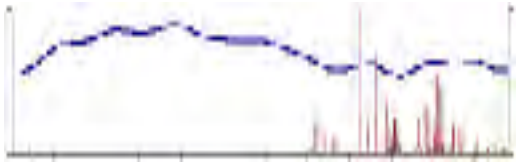
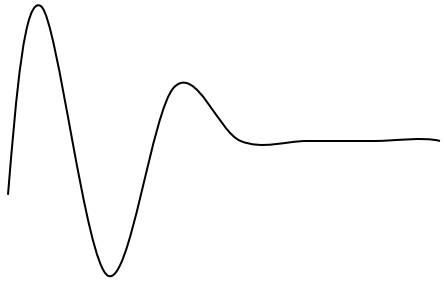
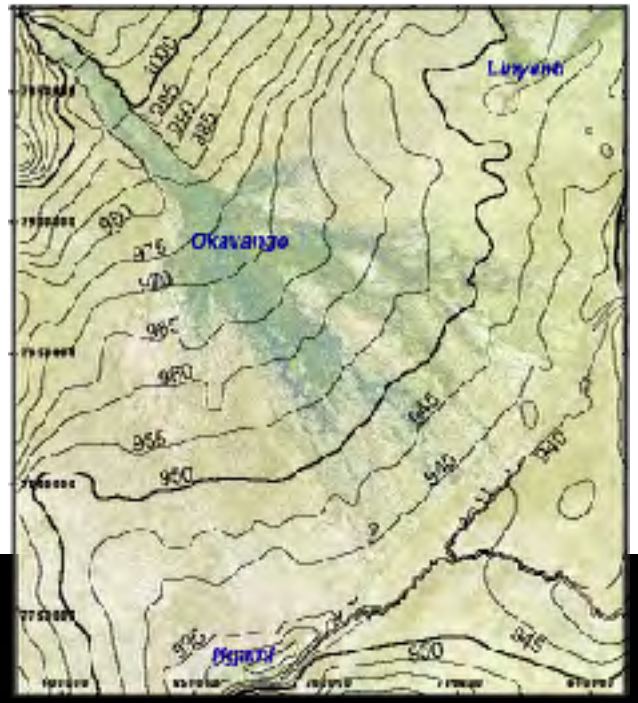
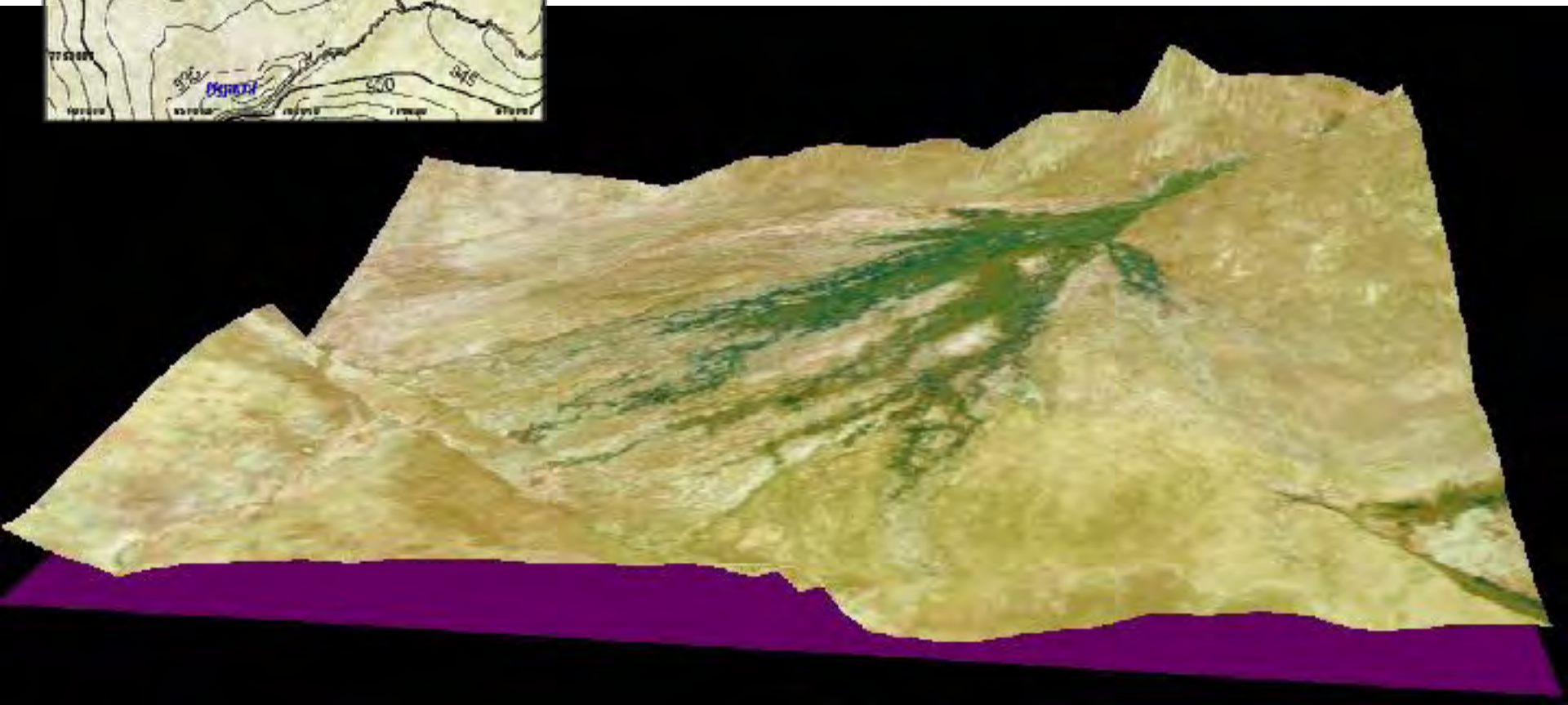
The Okavango Delta - Microtopography and hydrology



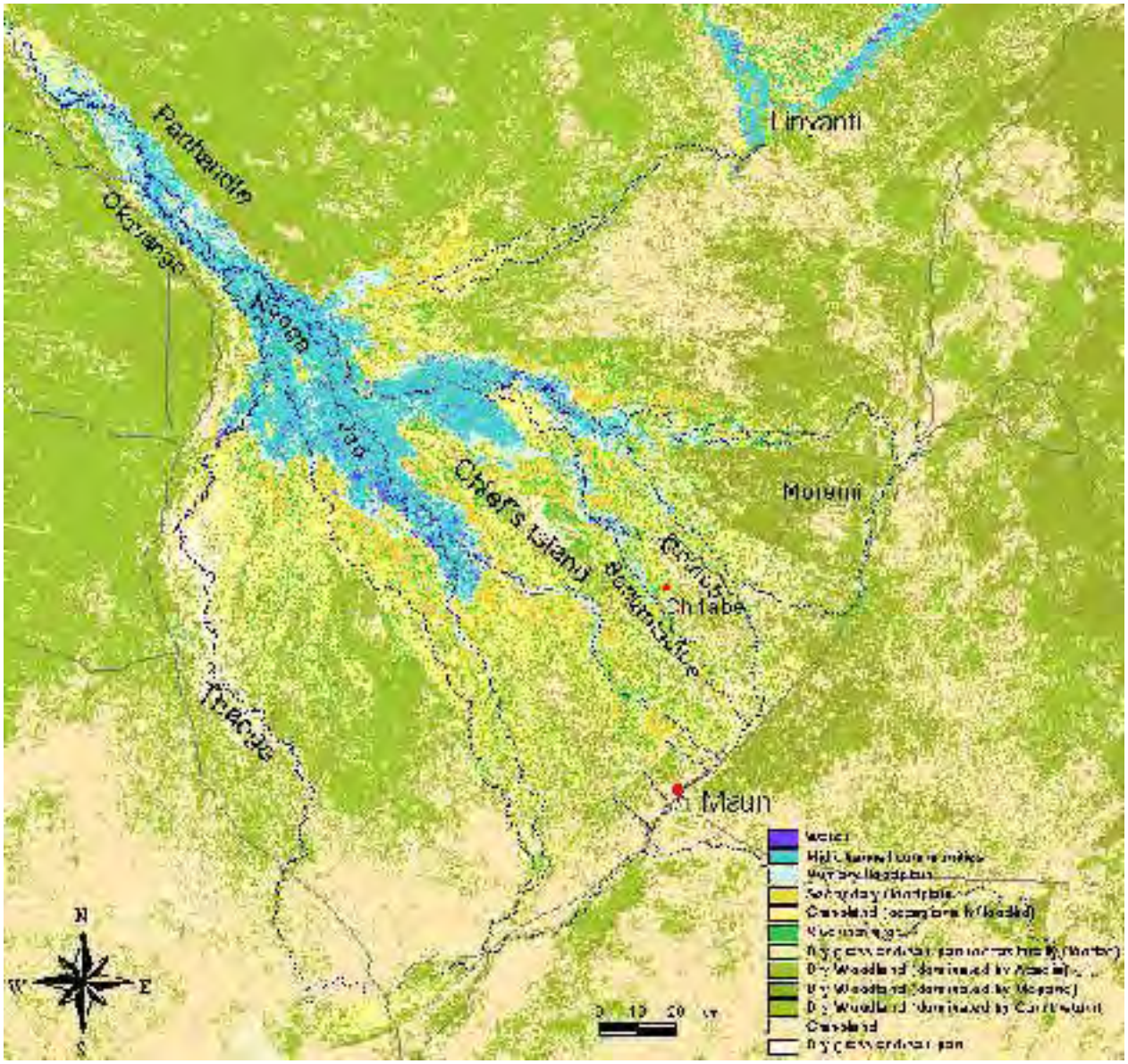


Topography of the Okavango Delta

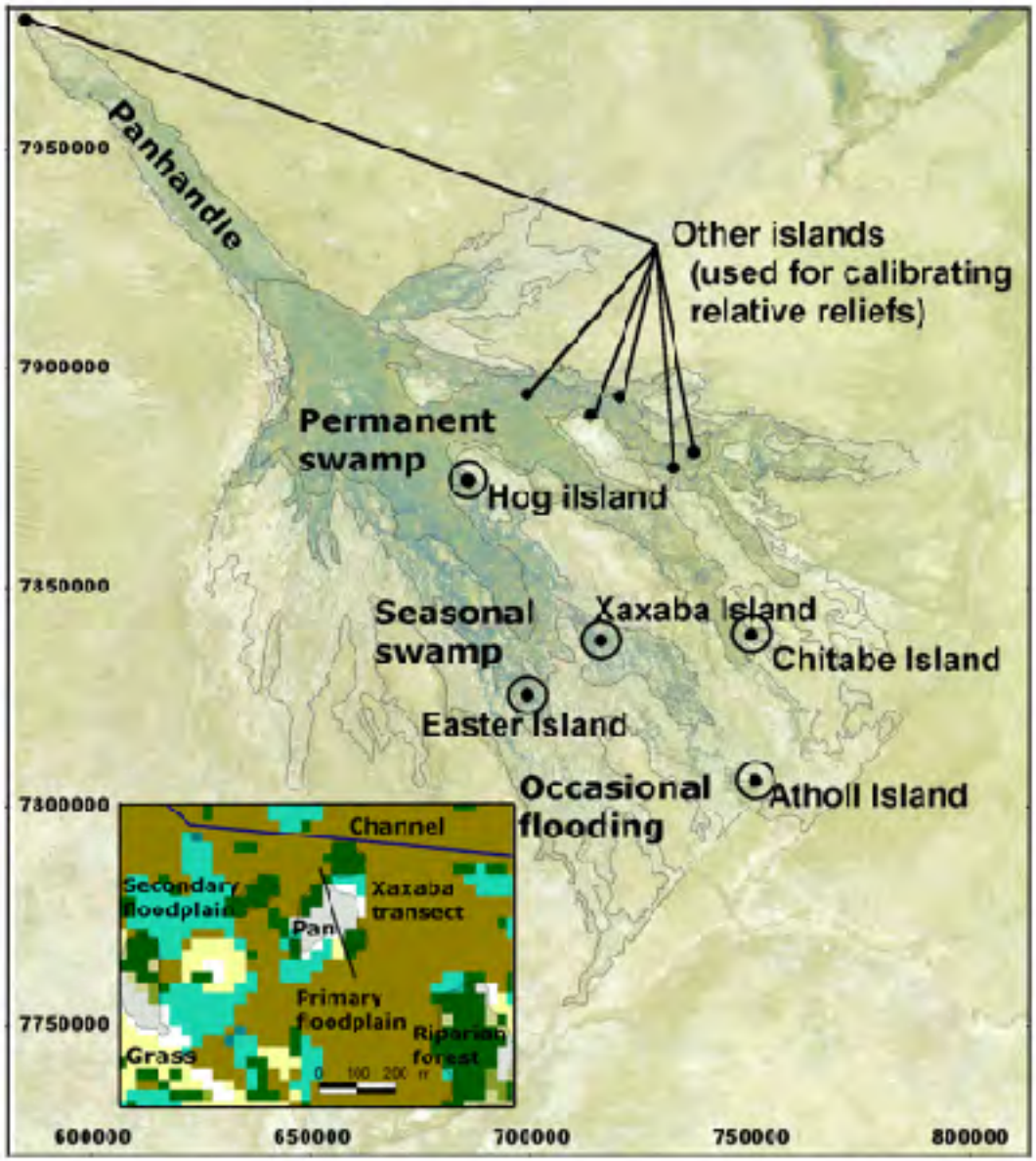




Landcover of the Okavango Delta – a window of the microtopography?



