stages was highly correlated with NDVI according to a study conducted by H. Sembiring *et. al*. This method is a potentially very useful method to monitor the green vegetation cover or the biomass (a.o. Tucker *et al.*, 1985, Shore, 2001). The NDVI is determined by the degree of absorption by chlorophyll in the red wavelengths, which is proportional to leaf chlorophyll density, and by the reflectance of near infrared radiation, which is proportional to green leaf density (Tucker *et al.*, 1985).

Van Bommel (2002) measured the NDVI values of Chief’s Island situated in the Okavango delta Botswana in April 2000. Hof (2003) investigated the quality and quantity of the grasses and sedges in the same area. Data about the green grass cover, the amount of biomass, and the leaf nitrogen content are available for April 2001. This gives a good possibility to study the relationship, because both the NDVI values and the actual vegetation data are available for the same area. The question rises whether there indeed was a relation between the NDVI values and the green grass cover, the green biomass and the leaf nitrogen content in this area, assuming that the green grass cover, the amount of green biomass, and the leaf nitrogen content were comparable for the same months in different years.

The aim of the research therefore was to establish a possible link between the quality and the quantity of the grass and sedge sward in April 2001, on Chief’s Island, Okavango Delta, Botswana and the available NDVI values of April 2000. The following research questions have been addressed:

- Does a relation exist between the NDVI values of April 2000 on Chief’s Island, Okavango Delta, Botswana, and the green grass cover of the relating plots in April 2001?
- Does a relation exist between the NDVI values of April 2000 on Chief’s Island, Okavango Delta, Botswana, and the amount of green biomass of the relating plots in April 2001?
- Does a relation exist between the NDVI values of April 2000 on Chief’s Island, Okavango Delta, Botswana, and the leaf nitrogen content of the relating plots in April 2001?

2. Methods

2.1. The study site

The research area was situated within the Okavango Delta. This is an inland delta which is fed by the Okavango River that spreads, due to the smooth surface, the sandy soil and the minor drop of 16 meters over 200 kilometres, into many streams in the northern part of Botswana. When the dry period is severest, the Delta is extensively flooded. In the rainy season the available amount of water decreases what might cause migration of animals. The Delta exists of more than 1000 islands varying in size from only a few square meters to 100 by 15 kilometres (Chief's Island). The vegetation of most islands consists of trees, mainly the mokolwane palm (*Hyphaene petersiana*)**,** the mopane (*Colophospermum mopane*), the baobab (*Adansonia digitata*) and different species of the *Acacia*, of which the dominant species is *Acacia erioloba*. The fauna is extensive (Else, 1997, Vlugt, 1999).

The research area from both Van Bommel and Hof was located on the largest Island within the Okavango Delta, Chief's Island. The research camp of the Harry Oppenheimer Okavango Research Centre (HOORC), from where the research took place, was located in the south western area of Chief's Island (19°32'52" S, 23°10'41" E) in Moremi Game Reserve. The camp was situated along the Boro River, upstream from Nxaraga Lagoon, at an elevation of 948 m. Three sites, which each were homogeneous in species composition and representative for the area, were selected for the analyses of the grass and sedge sward (Hof, 2003, Klop & Van Goethem, 2001). Crocks Island, Lions Island and the Mainland. In the research area, seven habitat types were defined (Hof 2003): sedge zone, lower floodplain, upper floodplain, grassland, mixed *Acacia* woodland, low density *Mopane* woodland, and high density *Mopane* woodland.

Van Bommel defined different habitat types than Hof. He distinguished three vegetation types; woodland, grass on dryland areas and grass on floodplain areas. Therefore, a re-classification of the habitat types needed to be made. However, not all the classifications made by Van Bommel appeared to be correct. Consequently, only the data from the Mainland, and the woodland from both Crocks Island and Lions Island could be taken into account. As a result, only two habitat types were used for the analyses, the floodplain (sedge zone, lower floodplain and upper floodplain from the Mainland) and the woodland (mixed *Acacia* woodland from Crocks Island and Lions Island and the high and low density *Mopane* woodlands from the Mainland) (Table 1).

Sites	*Habitat types Hof*	*Van Bommel*	*NDVI*	*Average neighbouring pixels*	*Difference (%)*	*X-Coordinates*	*Y-Coordinates*
Crocks	S	Woodland	0.260	0.321	-23%	722787	7841814
	LF	Woodland	0.300	0.311	-4%	722797	7841783
	UF	Woodland	0.300	0.311	-4%	722816	7841768
	G	Woodland	0.324	0.353	-9%	722807	7841711
	W	Woodland	0.342	0.324	5%	722819	7841477
Lions I	S	Water	0.033	0.032	3%	731348	7837600
	LF	Water	0.125	0.056	55%	731343	7837602
	UF	Water	0.097	0.088	10%	731330	7837595
	G	Water	0.105	0.181	-72%	731275	7837706
	W	Woodland	0.376	0.374	0%	731300	7837554
Mainland	S	Floodplain	0.284	0.278	2%	729031	7839232
	LF	Floodplain	0.241	0.279	-16%	729022	7839210
	UF	Floodplain	0.139	0.302	-117%	729013	7839178
	MH	Woodland	0.250	0.250	0%	736801	7839605
	ML	Woodland	0.295	0.285	3%	736858	7839526

Table 1: The sample sites during January 2001 till May 2001 with the habitat types and the UTM coordinates defined by Hof (2003), the classification by Van Bommel (2002), and the corresponding NDVI values with their differences in percentage considering the eight neighbouring pixels. With: Crocks: Crocks Island, Lions: Lions island, S: sedge zone, LF: lower floodplain, UF:, upper floodplain, G: grassland, W: mixed *Acacia* woodland, MH: high density *Mopane* woodland, ML: low density *Mopane* woodland.

2.2. The quality and quantity of the grass and sedge sward

Hof (2003) sampled the grass and sedge sward in April 2001. This took place on three sites; Crocks Island, Lions Island, and the Mainland. At the first two sites, five habitat types were distinguished; sedge zone, lower floodplain, upper floodplain, grassland and mixed *Acacia* woodland. These habitat types were distinguished along a wet-dry gradient. In these, the sedge zone was nearest to the permanent water, and the woodland was the most far from the permanent water. In Mainland, two different sites were distinguished, namely the Weir with a sedge zone, a lower floodplain and an upper floodplain community, and the Mopane Transect with two habitat types, a high density *Mopane* woodland, and a low density *Mopane* woodland community. The coordinates of these sites are available. Table 1 shows the used sites with the represented habitat types and the UTM co-ordinates.

At every site, the nutritional quality (amongst which the leaf nitrogen content), the quality in palatable plant parts (green parts and leaves) and the quantity of the grass and sedge sward of the different habitat types was established. The quantity was determined by estimating the green grass cover and the amount of biomass. These were estimated for the entire site after the determination of the green grass cover and the amount of biomass of the three most abundant grass and/ or sedge species (Hof 2003) (appendix table 1 and 2).

2.3. The NDVI values.

The NDVI (Normalised Digital Vegetation Index) values of the fieldwork area were delivered by Van Bommel (2002) (table 2). He obtained a Landsat 7 ETM+ image, path 174 and row 074 covering the south-eastern part of the Okavango Delta, from SAFARI 2000 (Swap & Privette, 1999) through the Tropical Rain Forest Information Centre (TRFIC). An image from April 3, 2000 was geo-referenced and re-projected to UTM, using the ellipsoid Clarke1880, datum Cape, zone 34, having a pixel size of 30 meter. The precision for the image was estimated at 8.2 meters. He distinguished three vegetation types; woodland, grass on dryland areas and grass on floodplain areas. Their NDVI values were calculated using the formula (Lillesand & Kiefer, 2000):

$$NDVI = (NIR - R) / (NIR + R)$$

Where

- NIR = near-infrared value
- R = visible red value

High positive NDVI values are reported to correspond to dense green vegetation cover, whereas negative values are usually associated with bare soil and non-vegetated surfaces. The values are available per pixel of $900m^2$. The values of the pixels that coincide with the UTM coordinates measured by Hof (2003) were used. The GPS readings had a precision of approximately 10 meters, which, in combination with the image geo-rectification, yielded a precision of about 0.5 pixel (Van Bommel 2002). Because the areas in which the habitat types were defined in the sites were not large and uniform (Hof 2003) and because the values for the neighbouring pixels differed considerably in a few cases (table 1), the relation with the NDVI values with the average green cover percentage and green biomass of the neighbouring pixels was also determined.

