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Water scarcity in northern Botswana – problems relating to water provision from the Okavango river system

Sue Ringrose, T. Bakaya, L.Cassidy, W.Matheson, M.Masie

Okavango Research Institute, University of Botswana, Maun, Bot

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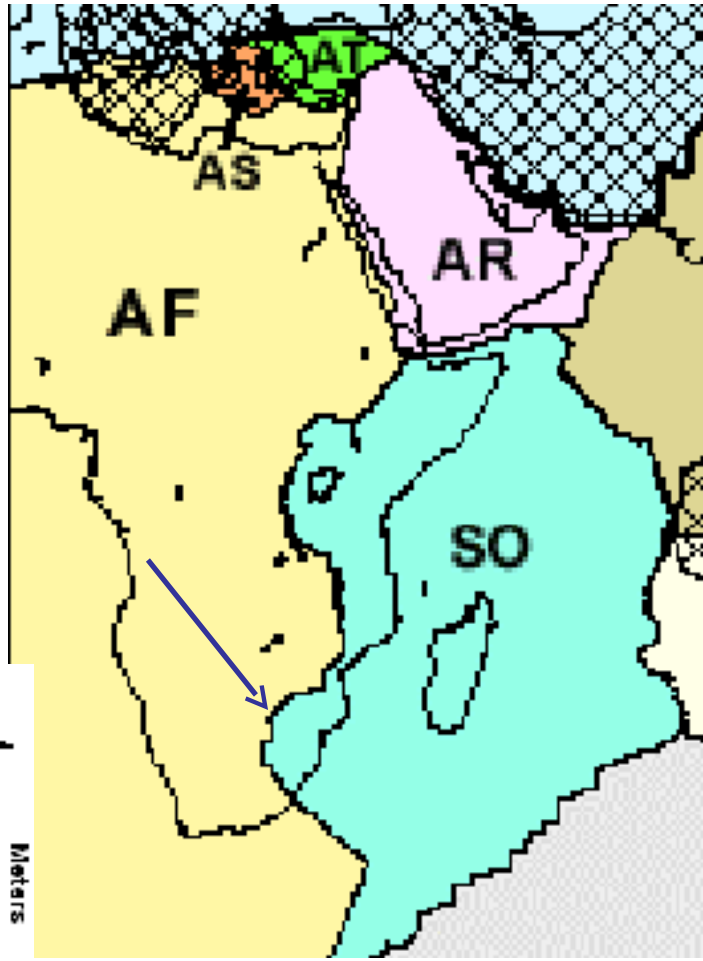
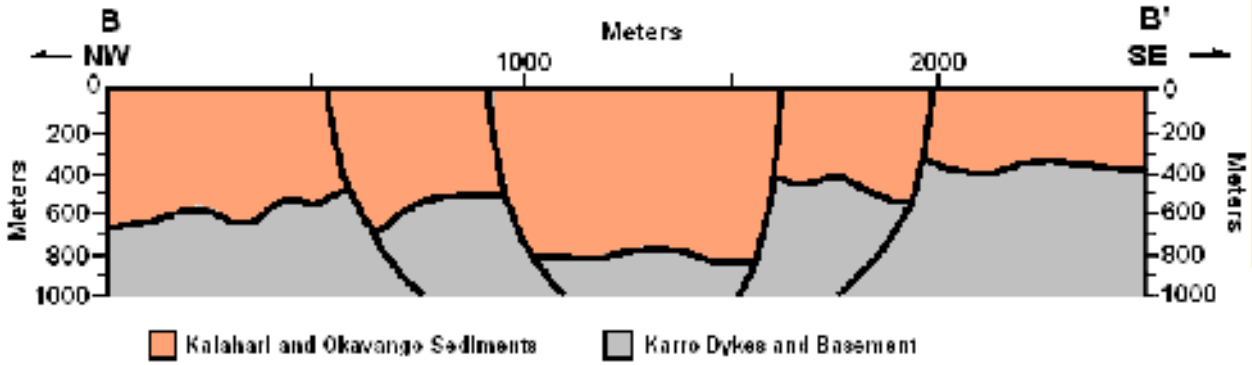
Flow into the semi-arid Kalahari 'desert'

Northern Botswana forms part of the Kalahari, being semi-arid with temperatures ranging from 2-34 deg C

Delta inflow ranges from 6000 to 16000 Mm3/year
Only 2% being available for groundwater recharge despite fault-lines and the porous nature of the Kalahari sands.

Most of Botswana relies on variable sparsely recharged groundwater hence aquifer (and supply) management is paramount





Why water scarcity?

Water scarcity in downstream sections of the Okavango catchment, northern Botswana, occurs as a result of:

· climatic (rainfall) variability,

·potential abstraction upstream,

·Variable plant distribution (bioengineering-hippos-termite mounds)

·tectonic instability and

·infrastructural management factors

·Basin management through OKACOM

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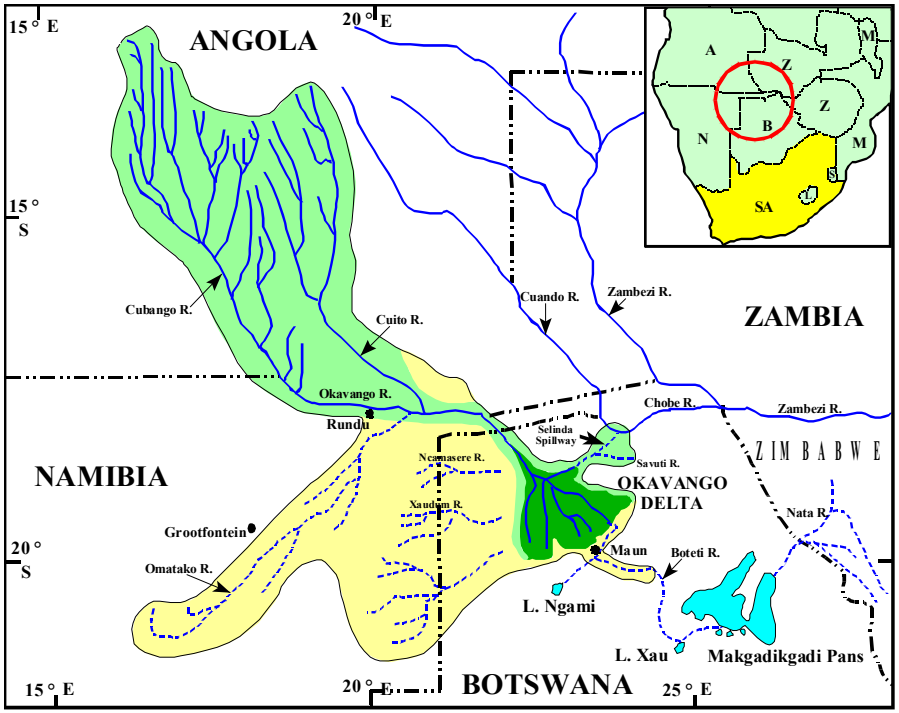