Islands with detailed surveys of landcover and topography

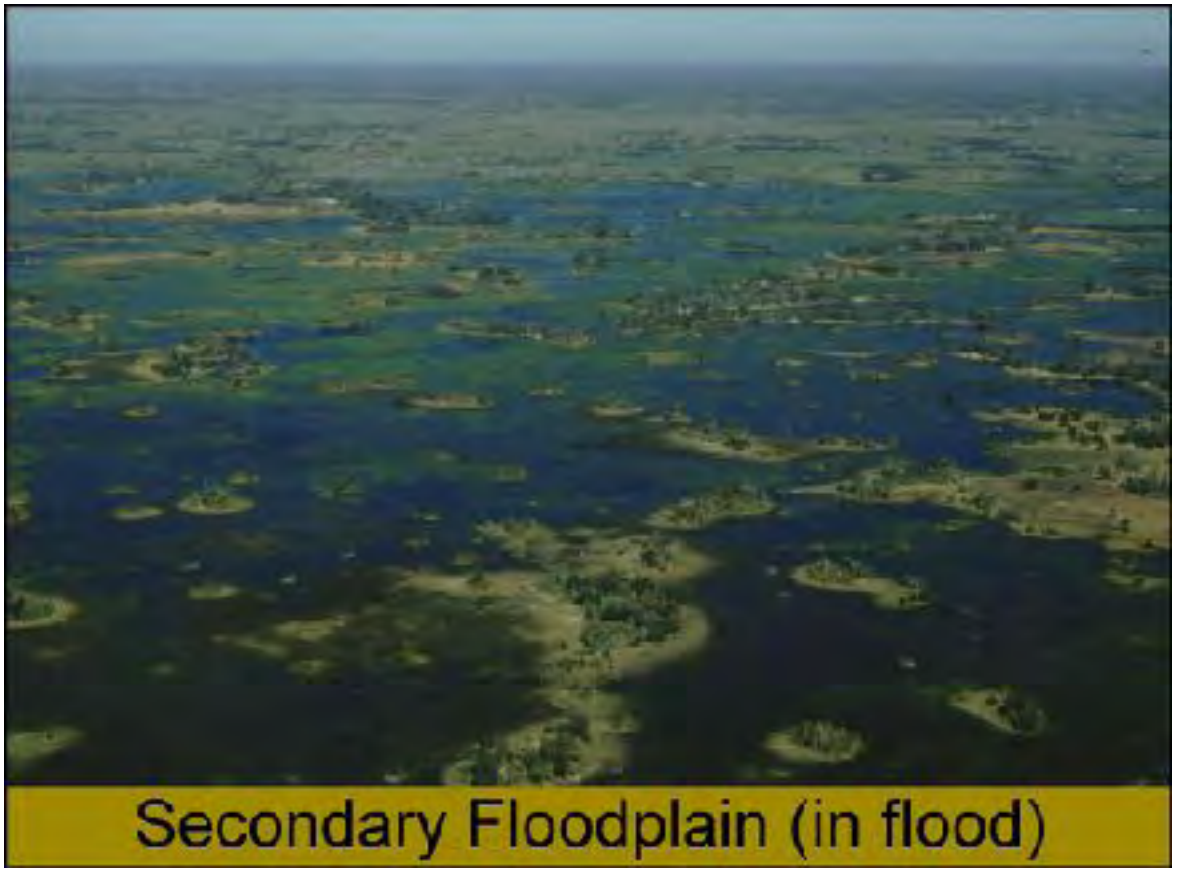


Water = 2.5 m below reference level

Permanent Swamp = 2.0 m below reference level

Primary floodplain = 1.6 m below reference level

Secondary floodplain = 1.0 m below reference level



Grassland = reference level

Salt pan = 0.5 m below reference level

Dry Grassland/Salt Pan

Occasionally flooded grassland = 0.5 m below reference level

Grassland (with occasional flooding)

Salt pan = 0.5 m below reference level

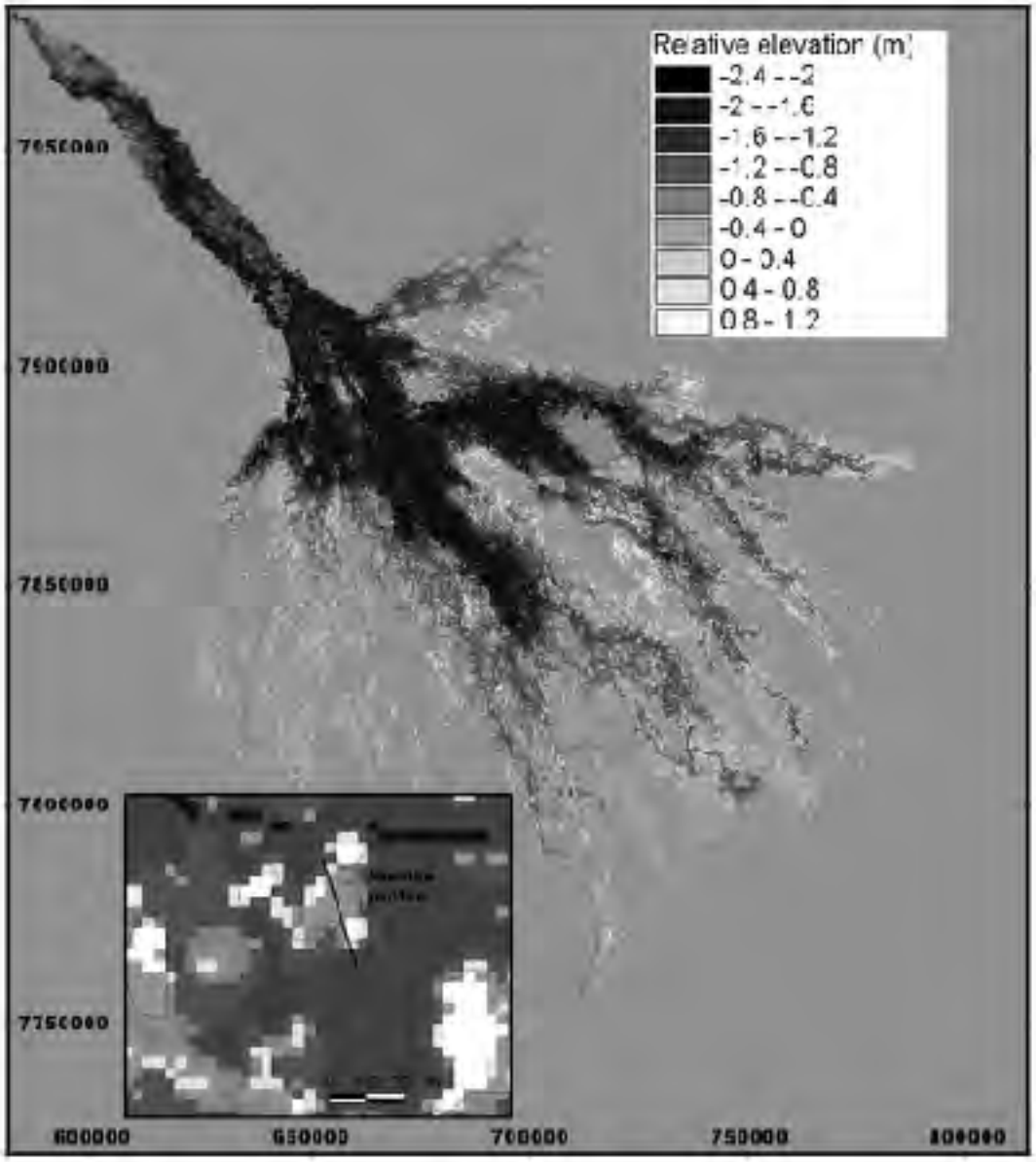
Dry Grassland/Salt Pan (with flooding)

Riverine forest = 1.2 m above reference level

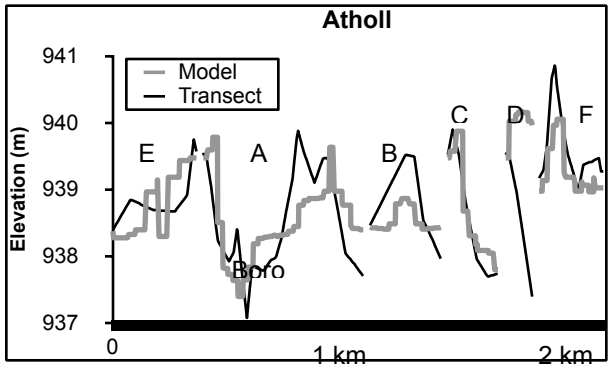
Dry woodland = reference level

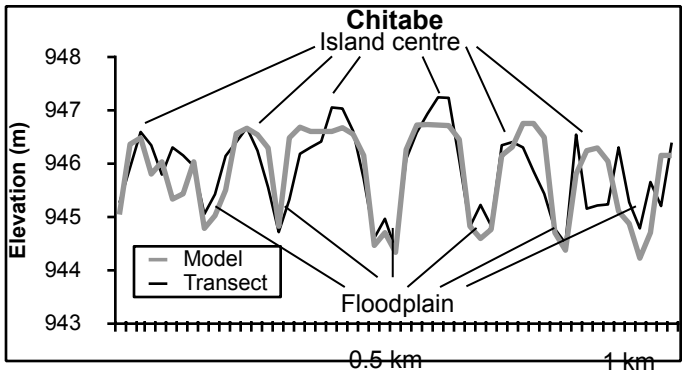
Dry woodland = reference level

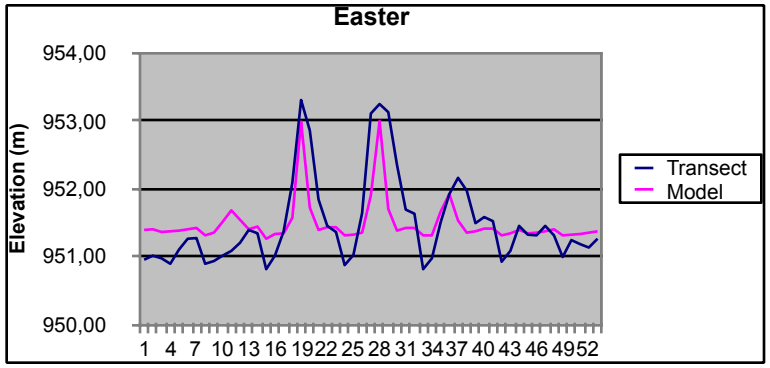
Relative microtopography of the Okavango Delta