2.4. Statistical analyses

The non-parametric Kruskal-Wallis and Mann-Whithey U test were used to test whether the NDVI values differed significantly per habitat type. These tests were also used to test whether the green grass cover, the amount of green biomass, and the leaf nitrogen content differed significantly per habitat type (De Vocht 2002).

The NDVI is normally used to estimate green vegetation, since photosynthesis occurs in the green parts of plant material. In April the amount of yellow parts of the total vegetation was considerable. In total 54% of the vegetation consisted of yellow parts and 46% of the vegetation consisted of green parts (figure 1). Therefore, because the NDVI is correlated with photosynthesis, the *green* biomass and *green* grass cover were used to study their relation with the NDVI values.

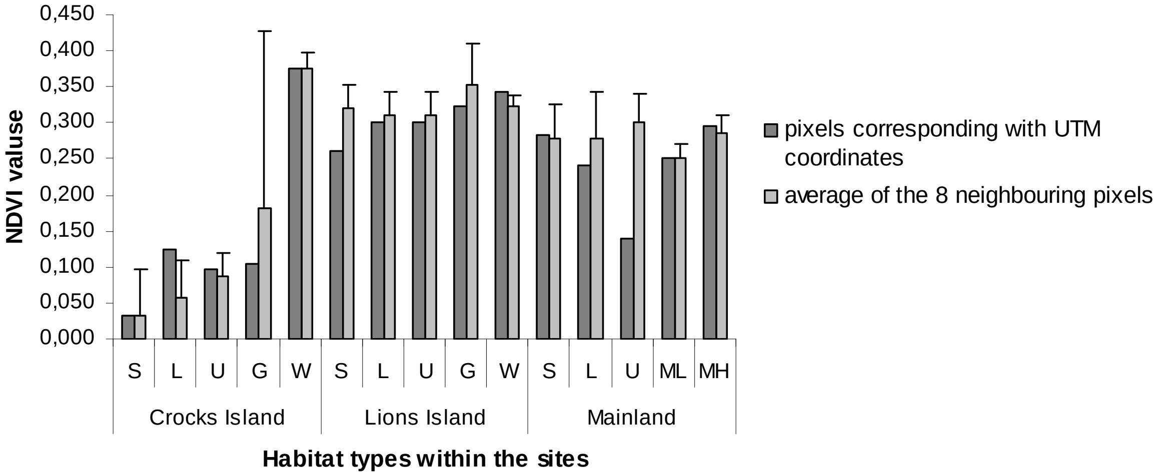

Figure 1: The yellow /green ratio per habitat type per site, April 2001, Okavango delta Botswana. With s: sedge zone, l: lower floodplain, u: upper floodplain, g: grassland, w: woodland, ml: *Mopane* woodland with low undergrowth, mh: *Mopane* woodland with high undergrowth. Crocks Island, S: N = 6, L: N = 9, U: N = 9, G: N = 9, W: N= 9. Lions Island, S: N = 9, L: N = 10, U: N = 7, G: N = 8, W: N= 8. Mainland, S: N = 9, L: N = 9, U: N = 9, ML: N = 9, MH: N= 9.

The relation between the NDVI values and green grass cover was calculated using a regression analyses. As well both the relation between the NDVI values and the green biomass, and the relation between the NDVI values and the leaf nitrogen content were calculated using a regression analyses. But, different habitat types give different NDVI regression lines (Pers. Comm. Clevers 2001). Because the defined sites each contain five different habitat types, it is not useful to calculate the regression of the NDVI values and the green grass cover between the different sites. Therefore, the regression was calculated for each habitat type separately, and not for the sites.

3 Results

3.1 The neighbouring pixels

The difference between the pixels and the neighbouring pixels was sometimes quite high (table 1). This differed from 0% to 117%, and was significant (Paired samples T-test p = 0.002, df = 61) with a mean difference of -0.024.

3.2 The NDVI values per habitat type

Figure 2 shows the NDVI values (Van Bommel, 2002) of the pixels corresponding with the UTM coordinates taken by Hof (2003) and the average NDVI values of the eight neighbouring pixels per corresponding pixel (Van Bommel, 2002). They are shown per correctly classified habitat type defined by Van Bommel 2002, this means the woodland habitat types and the floodplain habitat types. The NDVI values were significantly higher on the woodland then on the floodplain (Mann-Whitney U p: 0.000). They were not significantly different when the neighbouring pixels were taken into account (Mann-Whitney U p: 0.033).

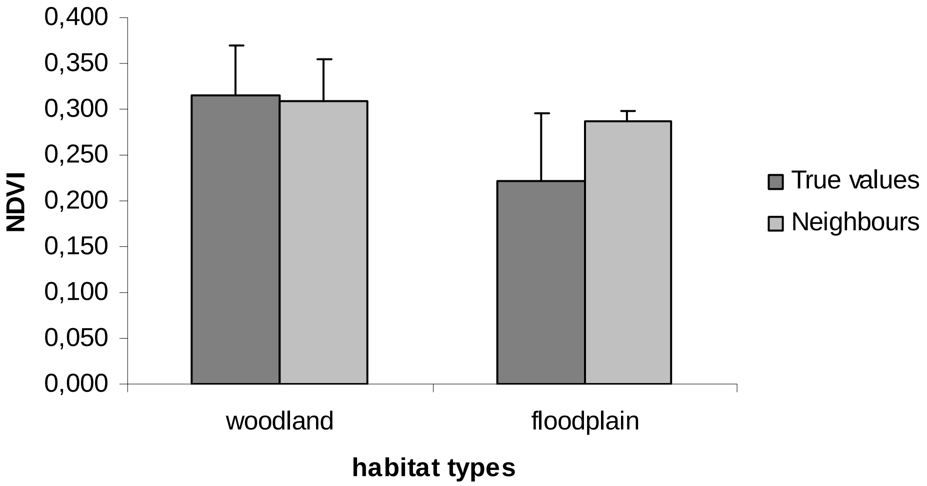

Figure 2: The average NDVI values (Van Bommel, 2002) of the pixels corresponding with the UTM coordinates taken by Hof (2003) and the average NDVI values of the eight neighbouring pixels per corresponding pixel(Van Bommel, 2002). Shown per classified habitat type. Woodland N = 4, floodplain N = 3.

3.3 The green grass cover

The green grass cover was significantly higher on the woodland then on the floodplain (Fig. 3) (Mann-Whitney U, p: 0.000). Figure 4 shows the regression between the NDVI values and the green grass cover for both the woodland and the floodplain. The NDVI values declined with increasing green grass cover at the floodplain, but this was not significant (regression analyses p: 0.108). On the other hand, at the woodland, the NDVI values increased significantly with increasing green grass cover (regression analyses p: 0.005). When the neighbouring pixels were taken into account the relations became more significant (regression analyses p: 0.087, respectively 0.004).