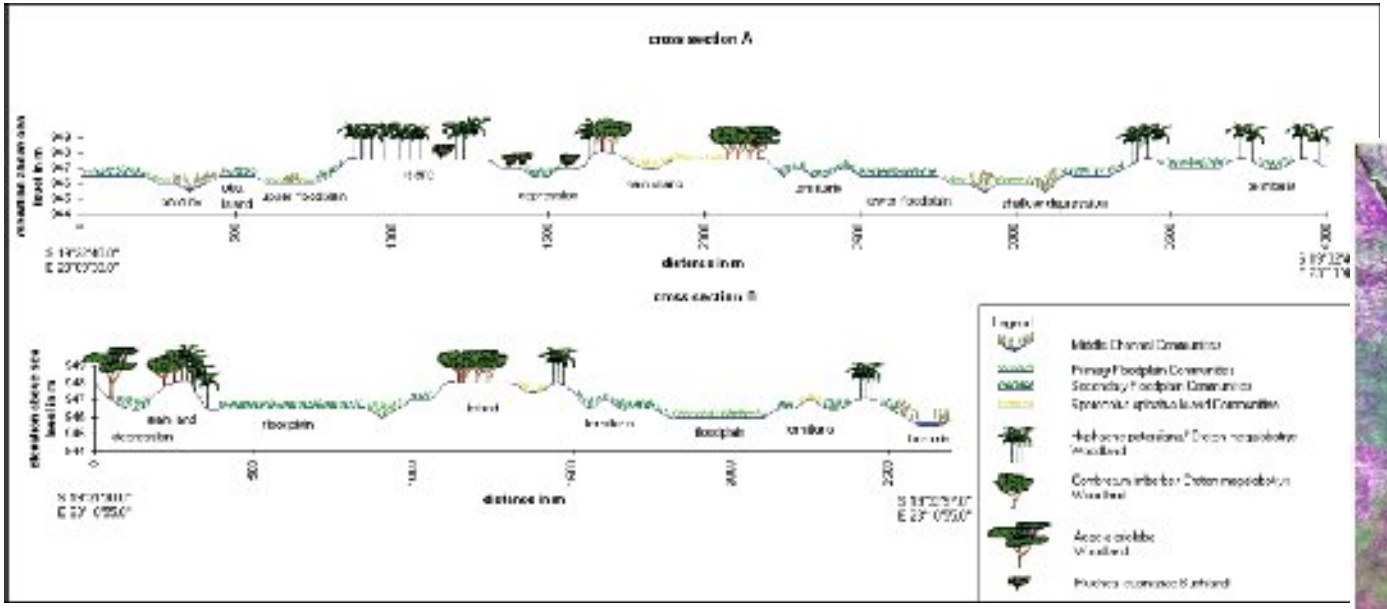
Bioengineering Aspects..

Waterways kept open
by hippo tracks…

Islands form partly
as a result
of termite mounds

Key issue is sustaining livelihoods

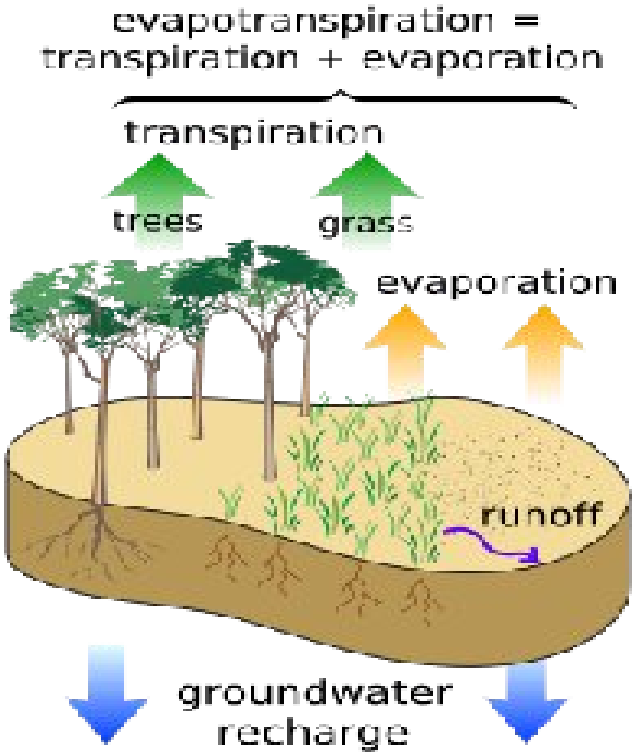
Delta characterised by habitat diversity – ranging from permanently flooded to permanently dry sub-environments



Upper Delta and panhandle – permanently flooded
Lower (distal) reaches – intermittently or occasionally flooded
- hence recharge in the distal portions problematic…

Water loss in Delta mainly climatically induced

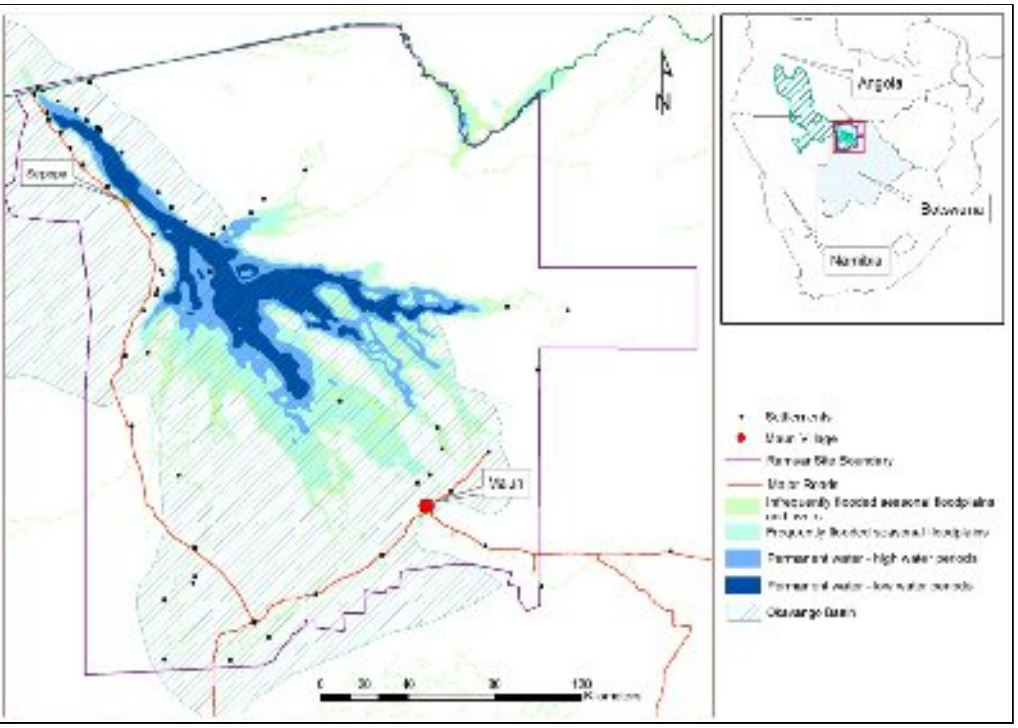
96% water lost in Delta/lower catchment mainly through evapotranspiration