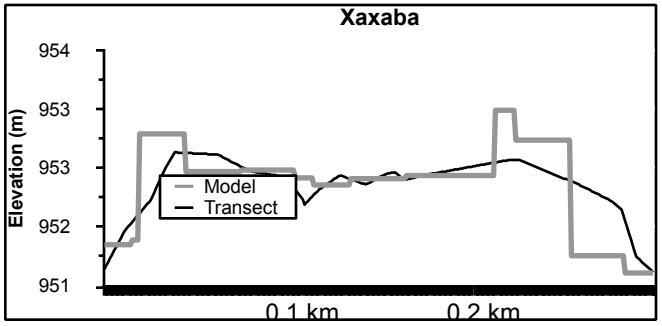


Evaluation of the microtopographic map









Primary islands built from accumulation of clastic sediments

Island types

Inverted channel island

Primary islands built from accumulation of clastic sediments

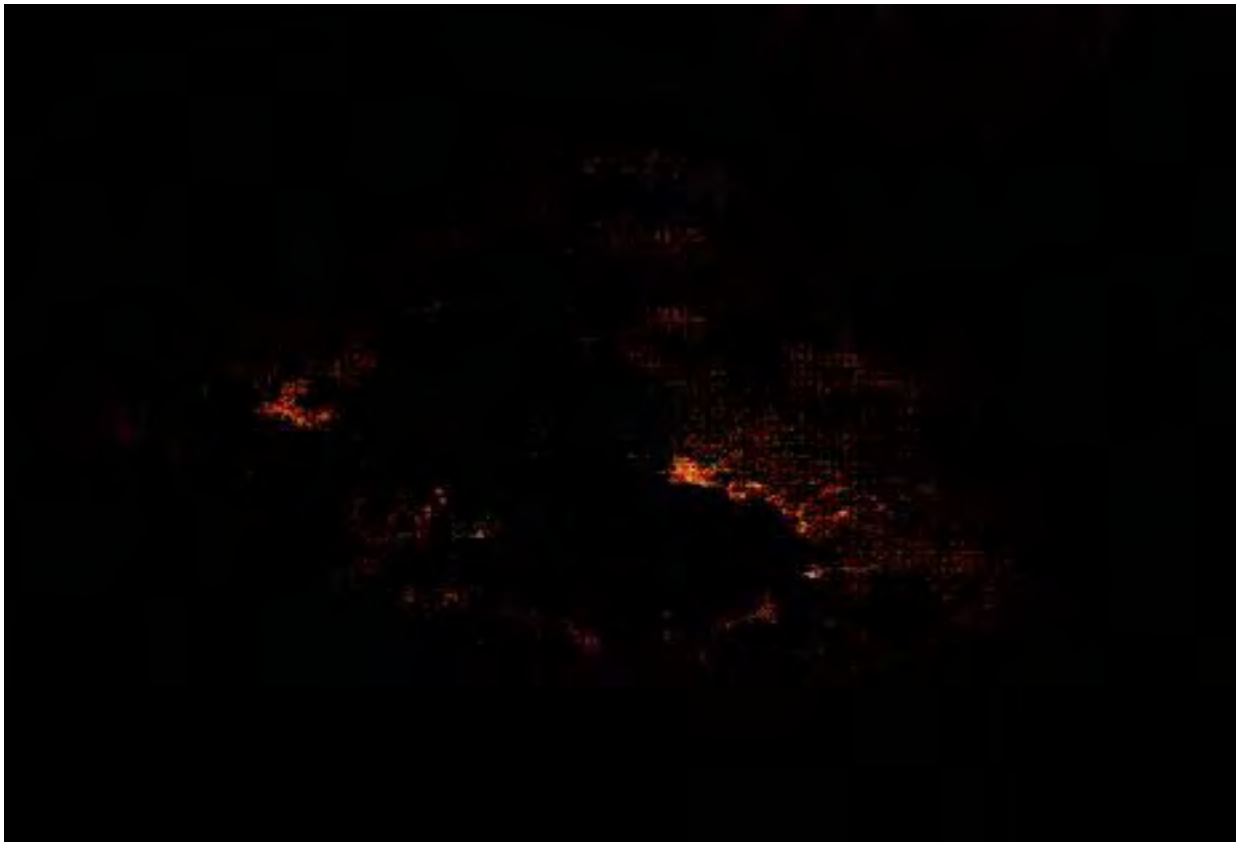
Island types

Scroll bar island

Primary islands built from accumulation of clastic sediments

Island types

Anthill island



Secondary islands grown from precipitation of chemical sediments

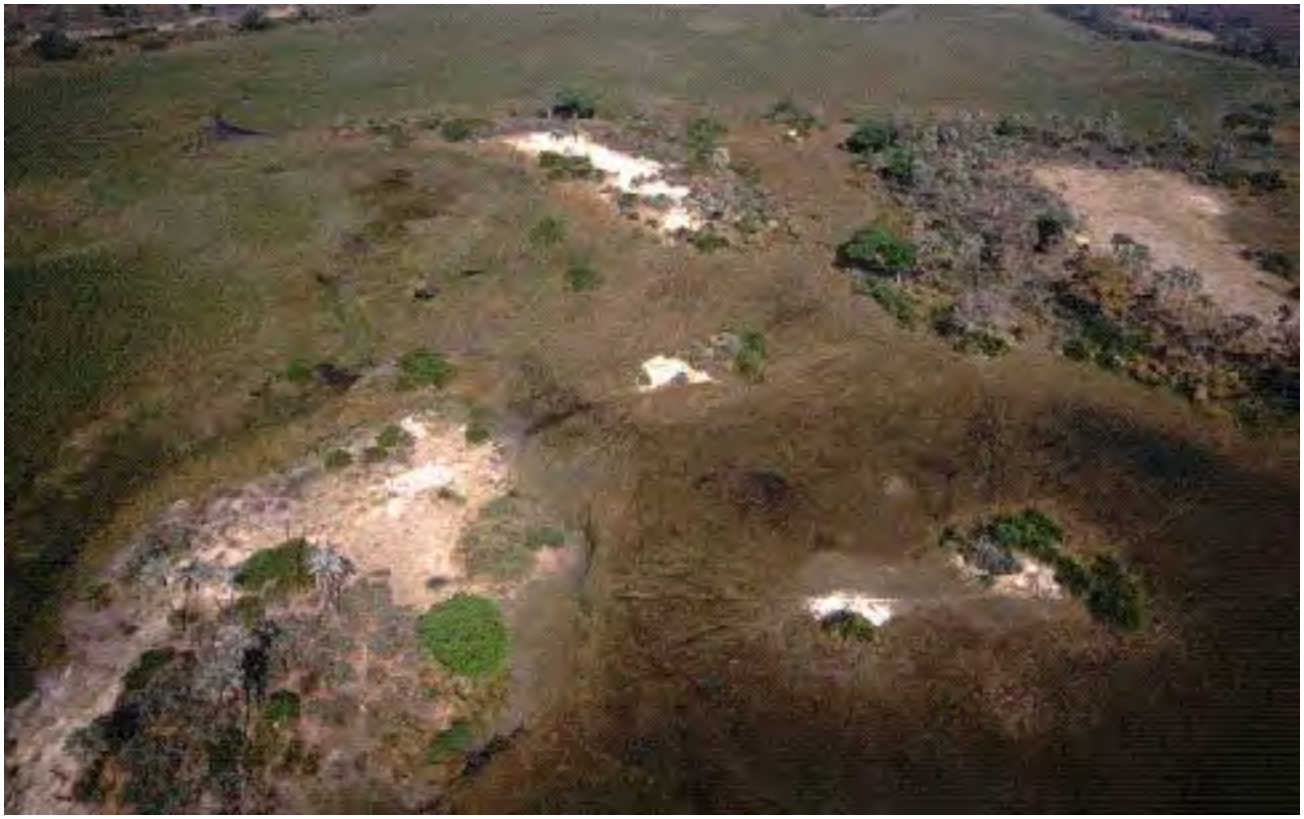
Island types

Riparian forest island

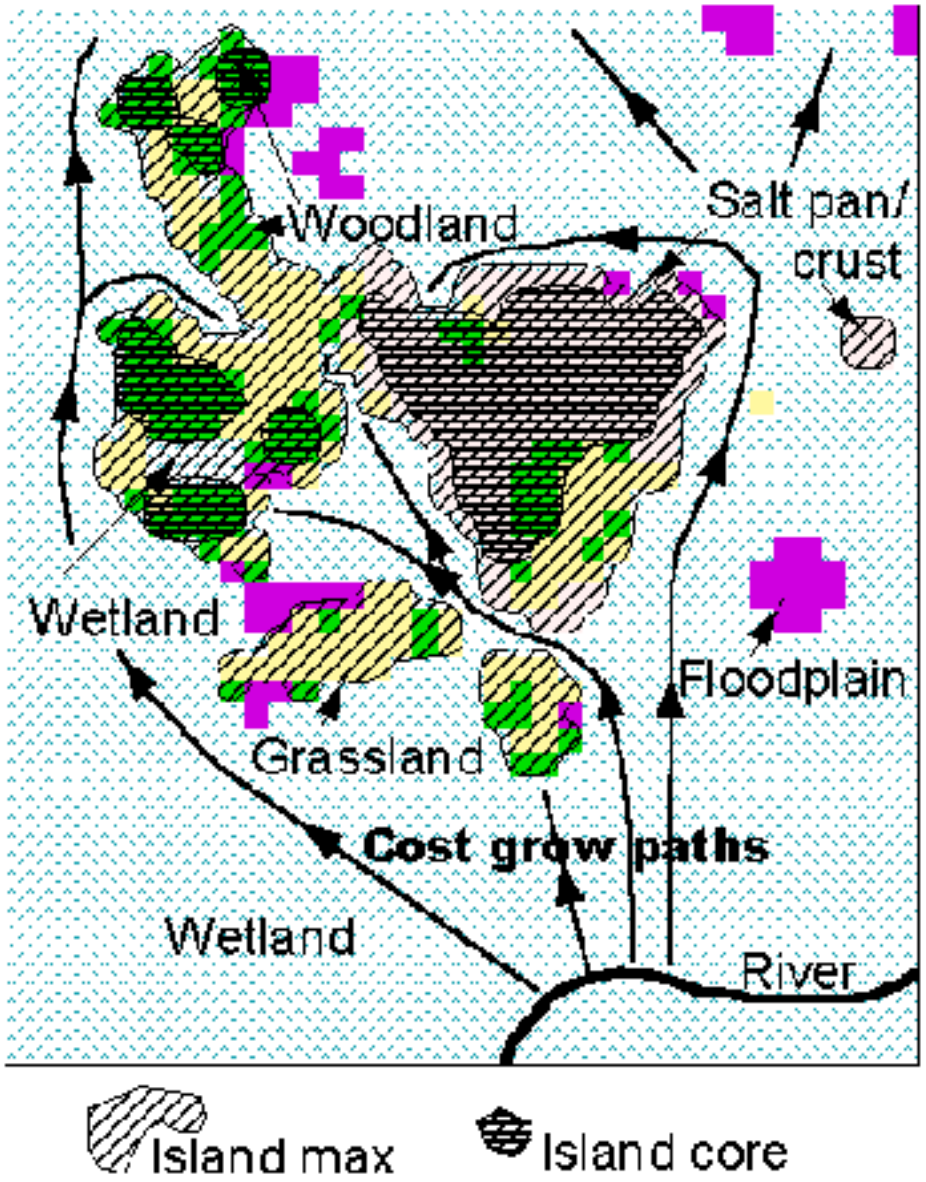
Secondary islands grown from precipitation of chemical sediments