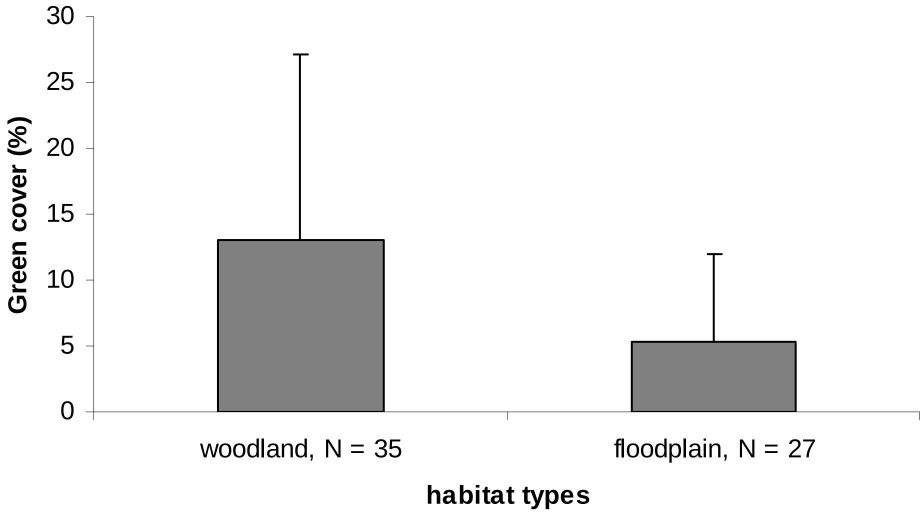

Figure 3: The green grass cover of the grass vegetation (%) per habitat type, April 2001 Chiefs Island, Okavango delta, Botswana (Hof, 2003).

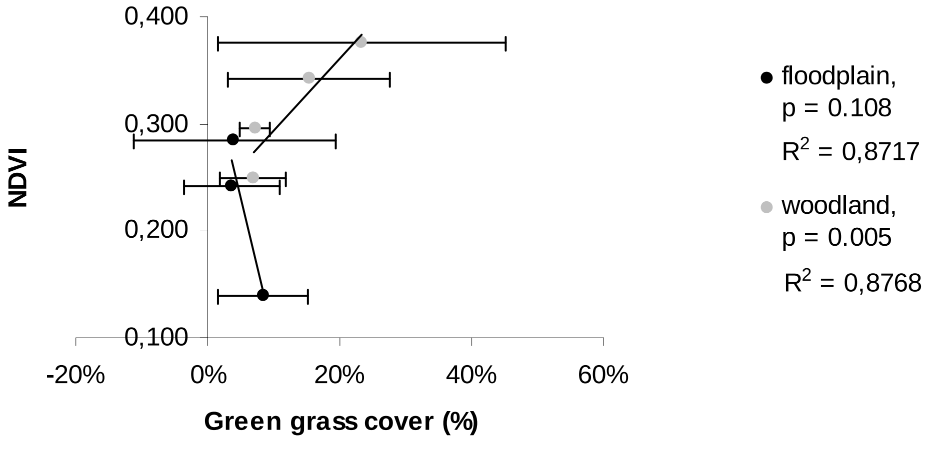

Figure 4: Regression green grass cover of the grass vegetation (%) per habitat type, April 2001 Chiefs Island, Okavango delta, Botswana (Hof 2003) with the NDVI values of the corresponding UTM- coordinates April 2000, Chiefs Island Okavango delta, Botswana (Van Bommel 2002). N = 9 per NDVI value for both the floodplain and the woodland.

3.4 The green biomass

The amount of green biomass was higher on the woodland then on the floodplain (Fig. 5). This trend was not significant (Mann-Whitney U, p: 0.126). Figure 6 shows the regression between the NDVI values and the green biomass. There was no significant relation between these two variables on both the floodplain and the woodland (regression analyses p: 0.684, p: 0.063). When the neighbouring pixels were taken into account the relations become even less significant (regression analyses p: 0.763, p: 0.063).

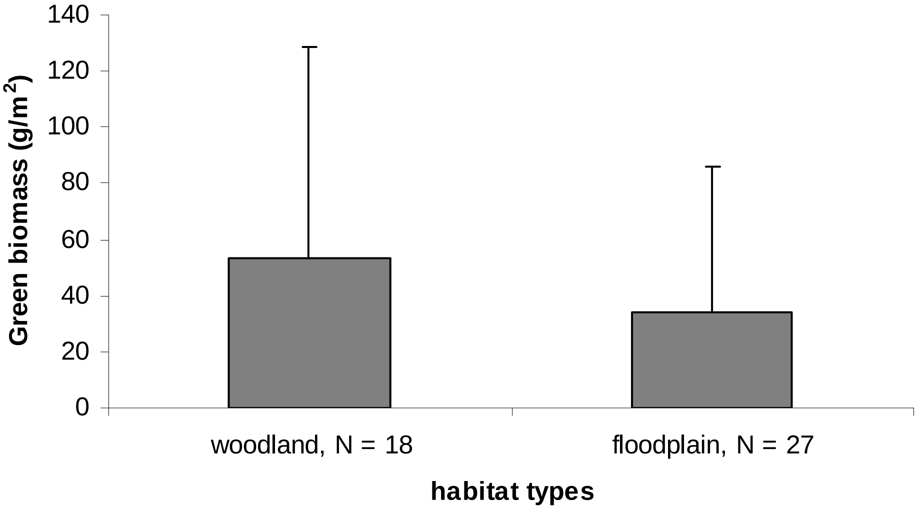

Figure 5: The amount of green biomass (g/m^2) per habitat type, April 2001 Chiefs Island, Okavango delta, Botswana (Hof, 2003)

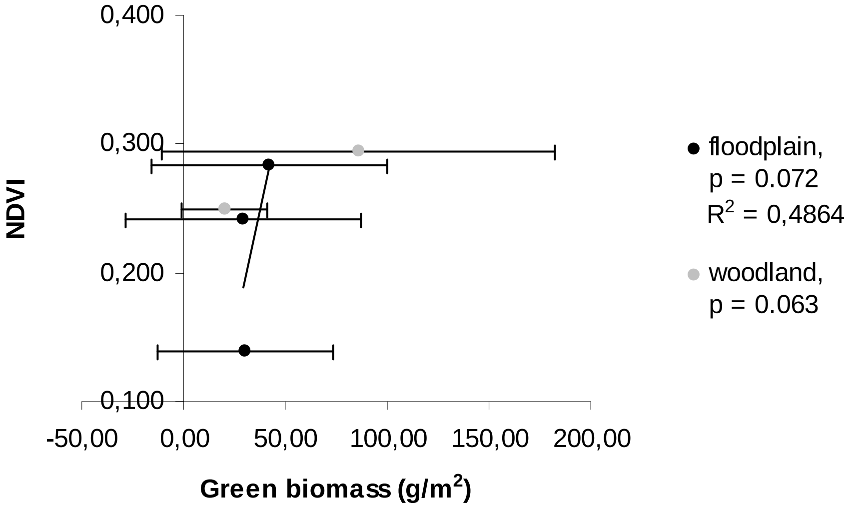

Figure 6: Regression green biomass (g/m^2) per habitat type, April 2001 Chiefs Island, Okavango delta, Botswana (Hof 2003) with the NDVI values of the corresponding UTM- coordinates April 2000, Chiefs Island Okavango delta, Botswana (Van Bommel 2002). N = 9 per NDVI value for both the floodplain and the woodland.

3.5 The leaf nitrogen content

The leaf nitrogen content was higher on the woodland then on the floodplain (Fig. 7). This trend was not significant (Mann-Whitney U, p: 0.024). Figure 8 shows the regression between the NDVI values and the leaf nitrogen content. There was no significant relation between these two variables on both the floodplain and the woodland (regression analyses p: 0.108, p: 0.223). When the neighbouring pixels were taken into account the relations were not significant either (regression analyses p: 0.075, p: 0.092).