Botswana is a semi-arid country (450 mm/year summer rainfall)

Urban Growth

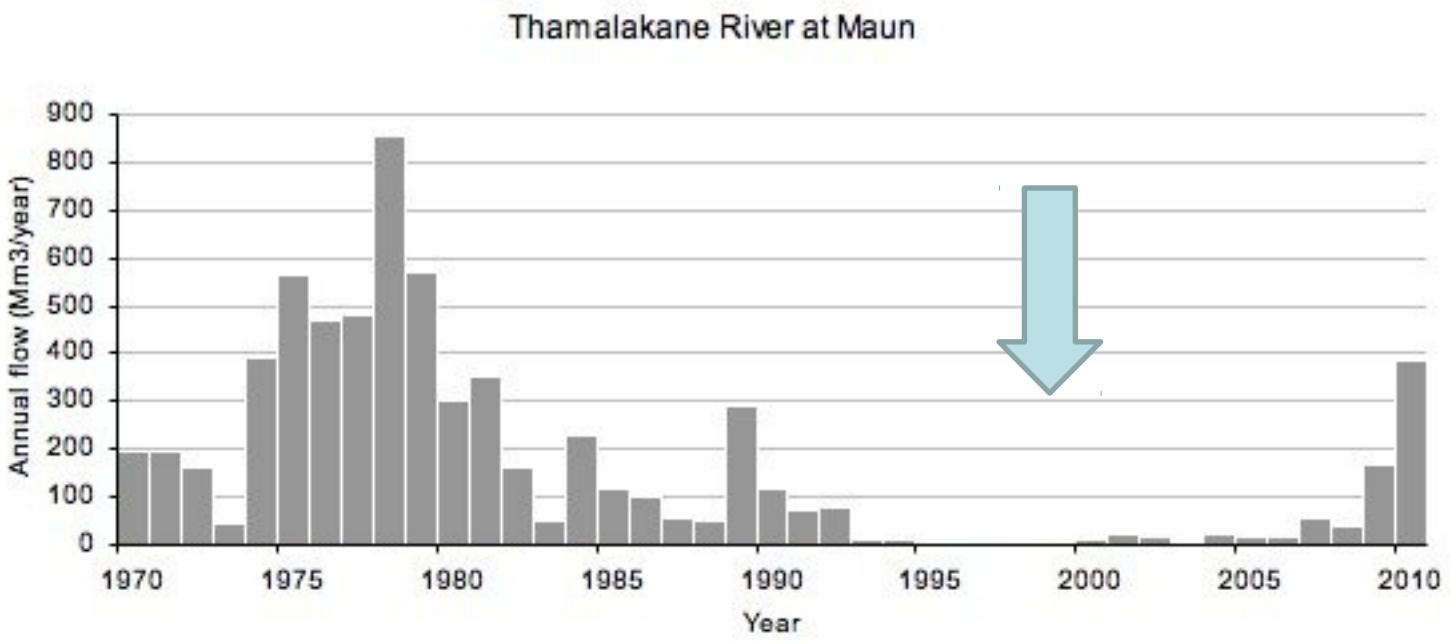
Expansion in Maun (to ca. 65 000 people) and areas has seen increasing demand on local water supplies Total regional demand - 120 000+ people – more pollution



Quantifying rapid expansion

	Maun Population	Intercensal incr. (%)	Ngamiland Population	Intercensal incr. (%)	Maun Village Area (km2)	Intercensal incr. (%)
1971 (est.)	13637	--	47723	--	4	--
1981	14925	8.6	68063	29.9	8	50.0
1991	26768	44.2	94534	28.0	80	90.0
2001	49822	46.3	122024	22.5	446**	82.1
2010 (proj. (a))	55000	9.4				
2010 (proj. (b))	60000	17.0				

Cyclic water flow – critical aspect of aquifer management



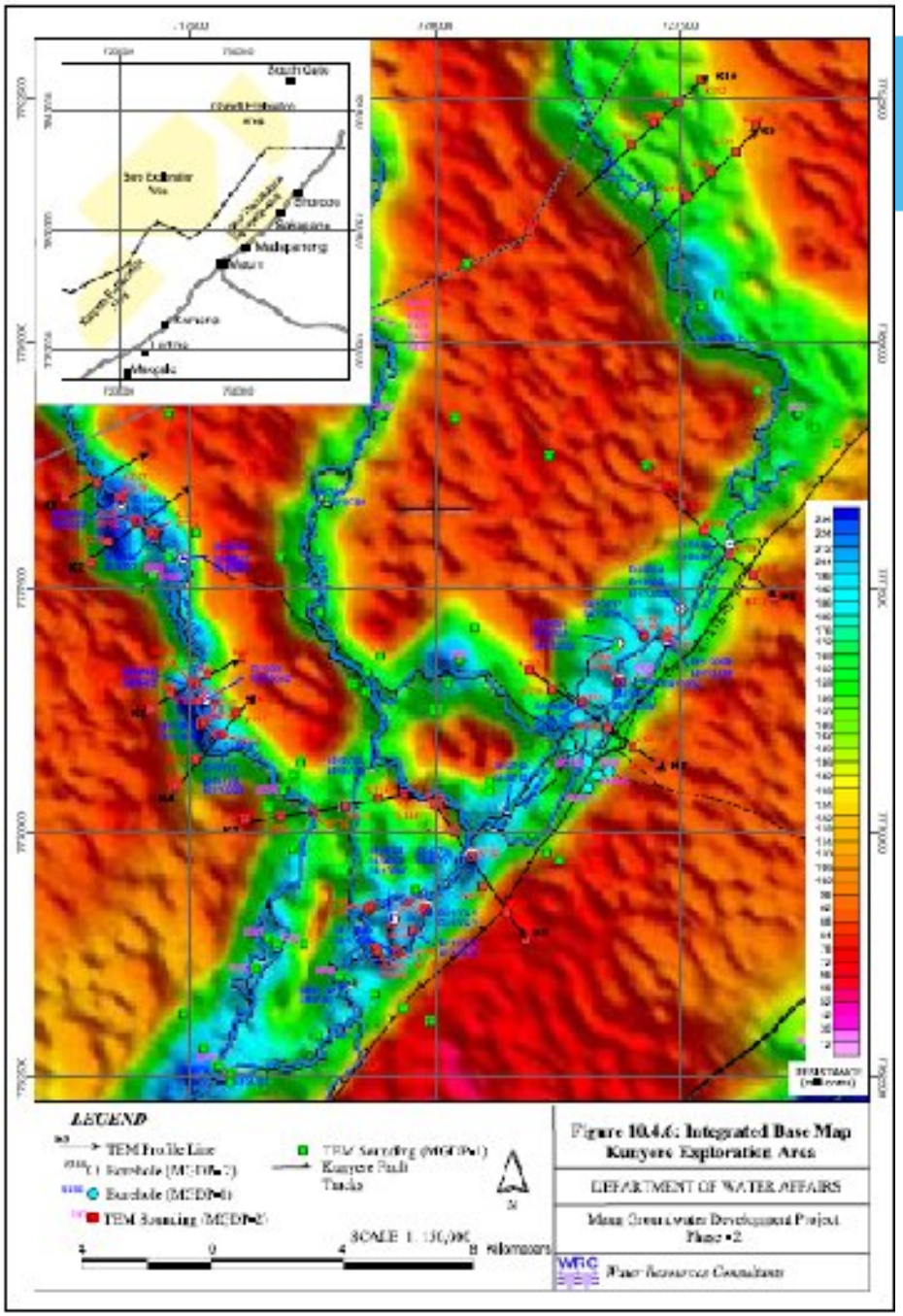
Time when DWA choose to undertake major aquifer survey corresponding to ‘drought’ and major urban growth