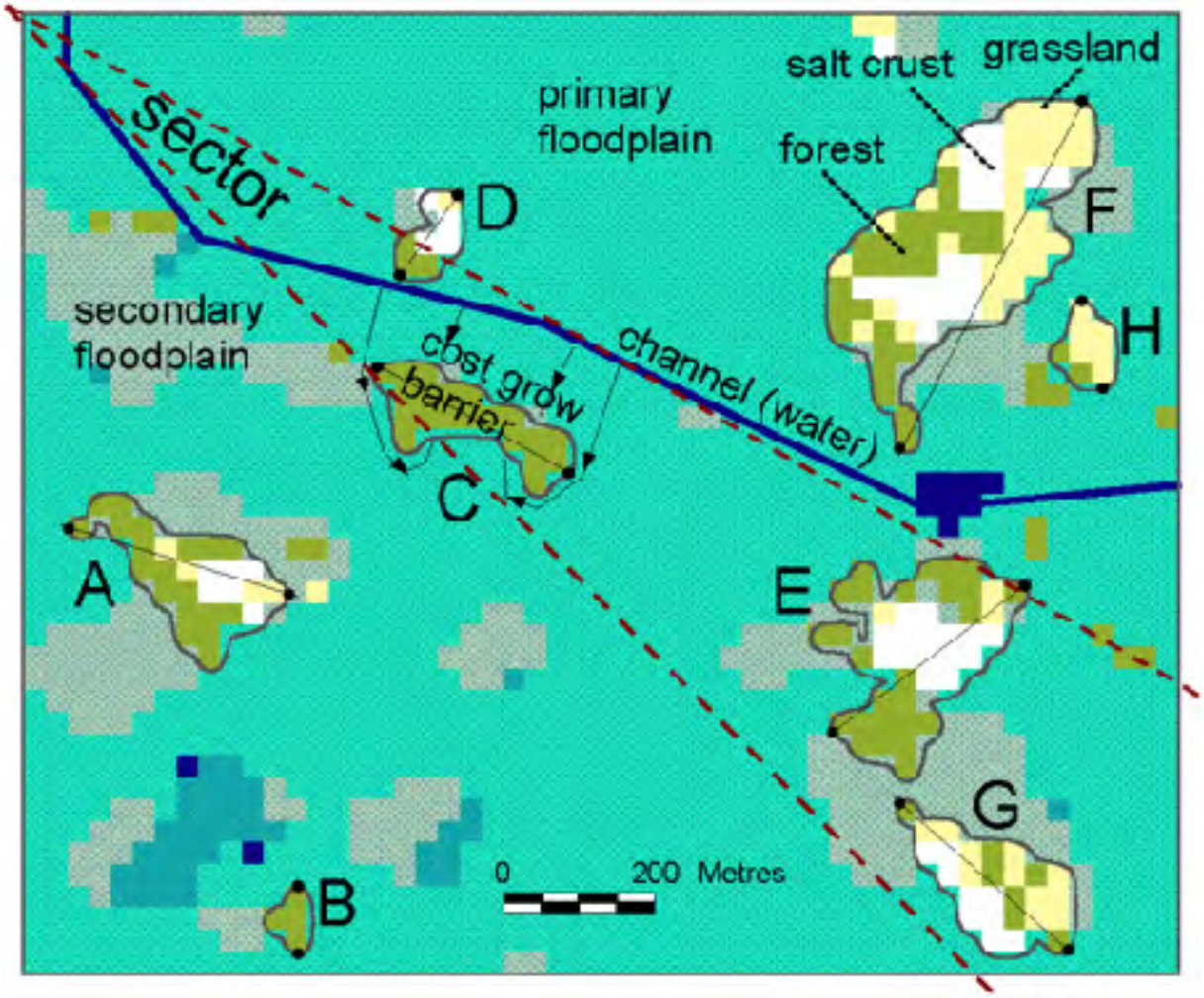
Island types

Salt islands

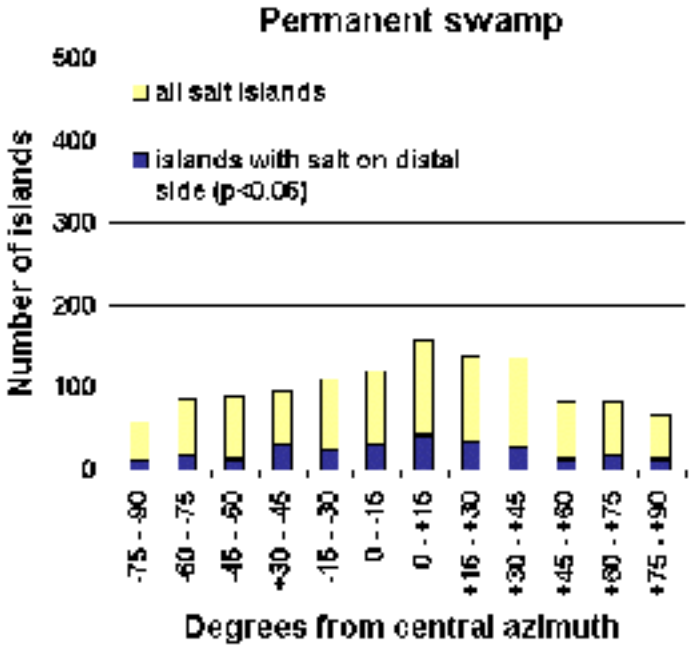


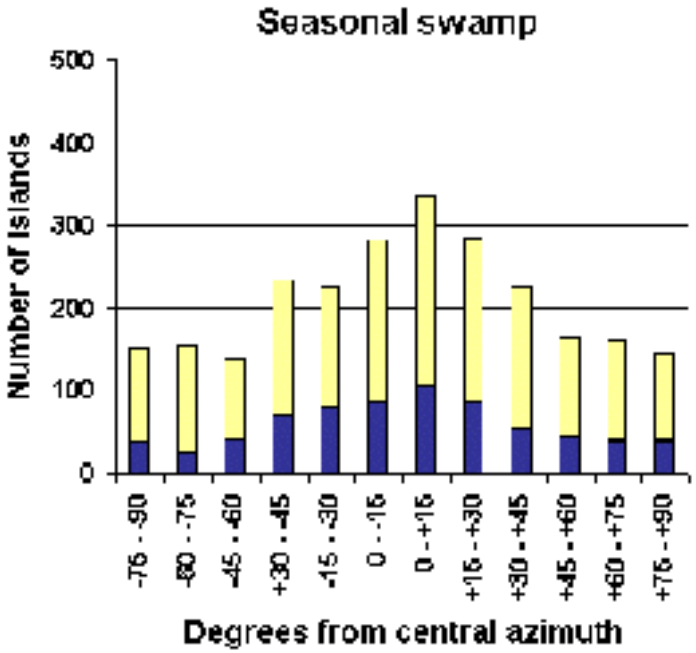
Island delineation

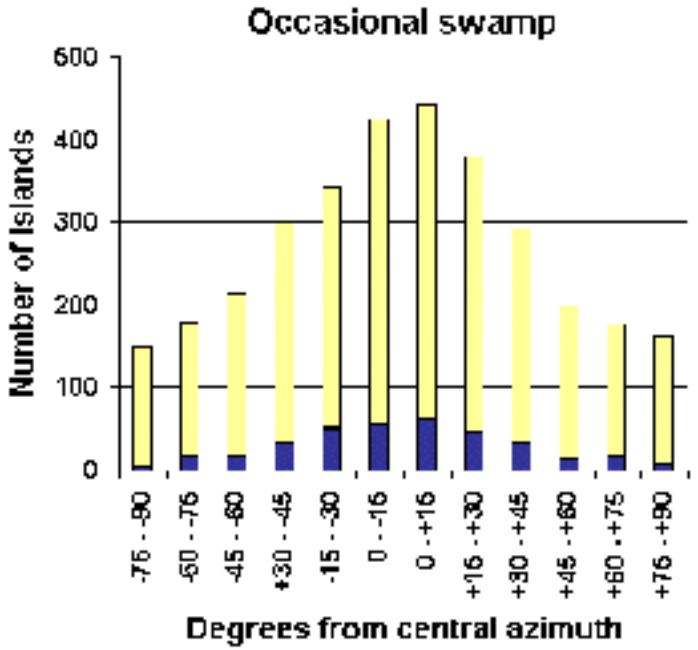




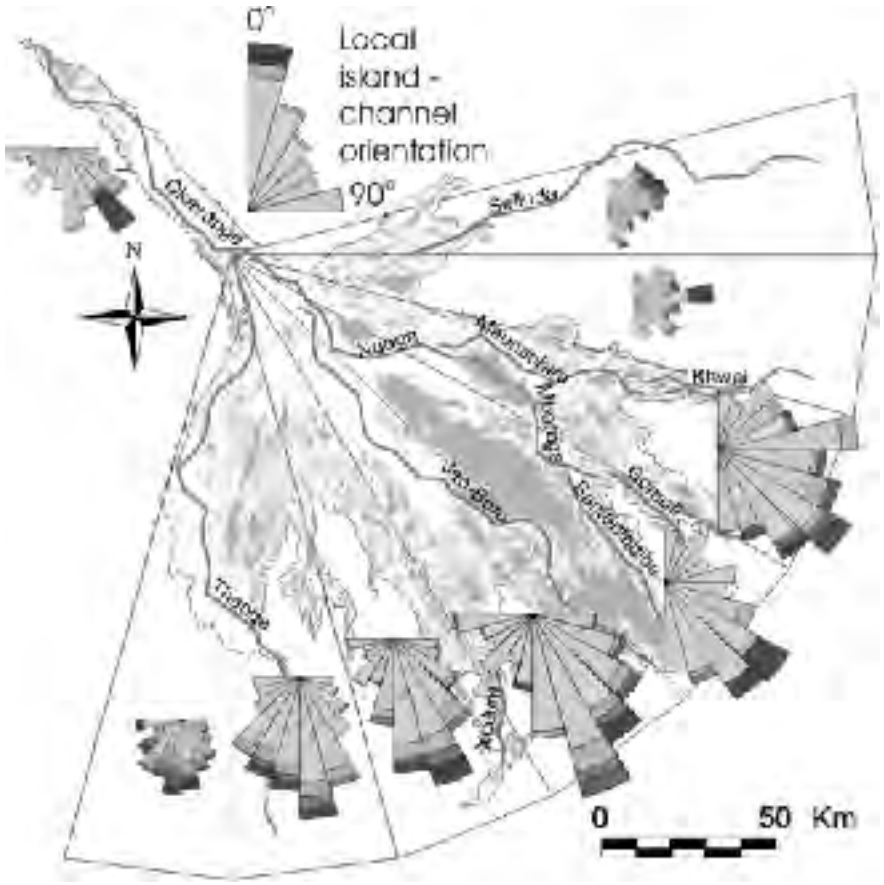
	A	B	C	D	E	F	G	H
Roundness	**0.49**	**0.91**	**0.51**	0.48	**0.36**	**0.47**	**0.58**	0.92
Regional salt position	**distal***	**na**	**na**	**proximal**	**distal**	equal	**proximal**	**na**
Channel salt position	**front**	**na**	**na**	**back**	back	**back**	**back***	**na**


Permanent swamp
all salt islands
islands with salt on distal side (p<0.05)
Number of Islands
0
100
200
300
400
500
-75 - -90
-60 - -75
-45 - -60
+30 - -45
-15 - -30
0 - -15
0 - +15
+16 - +30
+30 - +45
+45 - +60
+60 - +75
+75 - +90
Degrees from central azimuth


Seasonal swamp
Number of Islands
0
100
200
300
400
500
-75 - -90
-60 - -75
-45 - -60
+30 - -45
-15 - -30
0 - -15
0 - +15
+16 - +30
+30 - +45
+45 - +60
+60 - +75
+75 - +90
Degrees from central azimuth

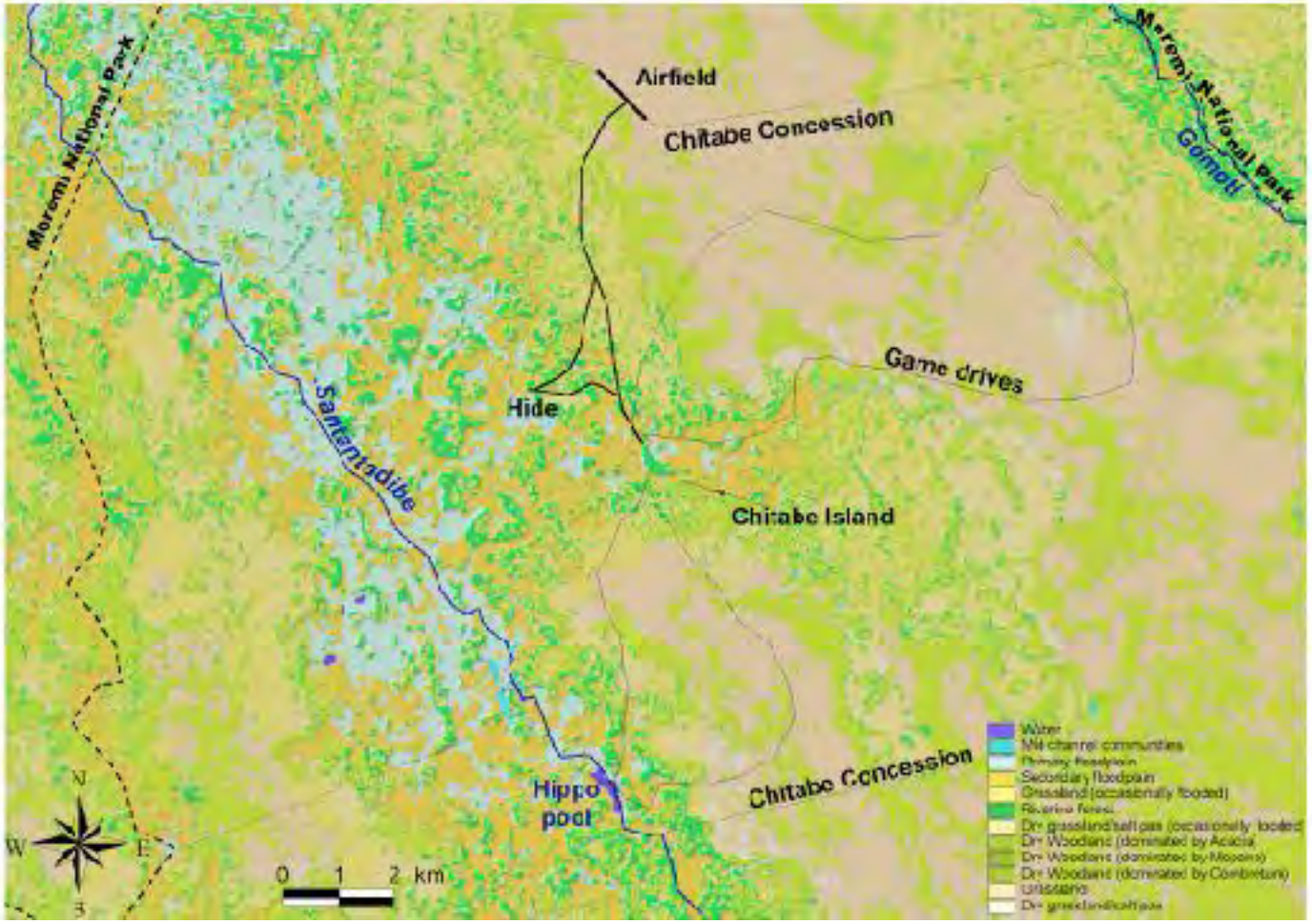

Occasional swamp
Number of Islands
0
100
200
300
400
500
600
-75 - -90
-60 - -75
-45 - -60
+30 - -45
-15 - -30
0 - -15
0 - +15
+16 - +30
+30 - +45
+45 - +60
+60 - +75
+75 - +90
Degrees from central azimuth