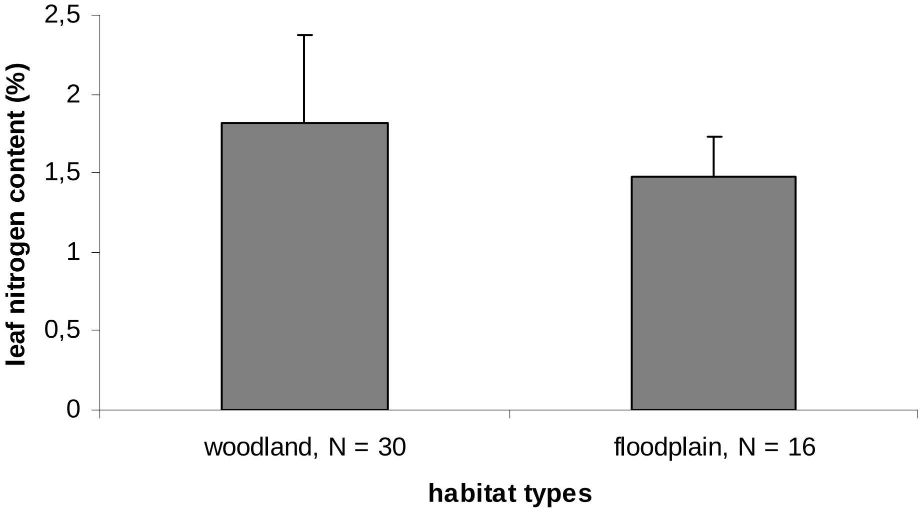

Figure 7: The amount of leaf nitrogen content of the grass vegetation (%) per habitat type, April 2001 Chiefs Island, Okavango delta, Botswana (Hof, 2003)

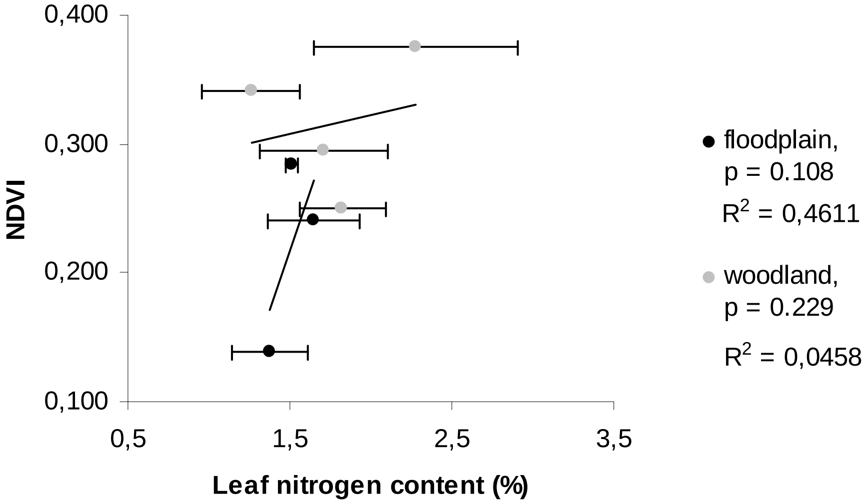

Figure 8: Regression leaf nitrogen content of the grass vegetation (%) per habitat type, April 2001 Chiefs Island, Okavango delta, Botswana (Hof 2003) with the NDVI values of the corresponding UTM- coordinates April 2000, Chiefs Island Okavango delta, Botswana (Van Bommel 2002). N = 9 per NDVI value for both the floodplain and the woodland.

4 Discussion

Although there was a significant difference between the NDVI values of the pixels with the corresponding UTM-coordinates and the average of the eight neighbouring pixels, this difference did not have a great effect on the analyses. Therefore, the best was to use the pixels that corresponded with the UTM-coordinates. Although, there in generally exists an error in definition of pixels, and the defined habitat types within the sites were situated closely together, the corresponding pixels must be considered as the best. It can be useful to take the neighbouring pixels in account, but in this research it did not have an effect.

The green grass cover was significantly higher on the woodland then on the floodplain. As well both the amount of green biomass and the leaf nitrogen content were higher on the woodland then on the floodplain, but this was based upon a trend and not a significant relationship. This fact and these trends were in accordance with the higher NDVI values found on the woodland.

Although the NDVI values significantly differed per habitat type, a significant relation between the NDVI values of April 2000, and the quality (leaf nitrogen content) and quantity (amount of green biomass, green grass cover) of the grass vegetation of April 2001 did not exist on Chiefs Island. Except for the significant increase of the NDVI values with increasing green grass cover on the woodland. There may be a fair amount of reasons for the lack of significant relations. First of all, the NDVI values or the data of the quality and quantity of the grass vegetation might not be accurate enough. Second of all, because of the habitat plots defined by Hof (2003) were small (16m^2) and the habitat surrounding the plots was not homogenous at all sites, the used pixels of the NDVI map of Van Bommel (2002) might have been on a too large scale (900m^2). Above all, the classification of habitat types differed considdering Hof (2003) and Van Bommel (2002). Furthermore, the vegetation might have changed little during the year. There has been a fire in 2001 before April, although it is not known whether this had affected the defined sites, it might have changed the situation. Alas NDVI based studies show highly variable relationships when predictions of the vegetation are considered (Van Dijk *et al.*, 1987). Probably the most important reason for this high variability is that NDVI is seriously disturbed radio metrically due to complex radiative interactions between the atmosphere, sensor view angle and solar zenith angle (Van Dijk *et al.*, 1987). Also Hazeu & Wamelink (2004) found that the relationship between leaf biomass and NDVI values often was not significant. Furthermore, the differences between the NDVI values used for this research were low within the habitat types. In literature good relations are found when the NDVI values range from 0.100 or 0.200 to 0.600 or even higher (Pers. Comm. Clevers 2001). Also differences in climate between the years may have influenced the lack of regression. Malo and Nicholson (1990, cited in

Damizadeh *et al.* 2001), Du Plessis *et al*. 1990 and Damizadeh *et al.* (2001) concluded that monthly changes in NDVI were correlated with changes in rainfall. As can be seen from figure 9, the amount of rainfall that fell in April was considerably higher in the year 2001 then in the year 2000. This could have affected the vegetation differently per site, consequently the NDVI values might not have been the same during these years.

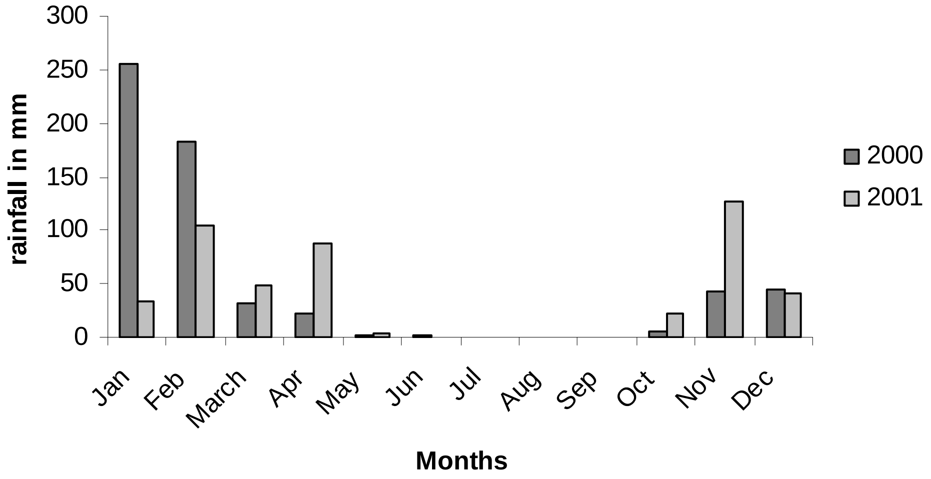

Figure 9: The rainfall data per month in Maun, Okavango Delta, Botswana for the year 2000 and 2001.

Conclusions

No significant relations existed between the NDVI values of Chiefs Island, April 2000, and the green grass cover, the green grass biomass, and the leaf nitrogen content of the grass vegetation of Chiefs Island, April 2001, except for the increasing NDVI values with increasing green grass cover at the woodland. This was probably due to the small range in NDVI values and the inaccuracy of the NDVI values compared to the size of the plots per habitat type and the homogeneity in the surrounding of the plots.

Acknowledgements

This research has been made possible thanks to the help of several people who I wish to thank. First of all I would like to thank Frans van Bommel, who delivered the necessary NDVI values. Furthermore I would like to thank my supervisor Dr. Ir. Ignas Heitkönig for his suggestions. I also had great help from Dr. Ir. Jan Clevers, Alterra, Remote Sensing for his help with the Data.