Data from Piotr Wolski

Effects of drought..

During the dry period water shortages were rampant, wells dried up and villages were abandoned..

Airborne TEM survey

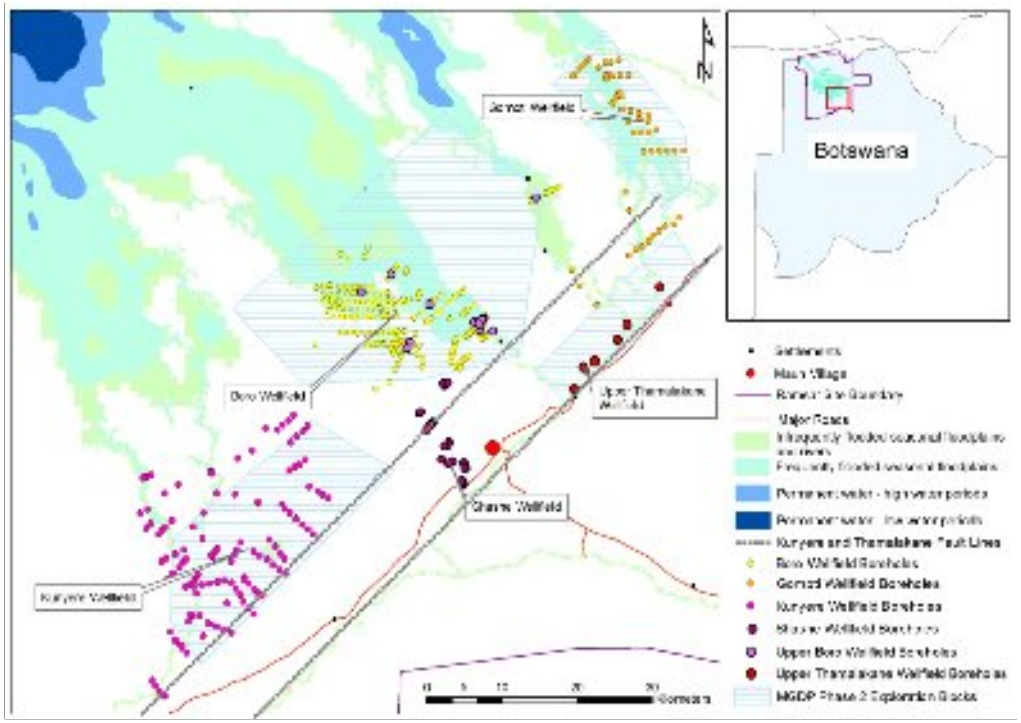


Aquifer exploration through airborne EM surveys (in drought period)

Areas of low resistance (high conductance) relatively deficient in near surface fresh groundwater

Aquifer areas of high resistance identified as being highest potential groundwater sources verified by boreholes