Island orientation – interacting with water flow over the Delta surface



Detail of the Chitabe area

Detailed relief of the Chitabe area

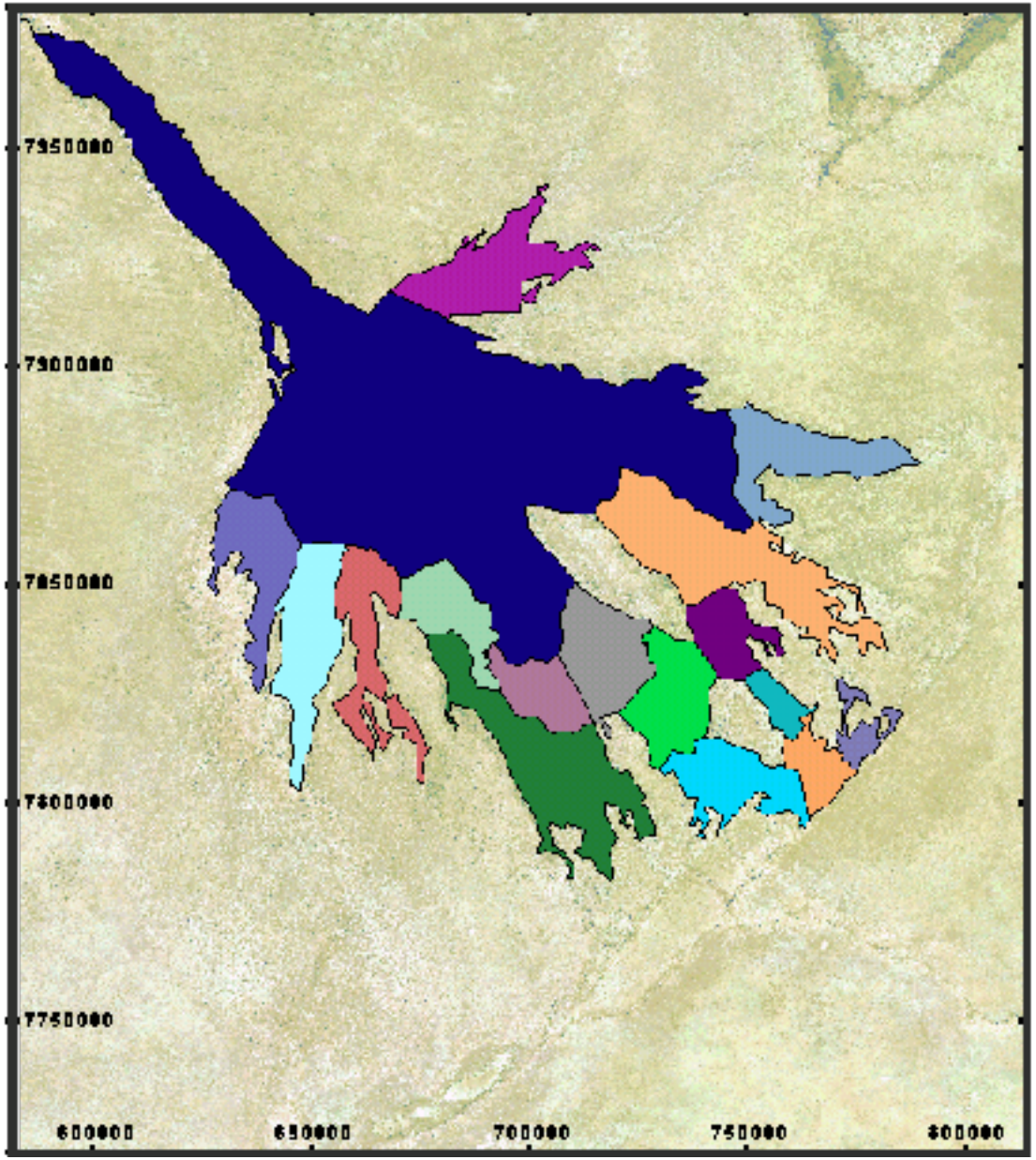


Microtopography – conclusions

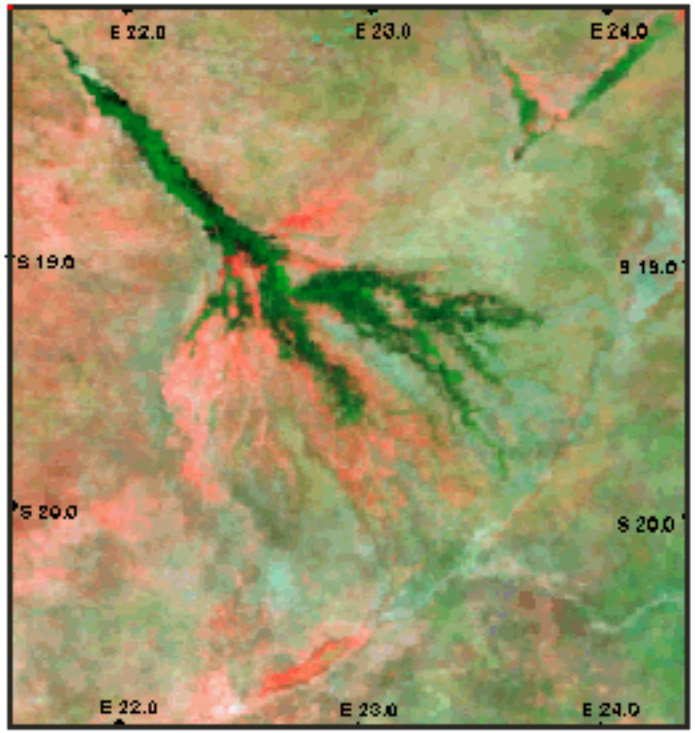
Simple compared to other methods
But some merits
•Cheap
•Fits land cover perfectly
•Bathymery in addition to topography

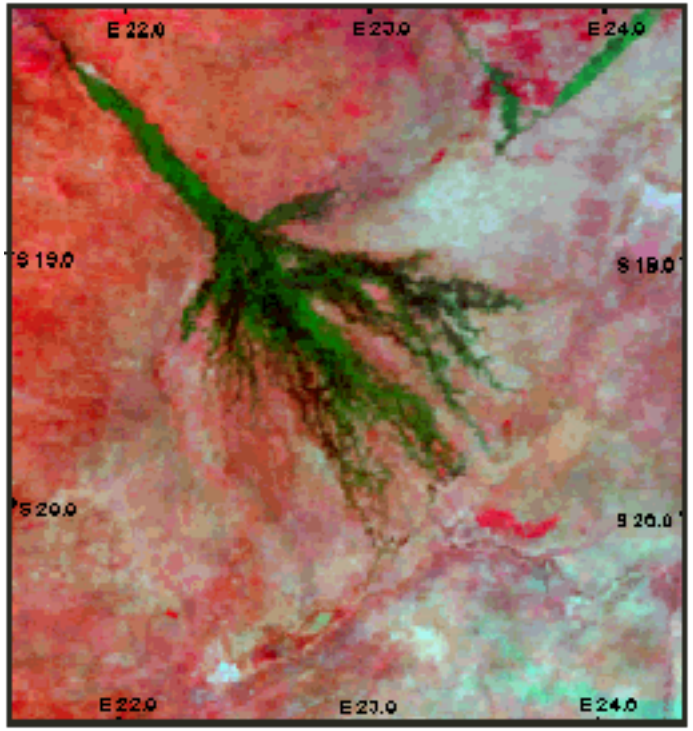
The volume represented by islands would take approximately 50000 years to accumulate given the rate of dissolved matter inflow to the Okavango Delta. Over this time period the total matter added to the present active (flooded) Delta would have built 1 metre.

Sub-basins of the Okavango delineated from the microtopography



Flooding of the Okavango – a statistical prediction model



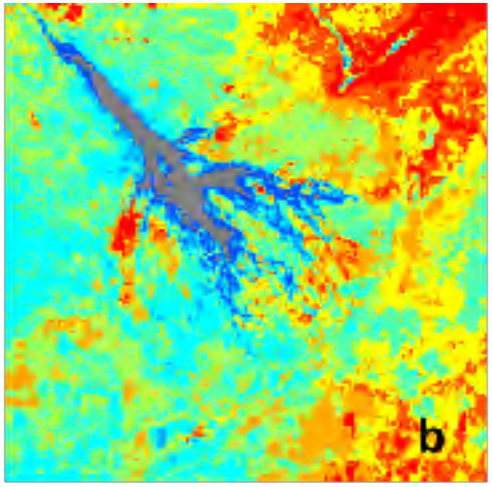


Calibrating and validating the Delta model

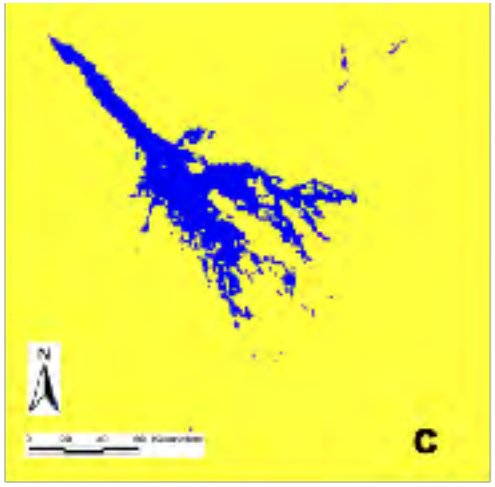
Classification of historical flood area

Unsupervised classification of ~ 400 satellite images (NOAA AVHRR, ERS-2 ATSR), and supervised classification of Landsat MSS / TM (subset of ~ 3000 images)

