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

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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
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
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
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

<table>
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<tr>
<th>Year</th>
<th>Maun Population</th>
<th>Intercensal incr. (%)</th>
<th>Ngamiland Population</th>
<th>Intercensal incr. (%)</th>
<th>Maun Village Area (km²)</th>
<th>Intercensal incr. (%)</th>
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<td>1971 (est.)</td>
<td>13637</td>
<td>--</td>
<td>47723</td>
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<td>68063</td>
<td>29.9</td>
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<td>122024</td>
<td>22.5</td>
<td>446**</td>
<td>82.1</td>
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<td>2010 (proj. (a))</td>
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<td>9.4</td>
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</table>
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.
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
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

Aquifer distribution based on main distributaries (3) and the outflow areas(2)
Distributary aquifer characteristics
Salinity erratic but increases with depth.

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

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..
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 an 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

And some are being disconnected..

By carrying water from the nearest river
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

Characteristics of the lower-distal Delta..

Flooded option (salinity problems)

Dry option (infrastructure problems)
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…

Acknowledgements

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Any questions??