Maun Groundwater Development Plan

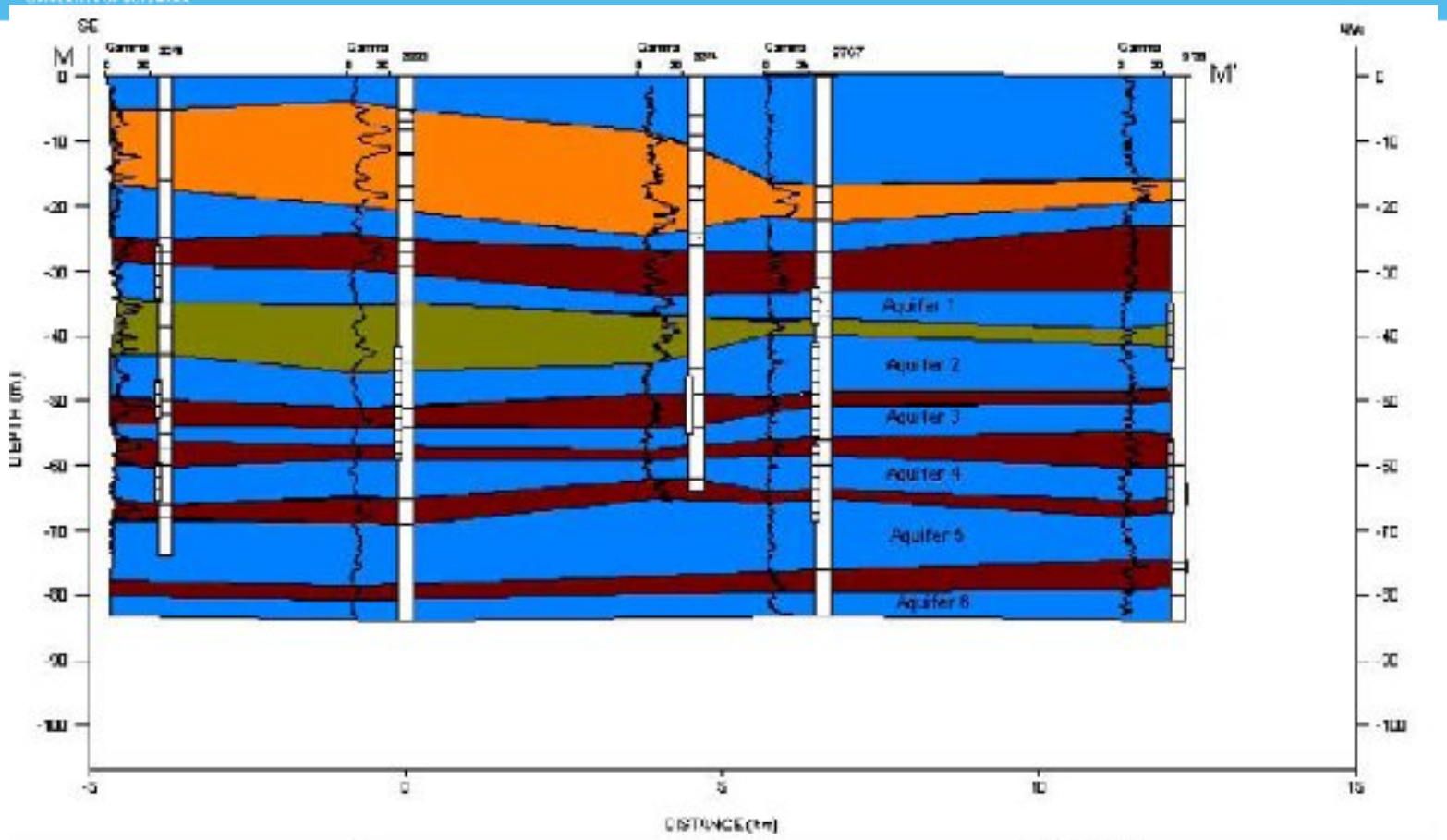


Aquifer distribution based on main distributaries (3) and the outflow areas(2)

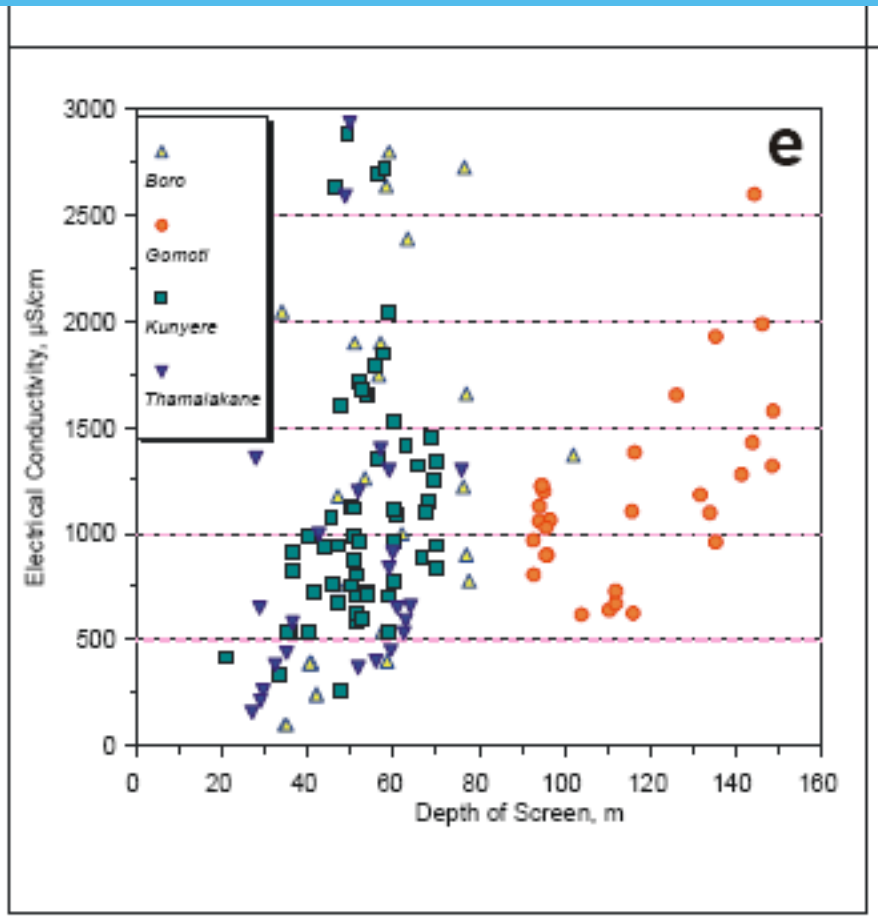
Extensive groundwater/aquifer exploration took place in 1995-2000 during the Maun Groundwater Development Plan (MGDP) – in two phases

ca. 600 boreholes all across mainly dry distributaries

Distributary aquifer characteristics



Salinity erratic but increases with depth..



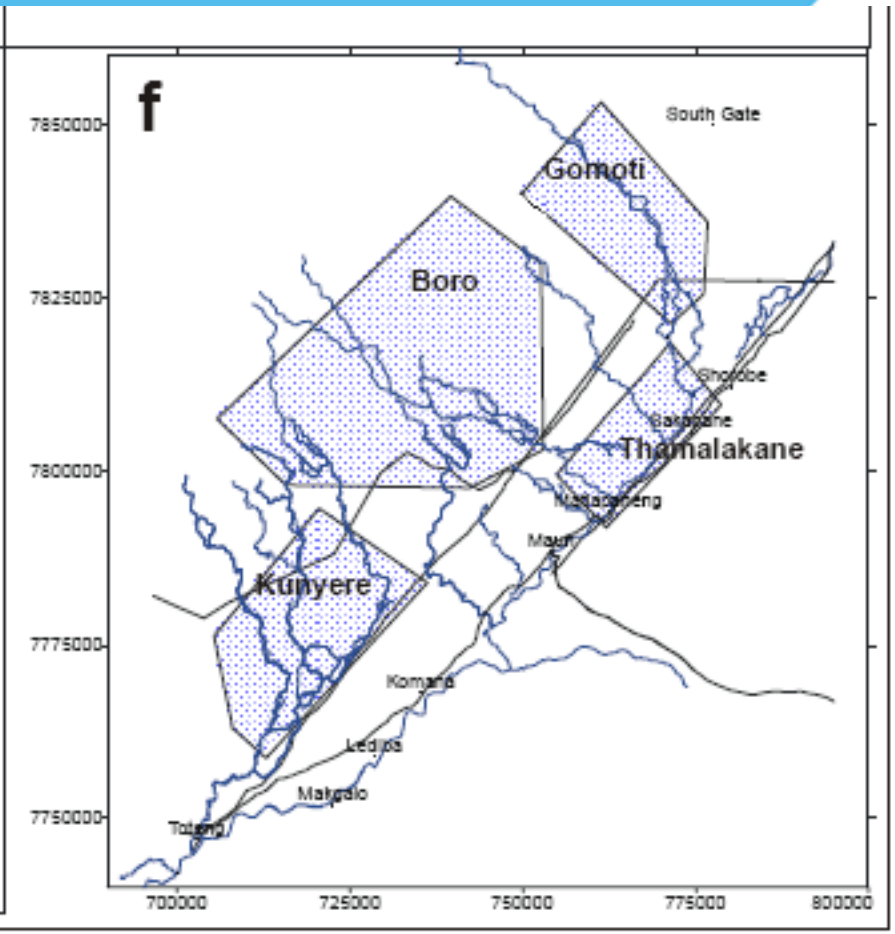
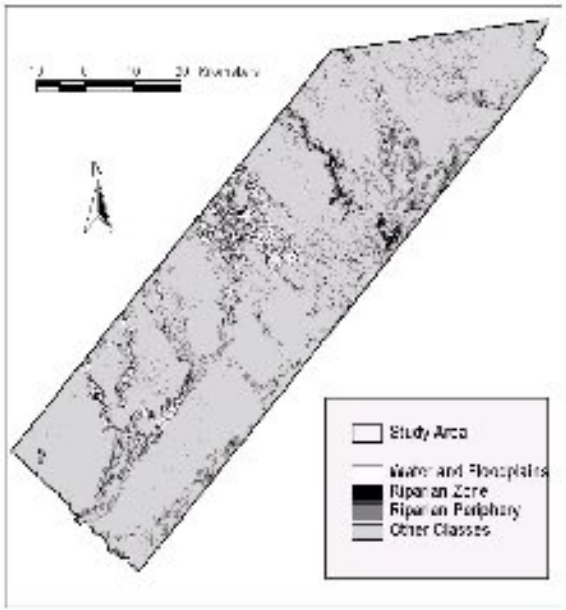