AVHRR

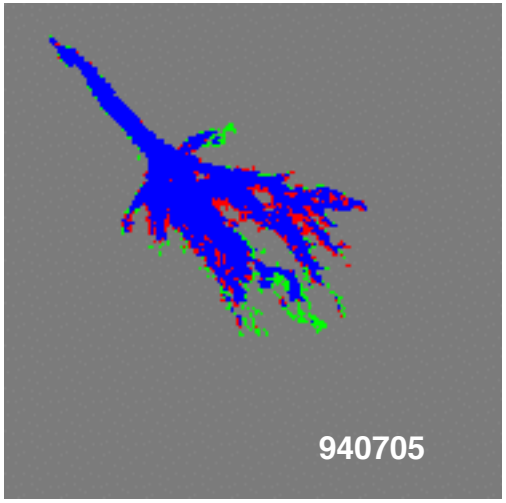


Unsupervised classification

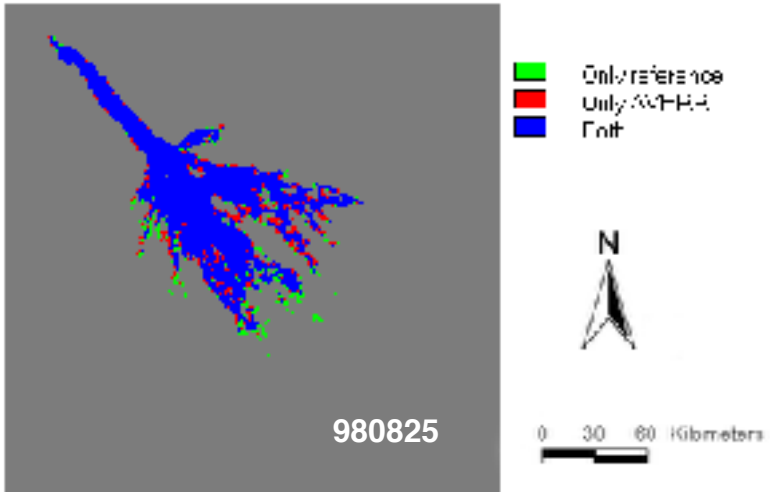


Manual reclassification

Evaluation of AVHRR against Landsat TM & ATSR

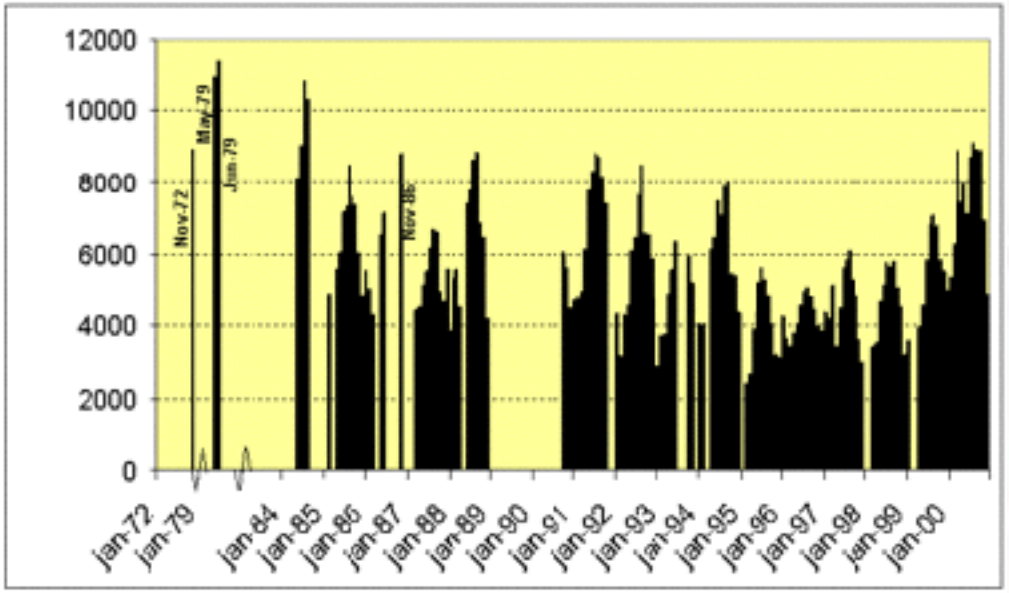


AVHRR vs. Landsat TM

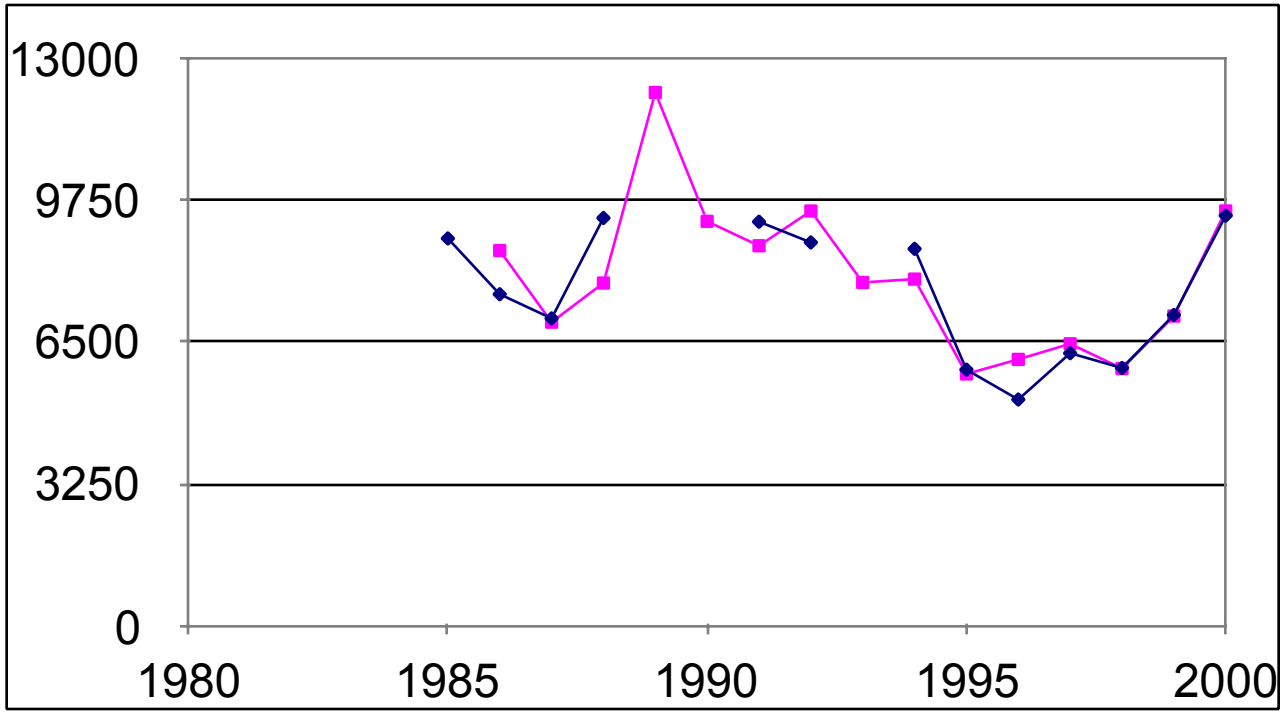


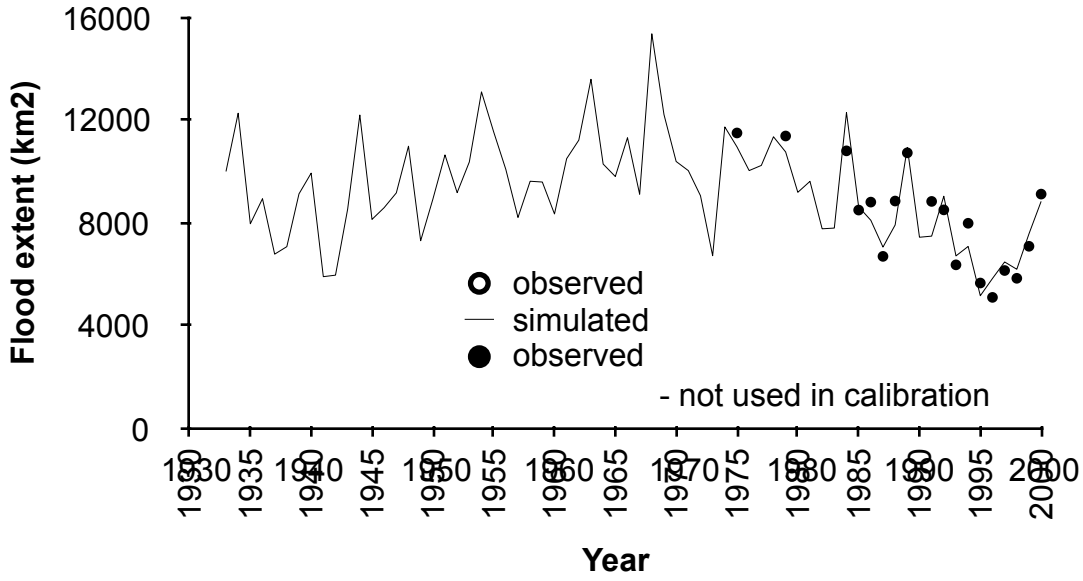
AVHRR vs. ATSR

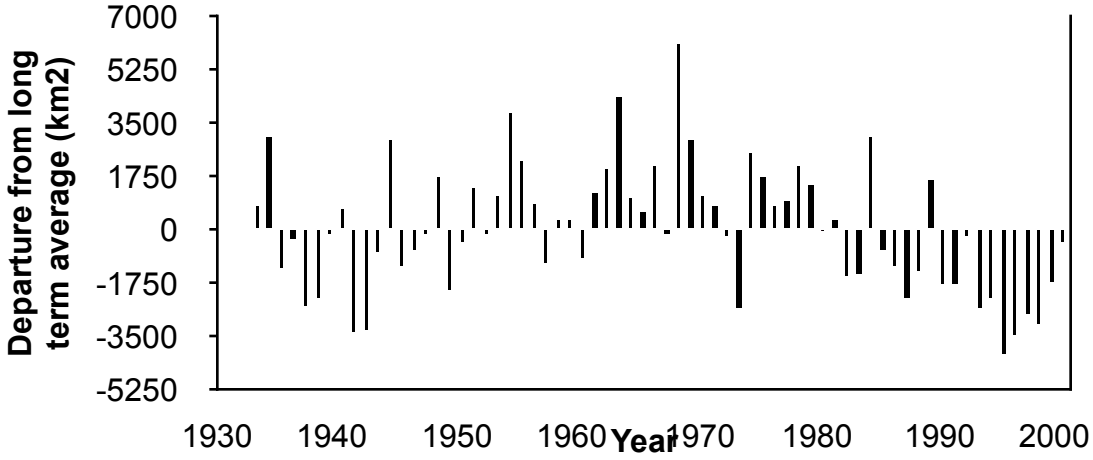
Flooding, years (1985-2000)

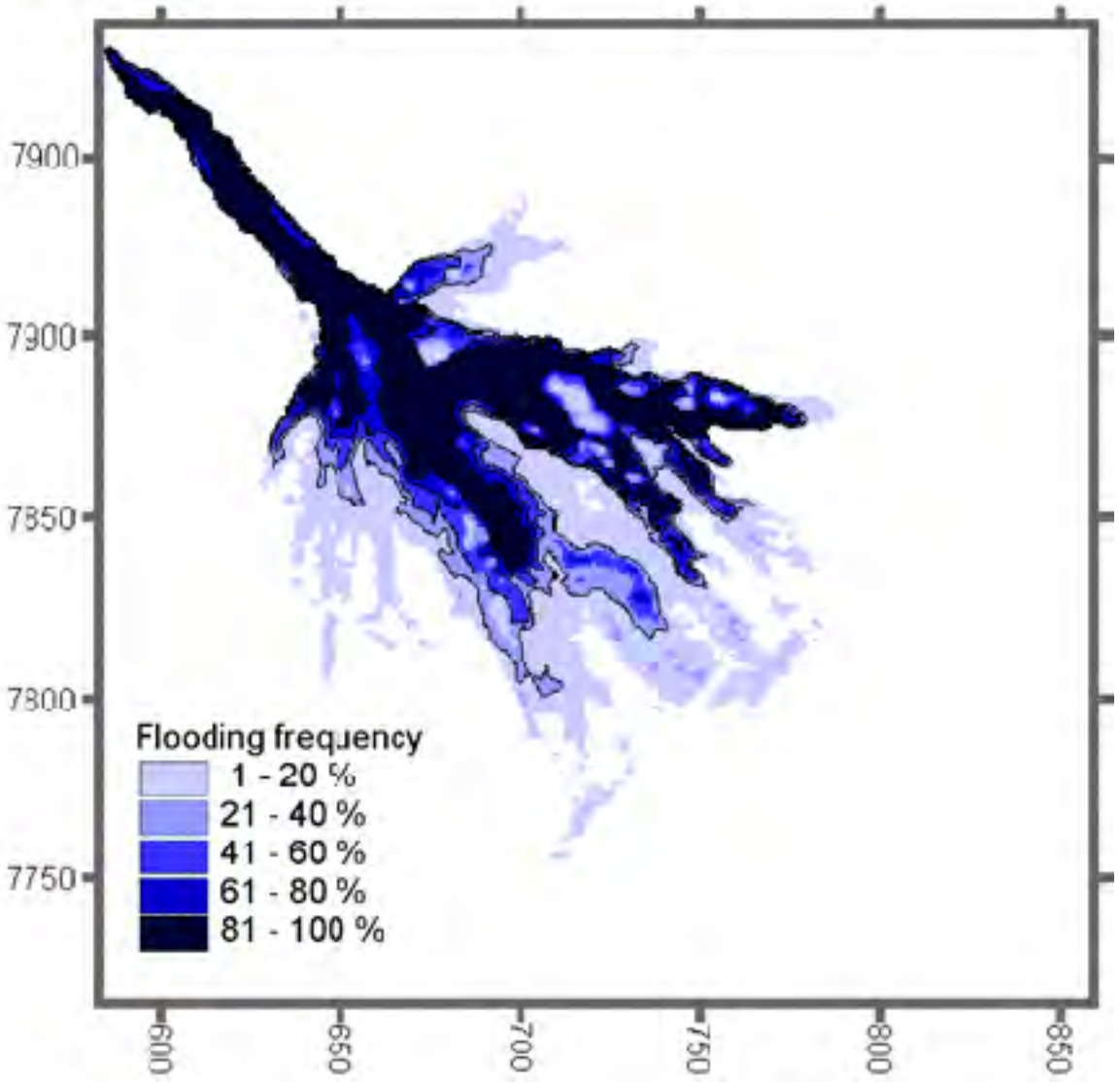


Maximum area of flooding =
Inflow at the Panhandle +
local precipitation +
previous years flood


13000
9750
6500
3250
0
1980
1985
1990
1995
2000


16000
12000
8000
4000
0
Flood extent (km2)
observed
simulated
observed
- not used in calibration
1930
1935
1940
1945
1950
1955
1960
1965
1970
1975
1980
1985
1990
1995
2000
Year


Departure from long term average (km2)
7000
5250
3500
1750
0
-1750
-3500
-5250
1930
1940
1950
1960
1970
1980
1990
2000
Year


7900
7850
7800
7750
600
650
700
750
800
850
Flooding frequency
1 - 20 %
21 - 40 %
41 - 60 %
61 - 80 %
81 - 100 %