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Appendix

Table 1: Output of the Multiple Comparisons Test of Bonferroni of the parameters per habitat type. W: mixed *Acacia* woodland, G: grassland, UF: upper floodplain, LF: lower floodplain, S: sedge zone, MH: *Mopane* high-density woodland, ML: *Mopane* low-density woodland

Dependent Variable	(I) Habitat type	(J) Habitat type	Mean Difference (I-J)	Std. Error	Sig.	95% Confidence Interval	
						Lower Bound	Upper Bound
length (cm)	W	G	65,999	6,490	0,000	46,179	85,818
		UF	26,415	5,918	0,000	8,343	44,487
		LF	28,469	5,879	0,000	10,513	46,424
		S	17,830	5,892	0,055	-0,163	35,824
		MH	26,875	7,735	0,012	3,253	50,498
		ML	-6,041	7,735	1,000	-29,664	17,581
	G	W	-65,999	6,490	0,000	-85,818	-46,179
		UF	-39,584	6,073	0,000	-58,129	-21,038
		LF	-37,530	6,035	0,000	-55,962	-19,099
		S	-48,168	6,048	0,000	-66,637	-29,700
		MH	-39,124	7,854	0,000	-63,110	-15,137
		ML	-72,040	7,854	0,000	-96,027	-48,054
	UF	W	-26,415	5,918	0,000	-44,487	-8,343
		G	39,584	6,073	0,000	21,038	58,129
		LF	2,054	5,415	1,000	-14,484	18,591
		S	-8,585	5,429	1,000	-25,164	7,994
		MH	0,460	7,389	1,000	-22,104	23,024
		ML	-32,457	7,389	0,000	-55,020	-9,893
	LF	W	-28,469	5,879	0,000	-46,424	-10,513
		G	37,530	6,035	0,000	19,099	55,962
		UF	-2,054	5,415	1,000	-18,591	14,484
		S	-10,638	5,387	1,000	-27,090	5,814
		MH	-1,593	7,358	1,000	-24,064	20,877
		ML	-34,510	7,358	0,000	-56,980	-12,040
	S	W	-17,830	5,892	0,055	-35,824	0,163
		G	48,168	6,048	0,000	29,700	66,637
		UF	8,585	5,429	1,000	-7,994	25,164
		LF	10,638	5,387	1,000	-5,814	27,090
		MH	9,045	7,368	1,000	-13,456	31,546
		ML	-23,872	7,368	0,027	-46,373	-1,371
	MH	W	-26,875	7,735	0,012	-50,498	-3,253
		G	39,124	7,854	0,000	15,137	63,110
		UF	-0,460	7,389	1,000	-23,024	22,104
		LF	1,593	7,358	1,000	-20,877	24,064
		S	-9,045	7,368	1,000	-31,546	13,456
		ML	-32,917	8,911	0,005	-60,130	-5,704
	ML	W	6,041	7,735	1,000	-17,581	29,664
		G	72,040	7,854	0,000	48,054	96,027
		UF	32,457	7,389	0,000	9,893	55,020
		LF	34,510	7,358	0,000	12,040	56,980
		S	23,872	7,368	0,027	1,371	46,373
		MH	32,917	8,911	0,005	5,704	60,130
dry weight (g)	W	G	9,864	3,091	0,032	0,425	19,304
		UF	4,819	2,830	1,000	-3,822	13,461

		LF	4,569	2,811	1,000	-4,016	13,154
		S	-5,243	2,817	1,000	-13,847	3,361
		MH	-1,388	3,699	1,000	-12,683	9,907
dry weight (g)	W	ML	-23,512	3,699	0,000	-34,807	-12,216
	G	W	-9,864	3,091	0,032	-19,304	-0,425
		UF	-5,045	2,891	1,000	-13,872	3,783
		LF	-5,295	2,873	1,000	-14,068	3,477
		S	-15,107	2,879	0,000	-23,898	-6,317
		MH	-11,252	3,746	0,059	-22,690	0,186
		ML	-33,376	3,746	0,000	-44,814	-21,938
	UF	W	-4,819	2,830	1,000	-13,461	3,822
		G	5,045	2,891	1,000	-3,783	13,872
		LF	-0,250	2,589	1,000	-8,158	7,657
		S	-10,062	2,596	0,003	-17,990	-2,135
		MH	-6,207	3,533	1,000	-16,996	4,582
		ML	-28,331	3,533	0,000	-39,120	-17,542
	LF	W	-4,569	2,811	1,000	-13,154	4,016
		G	5,295	2,873	1,000	-3,477	14,068
		UF	0,250	2,589	1,000	-7,657	8,158
		S	-9,812	2,576	0,003	-17,679	-1,945
		MH	-5,957	3,518	1,000	-16,701	4,788
		ML	-28,081	3,518	0,000	-38,825	-17,336
	S	W	5,243	2,817	1,000	-3,361	13,847
		G	15,107	2,879	0,000	6,317	23,898
		UF	10,062	2,596	0,003	2,135	17,990
		LF	9,812	2,576	0,003	1,945	17,679
		MH	3,855	3,523	1,000	-6,904	14,614
		ML	-18,269	3,523	0,000	-29,028	-7,510
	MH	W	1,388	3,699	1,000	-9,907	12,683
		G	11,252	3,746	0,059	-0,186	22,690
		UF	6,207	3,533	1,000	-4,582	16,996
		LF	5,957	3,518	1,000	-4,788	16,701
		S	-3,855	3,523	1,000	-14,614	6,904
		ML	-22,124	4,261	0,000	-35,136	-9,112
	ML	W	23,512	3,699	0,000	12,216	34,807
		G	33,376	3,746	0,000	21,938	44,814
		UF	28,331	3,533	0,000	17,542	39,120
		LF	28,081	3,518	0,000	17,336	38,825
		S	18,269	3,523	0,000	7,510	29,028
		MH	22,124	4,261	0,000	9,112	35,136
% leaves	W	G	-5,511	2,402	0,466	-12,845	1,824
		UF	-1,879	2,199	1,000	-8,593	4,835
		LF	5,395	2,184	0,291	-1,276	12,066
		S	13,493	2,189	0,000	6,808	20,178
		MH	0,639	2,874	1,000	-8,137	9,416
		ML	-0,035	2,874	1,000	-8,811	8,742
	G	W	5,511	2,402	0,466	-1,824	12,845
		UF	3,632	2,246	1,000	-3,227	10,491
		LF	10,906	2,232	0,000	4,090	17,723
		S	19,004	2,237	0,000	12,174	25,835
		MH	6,150	2,910	0,737	-2,737	15,038
		ML	5,476	2,910	1,000	-3,412	14,364
	UF	W	1,879	2,199	1,000	-4,835	8,593
		G	-3,632	2,246	1,000	-10,491	3,227