Figure 13.1: Salinity (EC) vs. Depth of Well Screen for all exploration areas

Use of riparian tree species



Two classes of riparian trees mapped by satellite imagery

Species differentiation based on relative frequency of freshwater and saline tolerant species

Added to TEM image using GIS techniques

Ecosystem sustainability

Mechanisms of salinity reduction through subterranean transportation better understood in terms of the importance of riparian trees. This is highly significant for perpetuating Okavango water quality and its transitioning into a salt pan

Riparian cover analysis

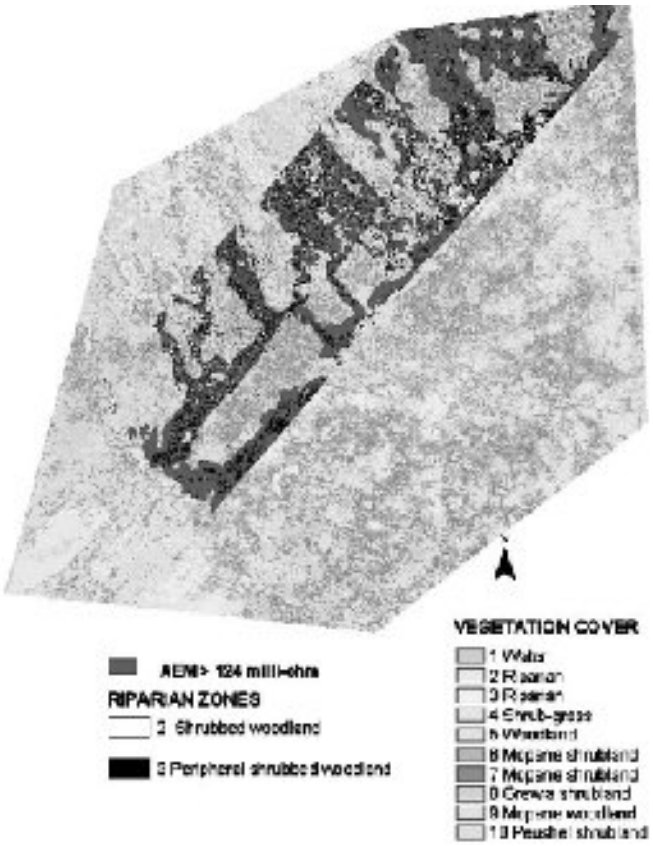


Fig. 5 Results of the electromagnetic data overlay on the vegetation classification showing the intersection of greater than 124 millichm data with Class 2 (Riparian Zone) and Class 3 (Riparian Periphery).

To help shed light on patchiness of aquifer salinity – tree species were identified and mapped in the riparian zones

Rooting depth – up to 30 m but oriented more towards near surface groundwater

Determined that certain species (e.g. *Hyphaenae petersiana*) are salt tolerant and these increase in frequency in the lower-most Delta

However is abundant freshwater within 50 km of Maun..

Yields on preferred aquifers

After drilling and testing,
·the Gomoti aquifer was found to yield 700-1798 m3/day or an estimated 4.41 Mm3/yr.

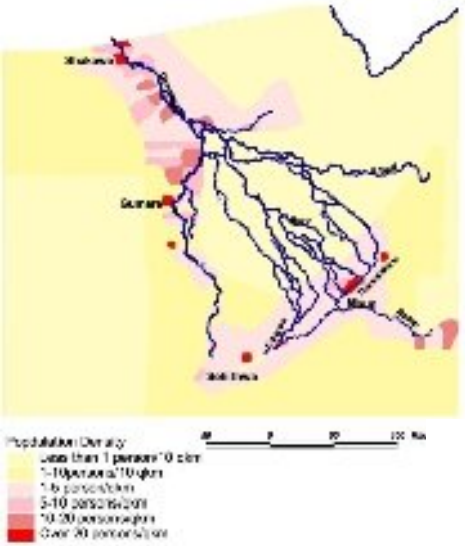
· The Kunyere (south) aquifer was found to yield 284-2796 m3/day or an estimated 4.48 Mm3/yr.

·The Matsibe (Kunyere north) aquifer was found to comprise a wide freshwater lens extending 70 m and yielding 186-528 m3/day or and estimated 1.08 Mm3/yr.