4500 km^2

5500 km^2

5000 km^2

6000 km^2

6500 km^2

7000 km^2

7500 km^2

8000 km^2

8500 km^2

9000 km^2

9500 km^2

10000 km^2

10500 km^2

11000 km^2

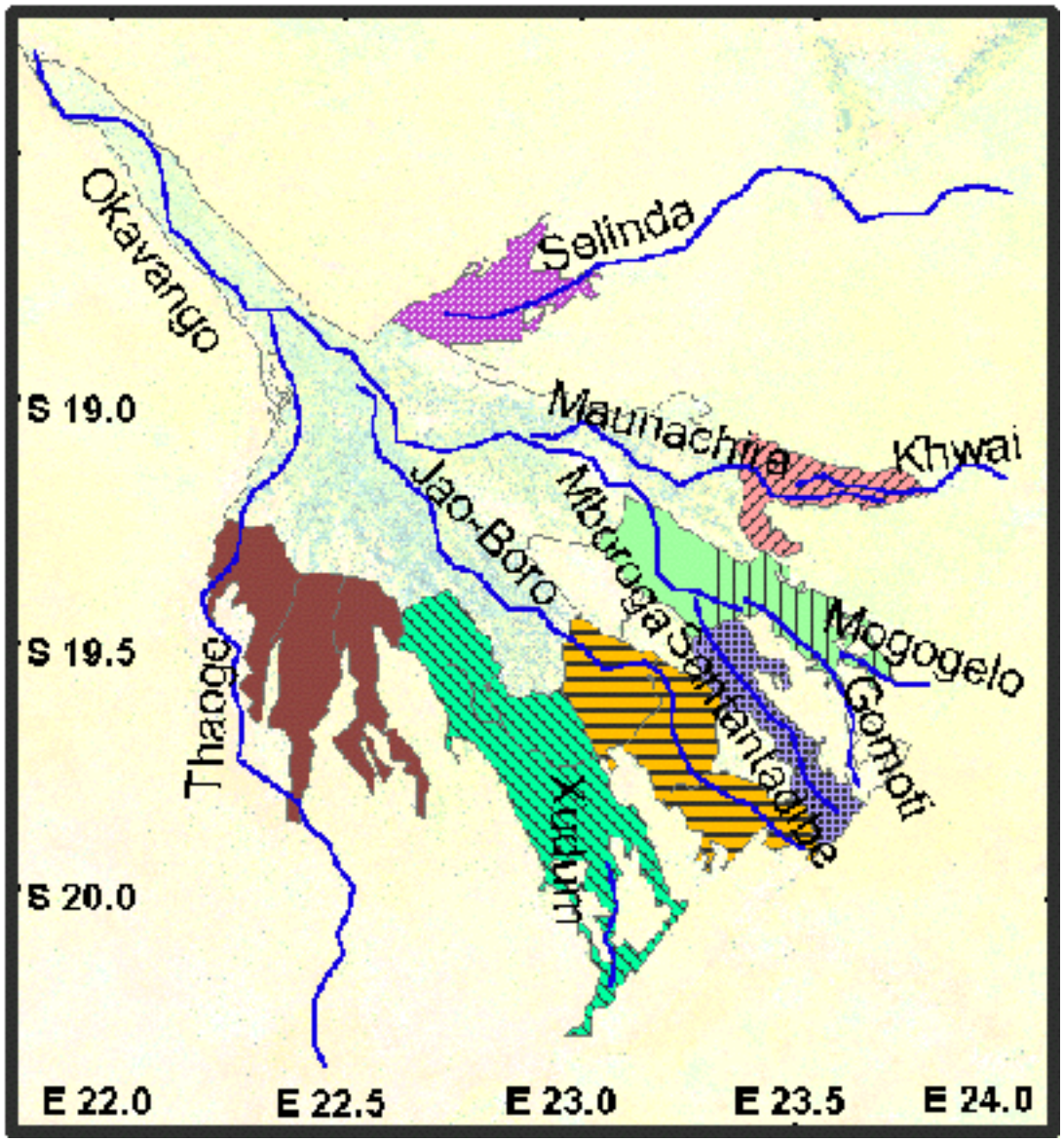
11500 km^2

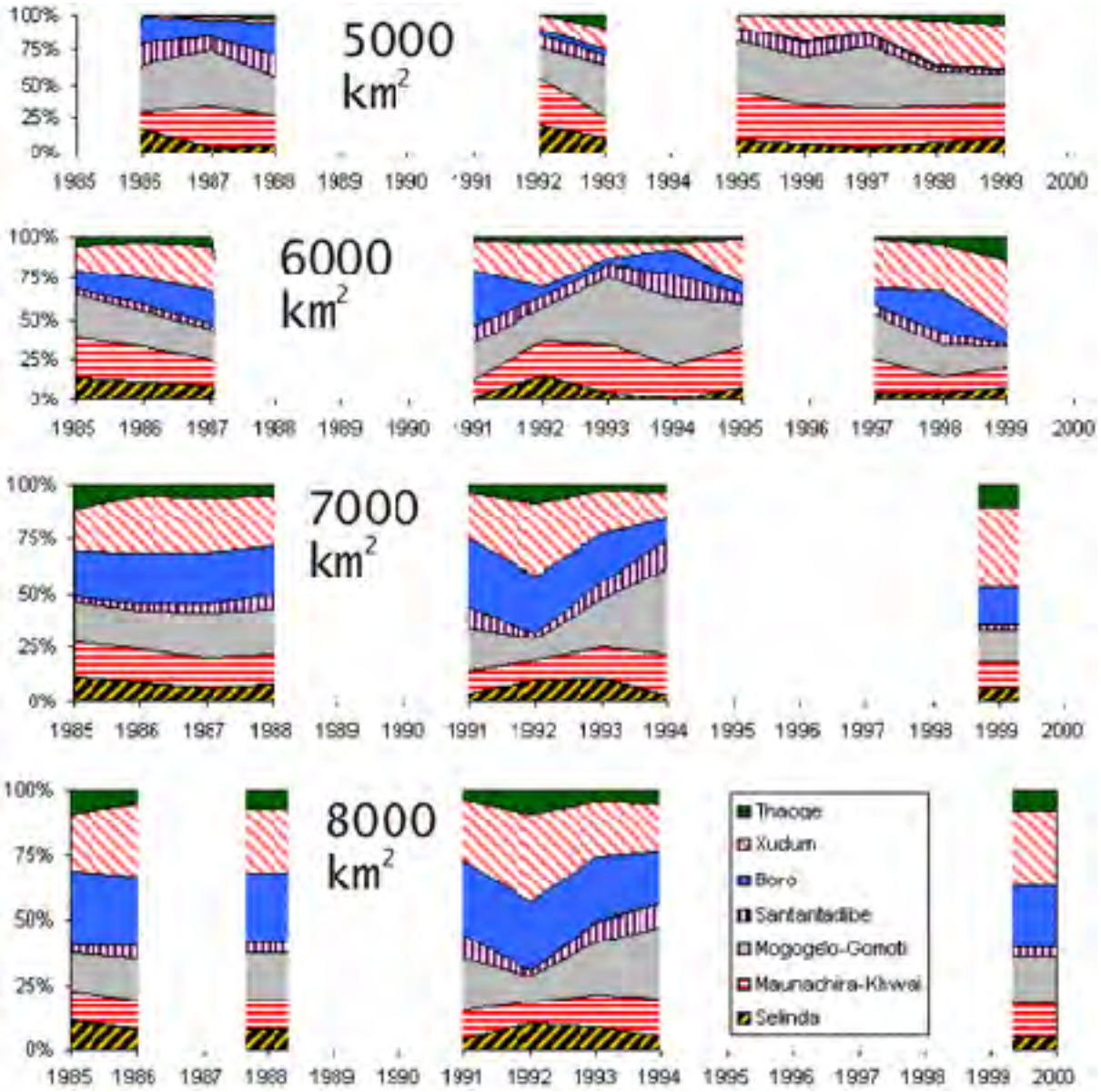
12000 km^2

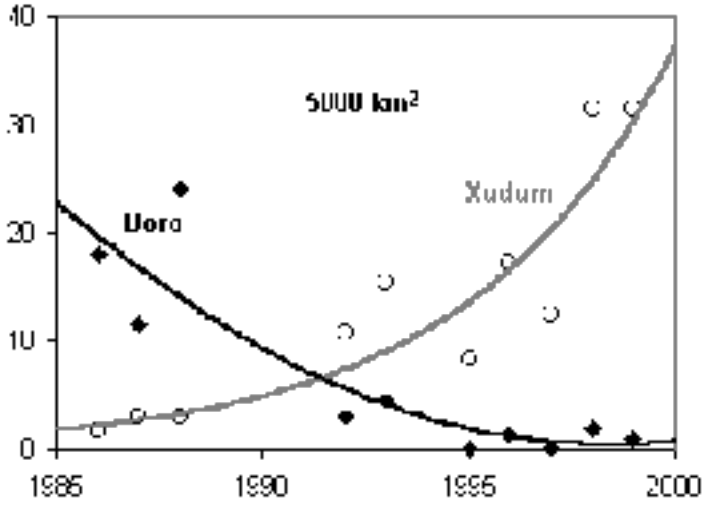
12500 km^2

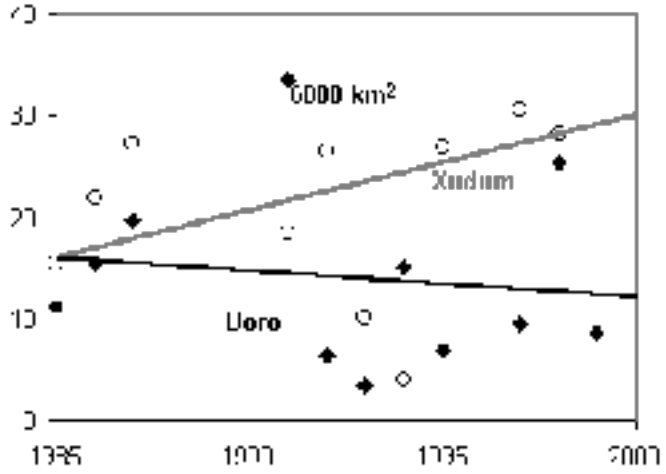
13000 km^2

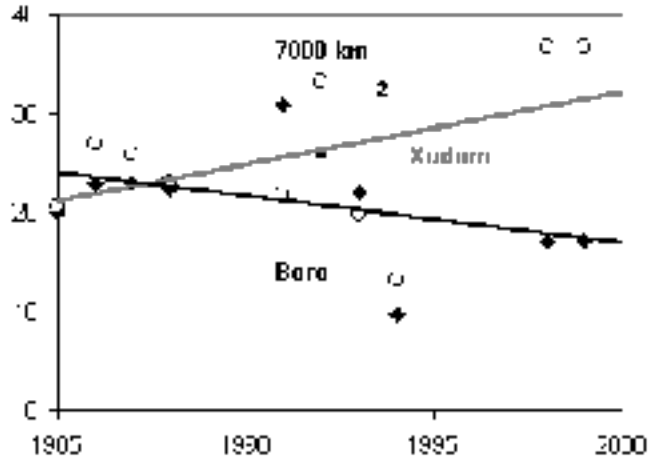
Sub-basins of the Okavango delineated from the microtopography

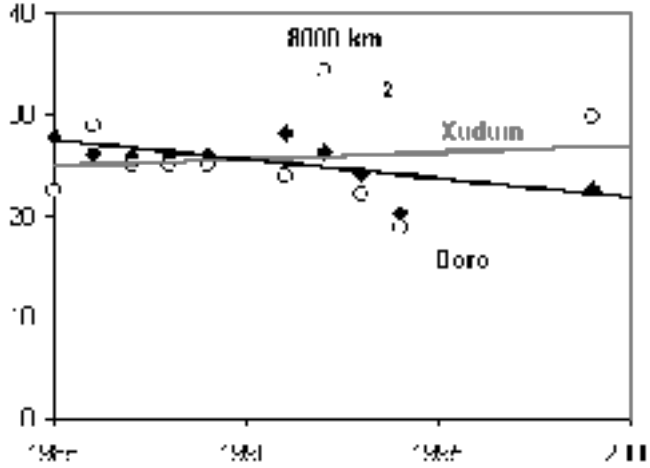



5000 km²
6000 km²
7000 km²
8000 km²
100%
75%
50%
25%
0%
1985 1986 1987 1988 1989 1990 1991 1992 1993 1994 1995 1996 1997 1998 1999 2000
Thaoge
Xudum
Boro
Santantadibe
Mogogelo-Gomoti
Maunachira-Khwai
Selinda