		LF	7,274	2,012	0,007	1,130	13,419
		S	15,372	2,017	0,000	9,213	21,532
		MH	2,519	2,745	1,000	-5,865	10,902
% leaves	UF	ML	1,844	2,745	1,000	-6,539	10,227
	LF	W	-5,395	2,184	0,291	-12,066	1,276
		G	-10,906	2,232	0,000	-17,723	-4,090
		UF	-7,274	2,012	0,007	-13,419	-1,130
		S	8,098	2,002	0,001	1,986	14,211
		MH	-4,756	2,734	1,000	-13,104	3,593
		ML	-5,430	2,734	0,999	-13,779	2,918
	S	W	-13,493	2,189	0,000	-20,178	-6,808
		G	-19,004	2,237	0,000	-25,835	-12,174
		UF	-15,372	2,017	0,000	-21,532	-9,213
		LF	-8,098	2,002	0,001	-14,211	-1,986
		MH	-12,854	2,737	0,000	-21,214	-4,494
		ML	-13,528	2,737	0,000	-21,888	-5,168
	MH	W	-0,639	2,874	1,000	-9,416	8,137
		G	-6,150	2,910	0,737	-15,038	2,737
		UF	-2,519	2,745	1,000	-10,902	5,865
		LF	4,756	2,734	1,000	-3,593	13,104
		S	12,854	2,737	0,000	4,494	21,214
		ML	-0,674	3,311	1,000	-10,785	9,436
	ML	W	0,035	2,874	1,000	-8,742	8,811
		G	-5,476	2,910	1,000	-14,364	3,412
		UF	-1,844	2,745	1,000	-10,227	6,539
		LF	5,430	2,734	0,999	-2,918	13,779
		S	13,528	2,737	0,000	5,168	21,888
		MH	0,674	3,311	1,000	-9,436	10,785
% green parts	W	G	-8,684	5,117	1,000	-24,315	6,947
		UF	-2,495	4,672	1,000	-16,768	11,777
		LF	-1,312	4,704	1,000	-15,680	13,057
		S	7,352	4,864	1,000	-7,506	22,209
		MH	-11,248	6,086	1,000	-29,841	7,345
		ML	-1,162	6,086	1,000	-19,754	17,431
	G	W	8,684	5,117	1,000	-6,947	24,315
		UF	6,189	4,755	1,000	-8,337	20,715
		LF	7,372	4,786	1,000	-7,248	21,993
		S	16,036	4,943	0,027	0,935	31,137
		MH	-2,564	6,150	1,000	-21,352	16,224
		ML	7,522	6,150	1,000	-11,265	26,310
	UF	W	2,495	4,672	1,000	-11,777	16,768
		G	-6,189	4,755	1,000	-20,715	8,337
		LF	1,184	4,307	1,000	-11,974	14,341
		S	9,847	4,481	0,598	-3,843	23,537
		MH	-8,753	5,786	1,000	-26,426	8,921
		ML	1,334	5,786	1,000	-16,340	19,007
	LF	W	1,312	4,704	1,000	-13,057	15,680
		G	-7,372	4,786	1,000	-21,993	7,248
		UF	-1,184	4,307	1,000	-14,341	11,974
		S	8,663	4,514	1,000	-5,127	22,453
		MH	-9,936	5,811	1,000	-27,687	7,815
		ML	0,150	5,811	1,000	-17,601	17,901
	S	W	-7,352	4,864	1,000	-22,209	7,506
		G	-16,036	4,943	0,027	-31,137	-0,935

		UF	-9,847	4,481	0,598	-23,537	3,843
		LF	-8,663	4,514	1,000	-22,453	5,127
		MH	-18,599	5,941	0,039	-36,749	-0,450
% green parts	S	ML	-8,513	5,941	1,000	-26,662	9,636
	MH	W	11,248	6,086	1,000	-7,345	29,841
		G	2,564	6,150	1,000	-16,224	21,352
		UF	8,753	5,786	1,000	-8,921	26,426
		LF	9,936	5,811	1,000	-7,815	27,687
		S	18,599	5,941	0,039	0,450	36,749
		ML	10,086	6,978	1,000	-11,229	31,401
	ML	W	1,162	6,086	1,000	-17,431	19,754
		G	-7,522	6,150	1,000	-26,310	11,265
		UF	-1,334	5,786	1,000	-19,007	16,340
		LF	-0,150	5,811	1,000	-17,901	17,601
		S	8,513	5,941	1,000	-9,636	26,662
		MH	-10,086	6,978	1,000	-31,401	11,229
biomass (g/m^2)	W	G	476,463	115,132	0,001	123,472	829,454
		UF	436,869	111,004	0,002	96,534	777,204
		LF	375,212	107,355	0,012	46,067	704,357
		S	140,239	109,139	1,000	-194,375	474,854
		MH	342,451	143,306	0,368	-96,920	781,821
		ML	-66,575	143,306	1,000	-505,945	372,795
	G	W	-476,463	115,132	0,001	-829,454	-123,472
		UF	-39,594	95,646	1,000	-332,840	253,653
		LF	-101,250	91,385	1,000	-381,432	178,932
		S	-336,223	93,474	0,008	-622,811	-49,636
		MH	-134,012	131,768	1,000	-538,007	269,983
		ML	-543,038	131,768	0,001	-947,033	-139,043
	UF	W	-436,869	111,004	0,002	-777,204	-96,534
		G	39,594	95,646	1,000	-253,653	332,840
		LF	-61,656	86,126	1,000	-325,716	202,403
		S	-296,630	88,340	0,019	-567,476	-25,783
		MH	-94,418	128,177	1,000	-487,403	298,567
		ML	-503,444	128,177	0,002	-896,429	-110,459
	LF	W	-375,212	107,355	0,012	-704,357	-46,067
		G	101,250	91,385	1,000	-178,932	381,432
		UF	61,656	86,126	1,000	-202,403	325,716
		S	-234,973	83,708	0,112	-491,617	21,671
		MH	-32,762	125,029	1,000	-416,097	350,573
		ML	-441,787	125,029	0,010	-825,122	-58,452
	S	W	-140,239	109,139	1,000	-474,854	194,375
		G	336,223	93,474	0,008	49,636	622,811
		UF	296,630	88,340	0,019	25,783	567,476
		LF	234,973	83,708	0,112	-21,671	491,617
		MH	202,211	126,565	1,000	-185,830	590,253
		ML	-206,814	126,565	1,000	-594,856	181,227
	MH	W	-342,451	143,306	0,368	-781,821	96,920
		G	134,012	131,768	1,000	-269,983	538,007
		UF	94,418	128,177	1,000	-298,567	487,403
		LF	32,762	125,029	1,000	-350,573	416,097
		S	-202,211	126,565	1,000	-590,253	185,830
		ML	-409,026	156,984	0,203	-890,332	72,281
	ML	W	66,575	143,306	1,000	-372,795	505,945
		G	543,038	131,768	0,001	139,043	947,033

		UF	503,444	128,177	0,002	110,459	896,429
		LF	441,787	125,029	0,010	58,452	825,122
		S	206,814	126,565	1,000	-181,227	594,856
biomass (g/m^2)	ML	MH	409,026	156,984	0,203	-72,281	890,332
% N	W	G	0,609	0,208	0,083	-0,034	1,252
		UF	0,763	0,169	0,000	0,241	1,285
		LF	0,979	0,163	0,000	0,474	1,484
		S	1,171	0,174	0,000	0,633	1,709
		MH	-0,319	0,208	1,000	-0,962	0,324
		ML	0,296	0,192	1,000	-0,296	0,888
	G	W	-0,609	0,208	0,083	-1,252	0,034
		UF	0,154	0,210	1,000	-0,496	0,804
		LF	0,370	0,206	1,000	-0,266	1,007
		S	0,562	0,215	0,204	-0,101	1,225
		MH	-0,928	0,243	0,004	-1,678	-0,177
		ML	-0,313	0,229	1,000	-1,021	0,395
	UF	W	-0,763	0,169	0,000	-1,285	-0,241
		G	-0,154	0,210	1,000	-0,804	0,496
		LF	0,216	0,166	1,000	-0,298	0,730
		S	0,408	0,177	0,472	-0,139	0,954
		MH	-1,082	0,210	0,000	-1,732	-0,432
		ML	-0,467	0,194	0,364	-1,067	0,133
	LF	W	-0,979	0,163	0,000	-1,484	-0,474
		G	-0,370	0,206	1,000	-1,007	0,266
		UF	-0,216	0,166	1,000	-0,730	0,298
		S	0,192	0,172	1,000	-0,338	0,722
		MH	-1,298	0,206	0,000	-1,934	-0,661
		ML	-0,683	0,189	0,009	-1,268	-0,098
	S	W	-1,171	0,174	0,000	-1,709	-0,633
		G	-0,562	0,215	0,204	-1,225	0,101
		UF	-0,408	0,177	0,472	-0,954	0,139
		LF	-0,192	0,172	1,000	-0,722	0,338
		MH	-1,490	0,215	0,000	-2,153	-0,827
		ML	-0,875	0,199	0,000	-1,489	-0,261
	MH	W	0,319	0,208	1,000	-0,324	0,962
		G	0,928	0,243	0,004	0,177	1,678
		UF	1,082	0,210	0,000	0,432	1,732
		LF	1,298	0,206	0,000	0,661	1,934
		S	1,490	0,215	0,000	0,827	2,153
		ML	0,615	0,229	0,170	-0,093	1,322
	ML	W	-0,296	0,192	1,000	-0,888	0,296
		G	0,313	0,229	1,000	-0,395	1,021
		UF	0,467	0,194	0,364	-0,133	1,067
		LF	0,683	0,189	0,009	0,098	1,268
		S	0,875	0,199	0,000	0,261	1,489
		MH	-0,615	0,229	0,170	-1,322	0,093
% P	W	G	-0,027	0,021	1,000	-0,091	0,036
		UF	0,072	0,017	0,001	0,021	0,124
		LF	0,113	0,016	0,000	0,063	0,162
		S	0,131	0,017	0,000	0,078	0,184
		MH	-0,018	0,021	1,000	-0,081	0,046
		ML	0,074	0,019	0,003	0,016	0,133
	G	W	0,027	0,021	1,000	-0,036	0,091
		UF	0,100	0,021	0,000	0,036	0,164