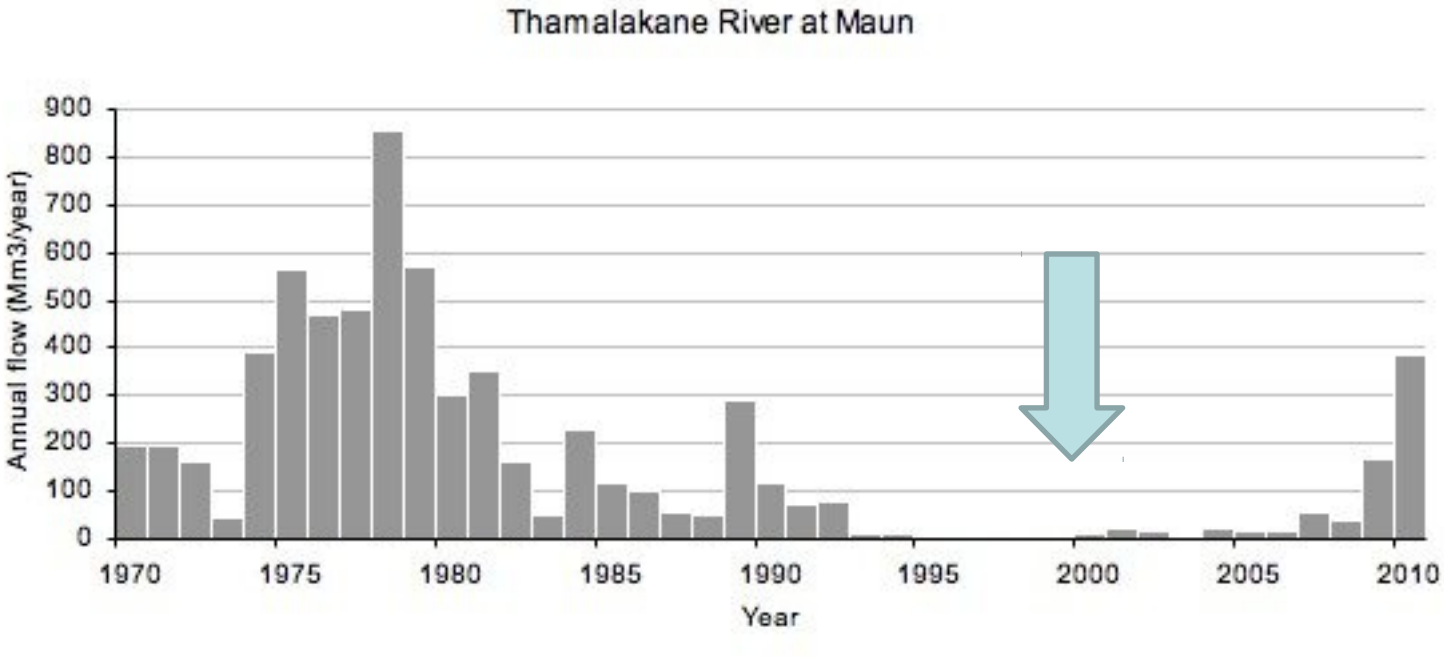
·Problems with all aquifers:
saline incursions from the high salinity interfluves
low levels of naturally occurring arsenic and fluoride

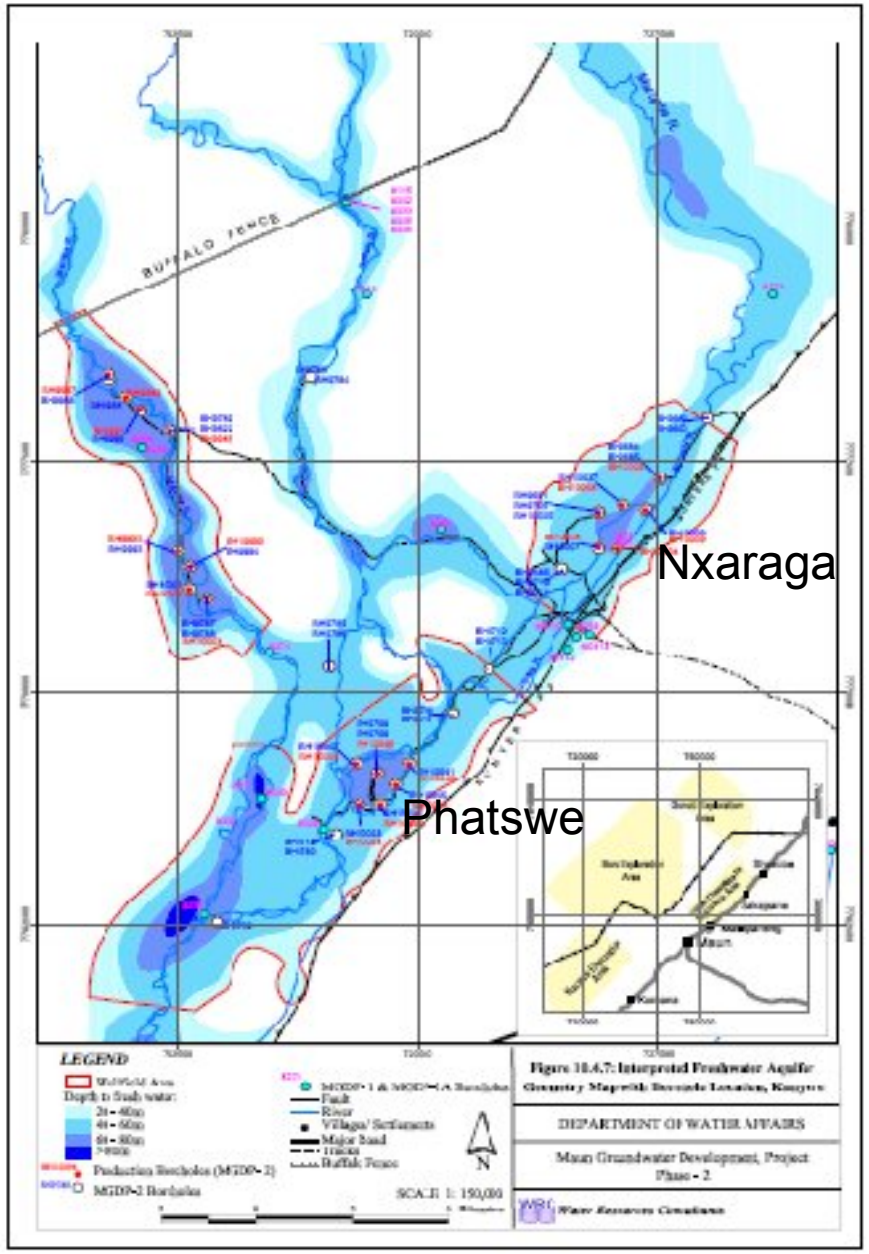
Thamalakane – too close to Maun (pollution)
Boro – too saline

So why is Maun suffering from a water shortage?



In 2010 the rivers were all flowing at the highest rates in decades and yet water ceased to flow in the taps..





One of the most promising aquifers (Kunyere) had only two working boreholes which piped water to Maun (low capacity)

So many people in these outlying areas continue to use water directly from the rivers or from stand pipes..

No water because…

The recently constructed boreholes are now flooded..

And there's a lack of funds to maintain the infrastructure

Now water scarcity due to:

Inability to maintain big Lister pumps by boat- being gradually replaced by generators and electric pumps..

Inspection sites
Flooded

Increasingly
erratic electrical supply

No access by land – supply slow is distributed drips, mainly at night!

People are coping by

By digging hand dug wells..