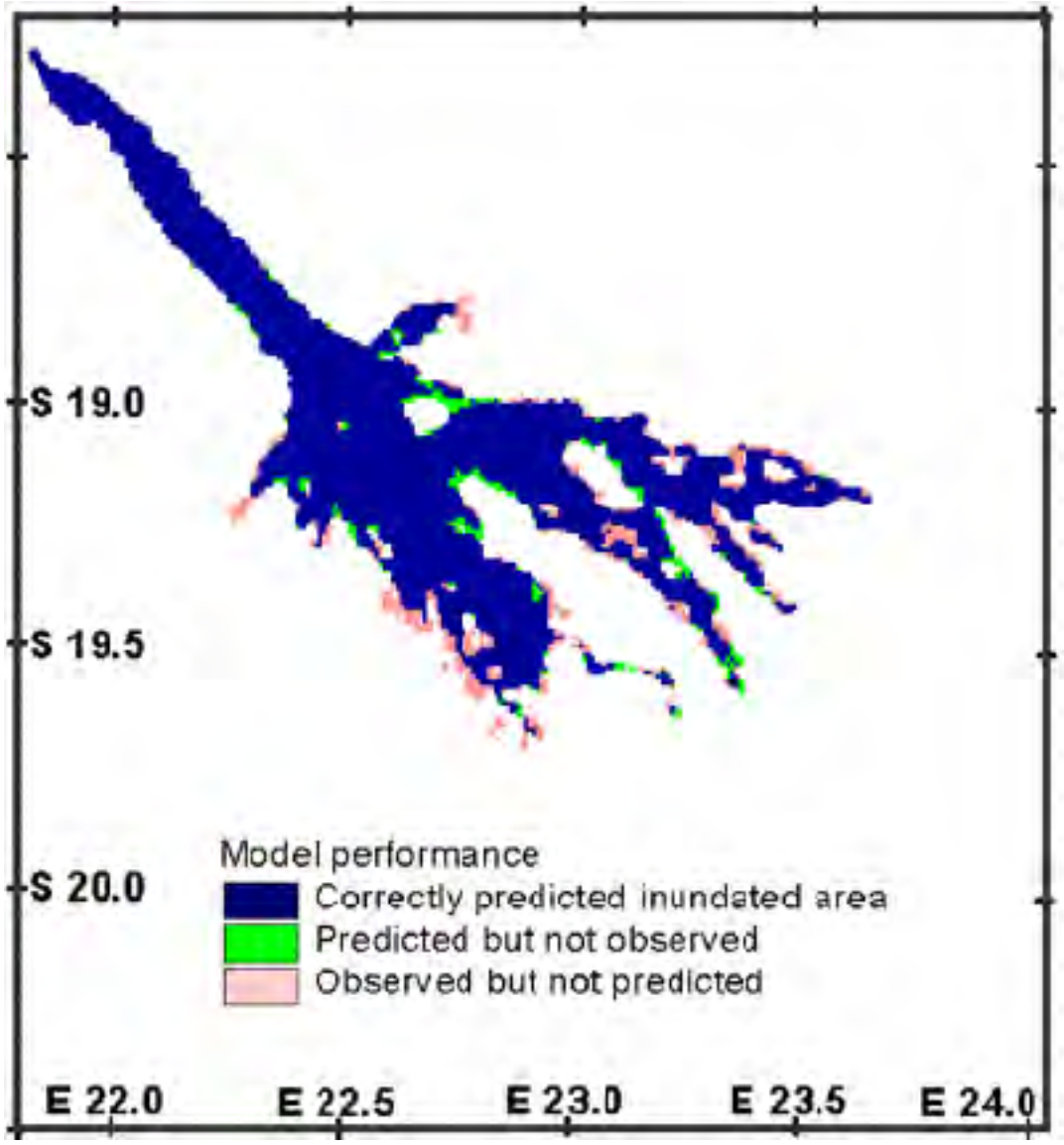

5000 km²
Xudum
Doro
40
30
20
10
0
1985
1990
1995
2000


6000 km²
Xudum
Doro
30
20
10
0

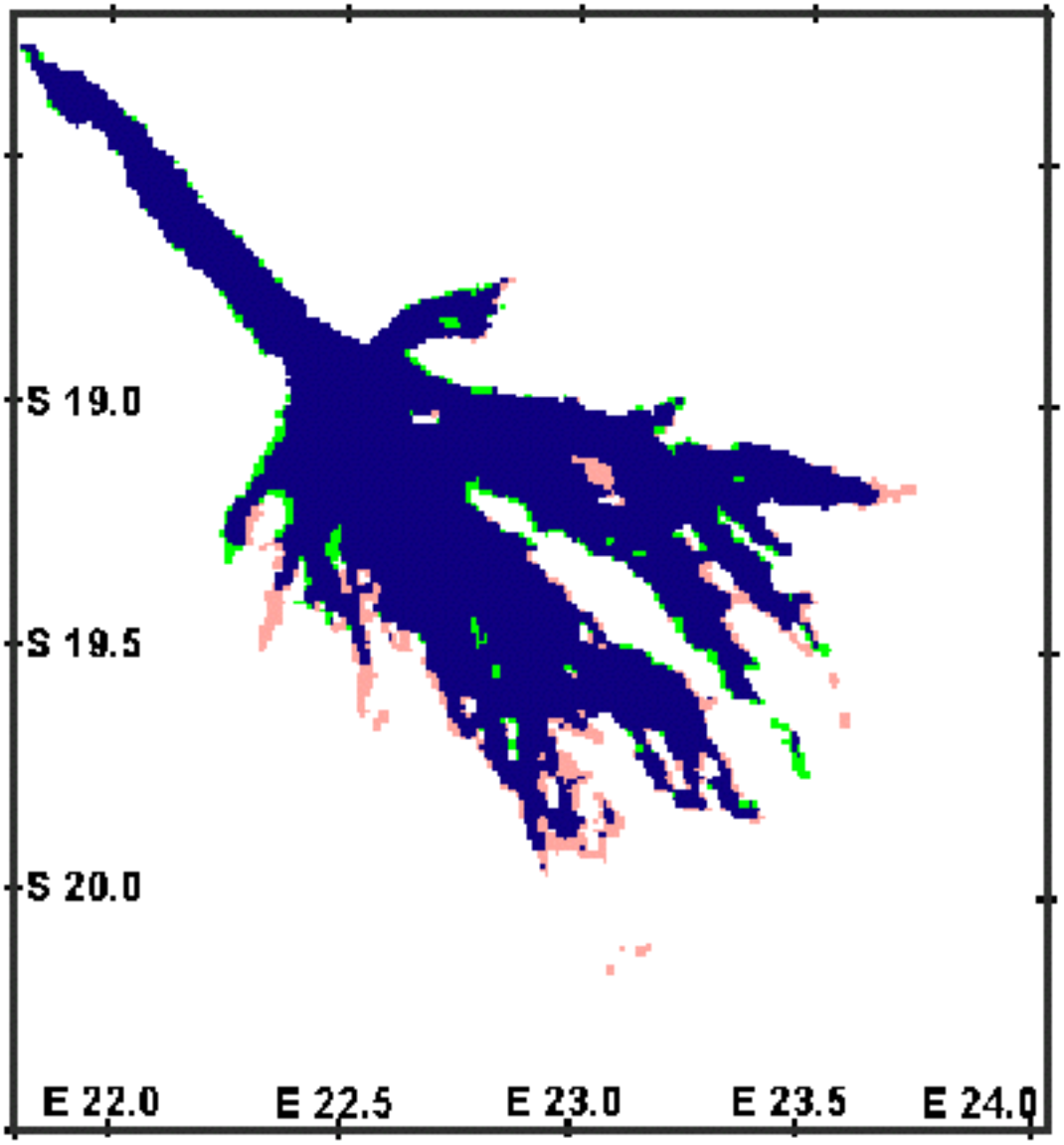

7000 km
2
Xudum
Doro
1985
1990
1995
2000


8000 km
2
Xudum
Doro
40
30
20
10
0

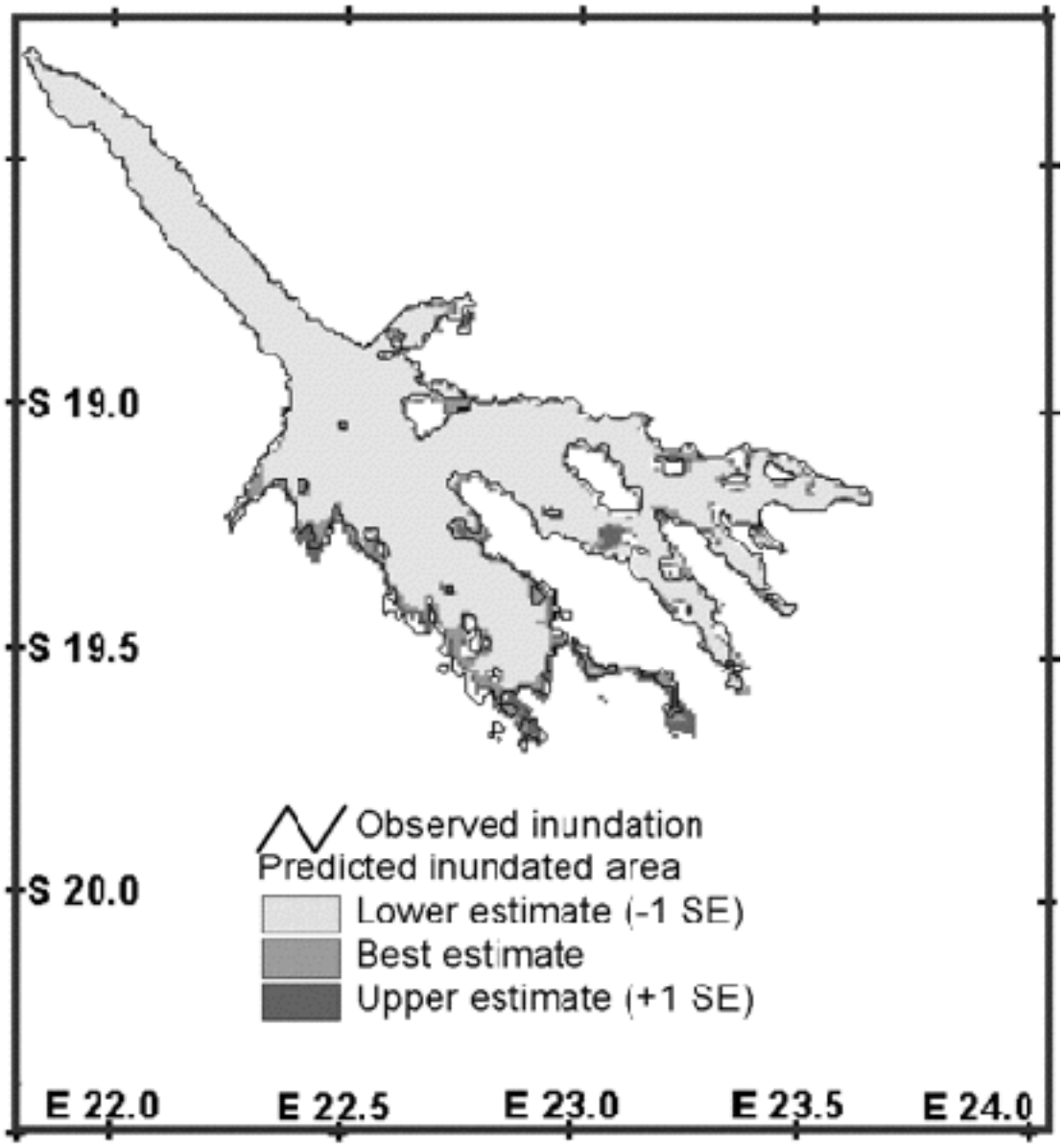
1995

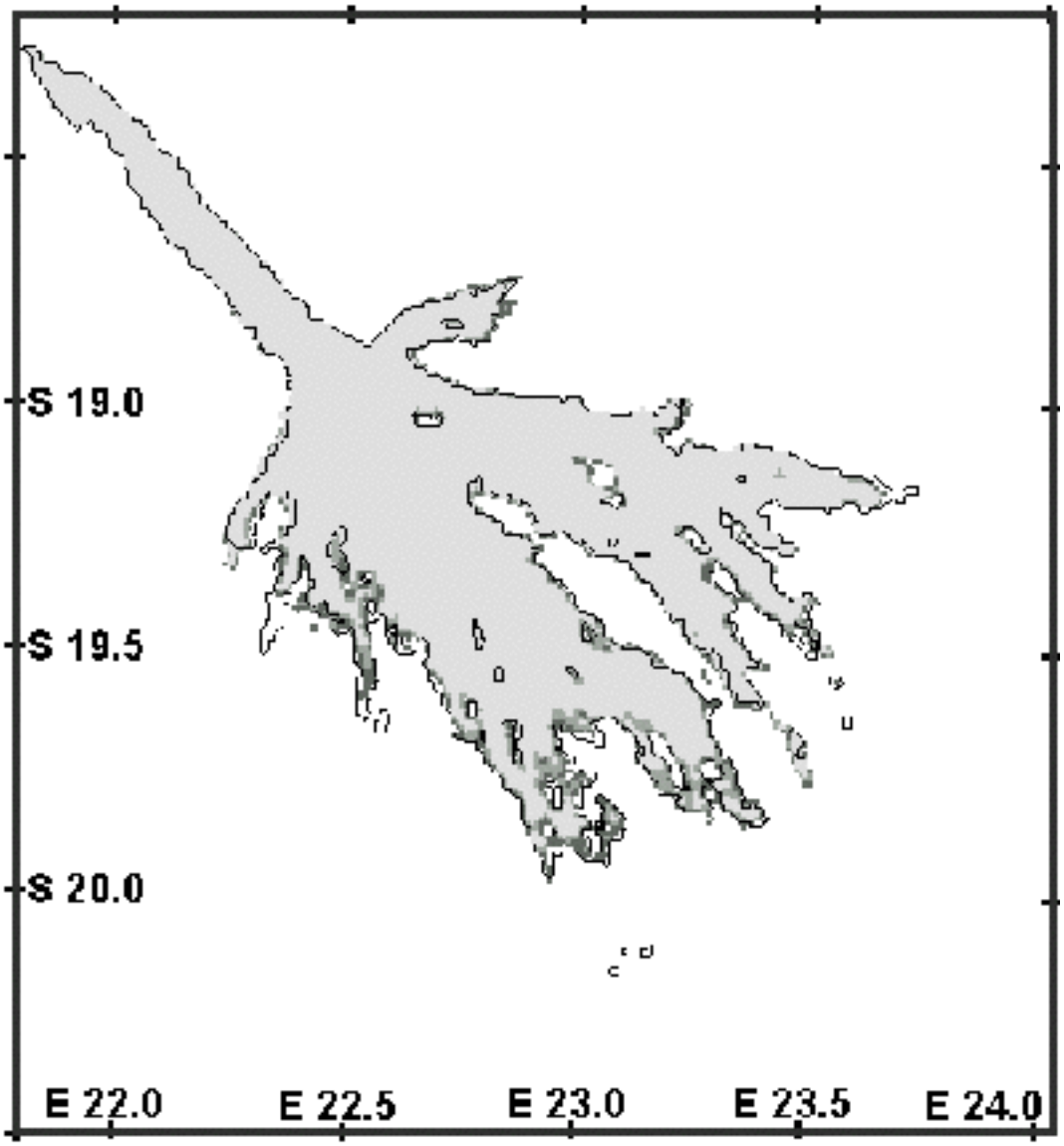

S 19.0
S 19.5
S 20.0
E 22.0
E 22.5
E 23.0
E 23.5
E 24.0
Model performance
Correctly predicted inundated area
Predicted but not observed
Observed but not predicted

2000



1995


S 19.0
S 19.5
S 20.0
E 22.0
E 22.5
E 23.0
E 23.5
E 24.0
Observed inundation
Predicted inundated area
Lower estimate (-1 SE)
Best estimate
Upper estimate (+1 SE)


S 19.0
S 19.5
S 20.0
E 22.0
E 22.5
E 23.0
E 23.5
E 24.0

Statistical hydrological model – conclusions

Simple compared to other methods
But some merits
- Cheap
- Easy to use
- Translation to spatial extension robust

Upstream water abstraction leads to a loss of 1 km^2 of wetland per million cubic metre of water abstracted.

Groundwater model for Xaxaba – a detail to explore?