		LF	0,140	0,020	0,000	0,077	0,203
		S	0,159	0,021	0,000	0,093	0,224
		MH	0,010	0,024	1,000	-0,064	0,084
% P	G	ML	0,102	0,023	0,000	0,032	0,172
	UF	W	-0,072	0,017	0,001	-0,124	-0,021
		G	-0,100	0,021	0,000	-0,164	-0,036
		LF	0,040	0,016	0,315	-0,010	0,091
		S	0,059	0,017	0,018	0,005	0,113
		MH	-0,090	0,021	0,001	-0,154	-0,026
		ML	0,002	0,019	1,000	-0,057	0,061
	LF	W	-0,113	0,016	0,000	-0,162	-0,063
		G	-0,140	0,020	0,000	-0,203	-0,077
		UF	-0,040	0,016	0,315	-0,091	0,010
		S	0,019	0,017	1,000	-0,033	0,071
		MH	-0,130	0,020	0,000	-0,193	-0,068
		ML	-0,038	0,019	0,893	-0,096	0,019
	S	W	-0,131	0,017	0,000	-0,184	-0,078
		G	-0,159	0,021	0,000	-0,224	-0,093
		UF	-0,059	0,017	0,018	-0,113	-0,005
		LF	-0,019	0,017	1,000	-0,071	0,033
		MH	-0,149	0,021	0,000	-0,215	-0,084
		ML	-0,057	0,020	0,087	-0,118	0,003
	MH	W	0,018	0,021	1,000	-0,046	0,081
		G	-0,010	0,024	1,000	-0,084	0,064
		UF	0,090	0,021	0,001	0,026	0,154
		LF	0,130	0,020	0,000	0,068	0,193
		S	0,149	0,021	0,000	0,084	0,215
		ML	0,092	0,023	0,002	0,022	0,162
	ML	W	-0,074	0,019	0,003	-0,133	-0,016
		G	-0,102	0,023	0,000	-0,172	-0,032
		UF	-0,002	0,019	1,000	-0,061	0,057
		LF	0,038	0,019	0,893	-0,019	0,096
		S	0,057	0,020	0,087	-0,003	0,118
		MH	-0,092	0,023	0,002	-0,162	-0,022
% Na	W	G	-0,114	0,046	0,323	-0,257	0,030
		UF	-0,180	0,038	0,000	-0,296	-0,063
		LF	-0,028	0,036	1,000	-0,140	0,085
		S	-0,056	0,039	1,000	-0,176	0,064
		MH	0,039	0,046	1,000	-0,104	0,182
		ML	0,039	0,043	1,000	-0,093	0,171
	G	W	0,114	0,046	0,323	-0,030	0,257
		UF	-0,066	0,047	1,000	-0,211	0,079
		LF	0,086	0,046	1,000	-0,056	0,228
		S	0,058	0,048	1,000	-0,090	0,206
		MH	0,153	0,054	0,114	-0,015	0,320
		ML	0,153	0,051	0,067	-0,005	0,311
	UF	W	0,180	0,038	0,000	0,063	0,296
		G	0,066	0,047	1,000	-0,079	0,211
		LF	0,152	0,037	0,001	0,037	0,267
		S	0,124	0,039	0,042	0,002	0,246
		MH	0,219	0,047	0,000	0,074	0,364
		ML	0,219	0,043	0,000	0,085	0,353
	LF	W	0,028	0,036	1,000	-0,085	0,140
		G	-0,086	0,046	1,000	-0,228	0,056

		UF	-0,152	0,037	0,001	-0,267	-0,037
		S	-0,028	0,038	1,000	-0,146	0,090
		MH	0,067	0,046	1,000	-0,075	0,209
% Na	LF	ML	0,067	0,042	1,000	-0,063	0,198
	S	W	0,056	0,039	1,000	-0,064	0,176
		G	-0,058	0,048	1,000	-0,206	0,090
		UF	-0,124	0,039	0,042	-0,246	-0,002
		LF	0,028	0,038	1,000	-0,090	0,146
		MH	0,095	0,048	1,000	-0,053	0,243
		ML	0,095	0,044	0,698	-0,042	0,232
	MH	W	-0,039	0,046	1,000	-0,182	0,104
		G	-0,153	0,054	0,114	-0,320	0,015
		UF	-0,219	0,047	0,000	-0,364	-0,074
		LF	-0,067	0,046	1,000	-0,209	0,075
		S	-0,095	0,048	1,000	-0,243	0,053
		ML	0,000	0,051	1,000	-0,157	0,158
	ML	W	-0,039	0,043	1,000	-0,171	0,093
		G	-0,153	0,051	0,067	-0,311	0,005
		UF	-0,219	0,043	0,000	-0,353	-0,085
		LF	-0,067	0,042	1,000	-0,198	0,063
		S	-0,095	0,044	0,698	-0,232	0,042
		MH	0,000	0,051	1,000	-0,158	0,157
% Ca	W	G	-0,024	0,065	1,000	-0,225	0,177
		UF	0,188	0,053	0,011	0,025	0,351
		LF	0,191	0,051	0,006	0,033	0,349
		S	0,229	0,054	0,001	0,061	0,397
		MH	-0,202	0,065	0,047	-0,403	-0,001
		ML	-0,028	0,060	1,000	-0,213	0,157
	G	W	0,024	0,065	1,000	-0,177	0,225
		UF	0,212	0,066	0,033	0,008	0,415
		LF	0,215	0,064	0,023	0,016	0,414
		S	0,253	0,067	0,005	0,046	0,460
		MH	-0,178	0,076	0,422	-0,413	0,056
		ML	-0,004	0,072	1,000	-0,225	0,217
	UF	W	-0,188	0,053	0,011	-0,351	-0,025
		G	-0,212	0,066	0,033	-0,415	-0,008
		LF	0,003	0,052	1,000	-0,158	0,164
		S	0,041	0,055	1,000	-0,129	0,212
		MH	-0,390	0,066	0,000	-0,593	-0,187
		ML	-0,216	0,061	0,011	-0,403	-0,028
	LF	W	-0,191	0,051	0,006	-0,349	-0,033
		G	-0,215	0,064	0,023	-0,414	-0,016
		UF	-0,003	0,052	1,000	-0,164	0,158
		S	0,038	0,054	1,000	-0,127	0,204
		MH	-0,393	0,064	0,000	-0,592	-0,194
		ML	-0,219	0,059	0,006	-0,402	-0,036
	S	W	-0,229	0,054	0,001	-0,397	-0,061
		G	-0,253	0,067	0,005	-0,460	-0,046
		UF	-0,041	0,055	1,000	-0,212	0,129
		LF	-0,038	0,054	1,000	-0,204	0,127
		MH	-0,431	0,067	0,000	-0,639	-0,224
		ML	-0,257	0,062	0,001	-0,449	-0,065
	MH	W	0,202	0,065	0,047	0,001	0,403
		G	0,178	0,076	0,422	-0,056	0,413

		UF	0,390	0,066	0,000	0,187	0,593
		LF	0,393	0,064	0,000	0,194	0,592
		S	0,431	0,067	0,000	0,224	0,639
% Ca	MH	ML	0,174	0,072	0,337	-0,047	0,396
	ML	W	0,028	0,060	1,000	-0,157	0,213
		G	0,004	0,072	1,000	-0,217	0,225
		UF	0,216	0,061	0,011	0,028	0,403
		LF	0,219	0,059	0,006	0,036	0,402
		S	0,257	0,062	0,001	0,065	0,449
		MH	-0,174	0,072	0,337	-0,396	0,047

Table 2: Output of the Multiple Comparisons test of Bonferroni between the parameters and the sites. CI: Crocks island, LI: Lions island, W: The Weir, M: The Mopane Transect.