By providing themselves with temporary storage

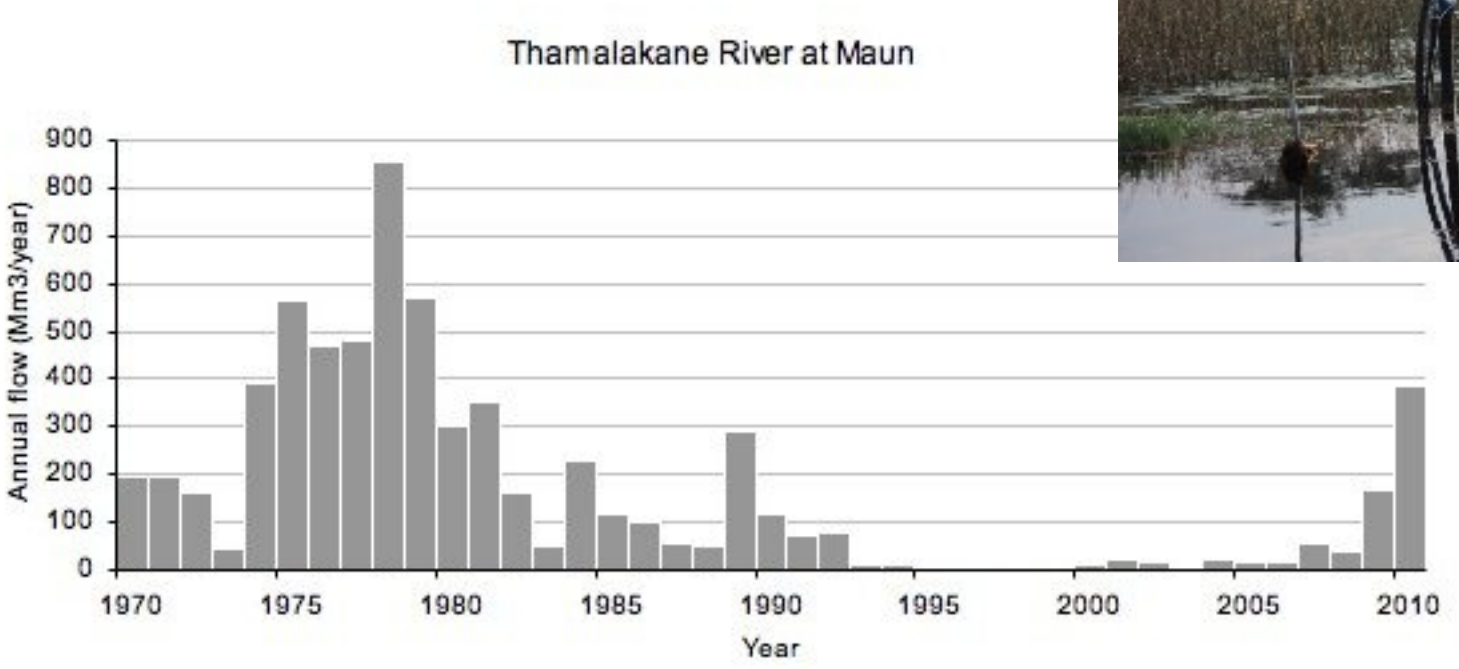
By carrying water from the nearest river

And some are being disconnected..

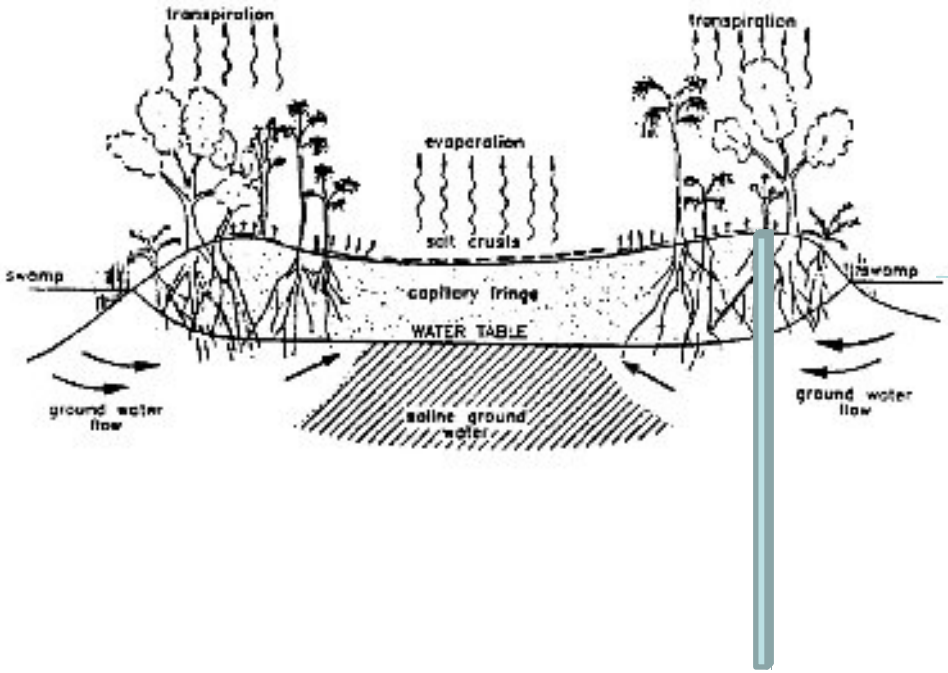
This was to be expected..

Aquifers recharged by flood pulsed wetlands need special consideration!

Designing a water supply system during a major dry period – cannot work during the next decadal wet cycle..

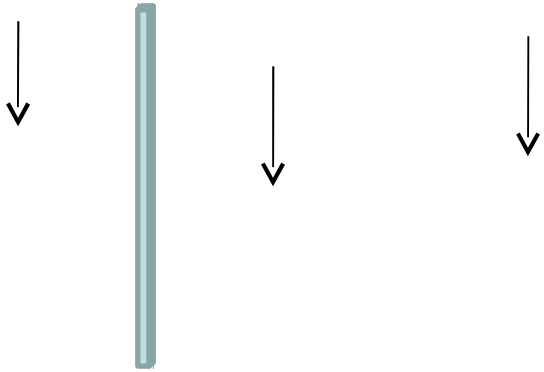


Groundwater/Flood Dynamics



Flooded option
(salinity problems)

Characteristics of the lower-distal Delta..



Dry option
(infrastructure problems)

RECOMMENDATION..

Be careful to locate boreholes so that they are accessible during flooding

Maybe needs a two tier system – with nested boreholes in the distributaries to access the lower groundwater during the dry decades

With dispersed boreholes on the adjacent interfluves to access higher groundwater table during wet decades

This involves double the initial infrastructure expense – which is not attractive especially in a developing economy....

THANK YOU…

Any questions??

Acknowledgements

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