Dependent Variable	(I) site	(J) site	Mean Difference (I-J)	Std. Error	Sig.	95% Confidence Interval	
						Lower Bound	Upper Bound
length (cm)	CI	LI	21,348	4,493	0,000	9,447	33,249
		W	6,259	5,370	1,000	-7,964	20,483
		M	-6,186	5,828	1,000	-21,623	9,252
	LI	CI	-21,348	4,493	0,000	-33,249	-9,447
		W	-15,089	5,319	0,028	-29,179	-0,998
		M	-27,534	5,782	0,000	-42,848	-12,219
	W	CI	-6,259	5,370	1,000	-20,483	7,964
		LI	15,089	5,319	0,028	0,998	29,179
		M	-12,445	6,487	0,334	-29,627	4,737
	M	CI	6,186	5,828	1,000	-9,252	21,623
		LI	27,534	5,782	0,000	12,219	42,848
		W	12,445	6,487	0,334	-4,737	29,627
dry weight (g)	CI	LI	2,664	2,073	1,000	-2,827	8,156
		W	2,267	2,479	1,000	-4,299	8,834
		M	-13,340	2,691	0,000	-20,467	-6,212
	LI	CI	-2,664	2,073	1,000	-8,156	2,827
		W	-0,397	2,458	1,000	-6,908	6,115
		M	-16,004	2,672	0,000	-23,081	-8,927
	W	CI	-2,267	2,479	1,000	-8,834	4,299
		LI	0,397	2,458	1,000	-6,115	6,908
		M	-15,607	2,998	0,000	-23,548	-7,667
	M	CI	13,340	2,691	0,000	6,212	20,467
		LI	16,004	2,672	0,000	8,927	23,081
		W	15,607	2,998	0,000	7,667	23,548
% leaves	CI	LI	-3,436	1,649	0,226	-7,803	0,931
		W	2,707	1,971	1,000	-2,514	7,928
		M	-3,553	2,140	0,585	-9,221	2,115
	LI	CI	3,436	1,649	0,226	-0,931	7,803
		W	6,143	1,955	0,011	0,965	11,321
		M	-0,117	2,125	1,000	-5,745	5,511
	W	CI	-2,707	1,971	1,000	-7,928	2,514
		LI	-6,143	1,955	0,011	-11,321	-0,965
		M	-6,260	2,384	0,053	-12,574	0,054
	M	CI	3,553	2,140	0,585	-2,115	9,221
		LI	0,117	2,125	1,000	-5,511	5,745
		W	6,260	2,384	0,053	-0,054	12,574
% green parts	CI	LI	5,917	3,324	0,454	-2,890	14,724
		W	9,758	4,042	0,097	-0,951	20,467
		M	-0,934	4,238	1,000	-12,163	10,295
	LI	CI	-5,917	3,324	0,454	-14,724	2,890
		W	3,841	3,999	1,000	-6,754	14,436
		M	-6,851	4,197	0,620	-17,971	4,269
	W	CI	-9,758	4,042	0,097	-20,467	0,951
		LI	-3,841	3,999	1,000	-14,436	6,754
		M	-10,692	4,786	0,156	-23,372	1,988
	M	CI	0,934	4,238	1,000	-10,295	12,163
		LI	6,851	4,197	0,620	-4,269	17,971
		W	10,692	4,786	0,156	-1,988	23,372
biomass (g/m2)	CI	LI	224,706	72,870	0,013	31,101	418,312

		W	63,644	81,527	1,000	-152,962	280,250
		M	-59,686	98,618	1,000	-321,700	202,328
	LI	CI	-224,706	72,870	0,013	-418,312	-31,101
		W	-161,063	76,251	0,213	-363,652	41,527
		M	-284,392	94,303	0,017	-534,943	-33,841
	W	CI	-63,644	81,527	1,000	-280,250	152,962
		LI	161,063	76,251	0,213	-41,527	363,652
		M	-123,330	101,142	1,000	-392,050	145,391
	M	CI	59,686	98,618	1,000	-202,328	321,700
		LI	284,392	94,303	0,017	33,841	534,943
		W	123,330	101,142	1,000	-145,391	392,050
% N	CI	LI	-0,146	0,149	1,000	-0,545	0,253
		W	0,234	0,176	1,000	-0,238	0,705
		M	-0,683	0,171	0,001	-1,141	-0,226
	LI	CI	0,146	0,149	1,000	-0,253	0,545
		W	0,380	0,171	0,168	-0,078	0,837
		M	-0,537	0,166	0,009	-0,980	-0,094
	W	CI	-0,234	0,176	1,000	-0,705	0,238
		LI	-0,380	0,171	0,168	-0,837	0,078
		M	-0,917	0,191	0,000	-1,426	-0,407
	M	CI	0,683	0,171	0,001	0,226	1,141
		LI	0,537	0,166	0,009	0,094	0,980
		W	0,917	0,191	0,000	0,407	1,426
% P	CI	LI	-0,003	0,016	1,000	-0,047	0,040
		W	0,058	0,019	0,018	0,007	0,109
		M	-0,020	0,019	1,000	-0,070	0,030
	LI	CI	0,003	0,016	1,000	-0,040	0,047
		W	0,061	0,019	0,008	0,011	0,111
		M	-0,017	0,018	1,000	-0,066	0,031
	W	CI	-0,058	0,019	0,018	-0,109	-0,007
		LI	-0,061	0,019	0,008	-0,111	-0,011
		M	-0,078	0,021	0,001	-0,134	-0,023
	M	CI	0,020	0,019	1,000	-0,030	0,070
		LI	0,017	0,018	1,000	-0,031	0,066
		W	0,078	0,021	0,001	0,023	0,134
% Na	CI	LI	0,098	0,029	0,006	0,020	0,177
		W	-0,027	0,035	1,000	-0,120	0,065
		M	0,143	0,034	0,000	0,053	0,233
	LI	CI	-0,098	0,029	0,006	-0,177	-0,020
		W	-0,125	0,034	0,002	-0,215	-0,036
		M	0,045	0,033	1,000	-0,042	0,132
	W	CI	0,027	0,035	1,000	-0,065	0,120
		LI	0,125	0,034	0,002	0,036	0,215
		M	0,171	0,037	0,000	0,070	0,271
	M	CI	-0,143	0,034	0,000	-0,233	-0,053
		LI	-0,045	0,033	1,000	-0,132	0,042
		W	-0,171	0,037	0,000	-0,271	-0,070
% Ca	CI	LI	-0,054	0,042	1,000	-0,167	0,059
		W	0,148	0,050	0,021	0,015	0,282
		M	-0,223	0,049	0,000	-0,353	-0,093
	LI	CI	0,054	0,042	1,000	-0,059	0,167
		W	0,202	0,049	0,000	0,072	0,332
		M	-0,169	0,047	0,003	-0,295	-0,044
	W	CI	-0,148	0,050	0,021	-0,282	-0,015

	LI	-0,202	0,049	0,000	-0,332	-0,072
	M	-0,372	0,054	0,000	-0,516	-0,227
M	CI	0,223	0,049	0,000	0,093	0,353
	LI	0,169	0,047	0,003	0,044	0,295
	W	0,372	0,054	0,000	0,227	0,516