Groundwater Resources for Southern Province

Findings & Achievements - Sep 2007
Presentation Outline

1. Project Framework
2. Groundwater Information Systems
3. Groundwater Systems and their Potential
4. Groundwater Quality
Project Framework

- **Duration**

- **Overall objectives**
  - Effective groundwater resource planning and management in the Southern Province
  - Strengthening of the capacities in the Zambian water sector
  - Improved water supply

- **Tasks**
  - Assessment of the groundwater quantity and quality of the various aquifer systems.
  - *Groundwater Information System*: Create and distribute hydrogeological maps and data for management purposes
  - Advise regulation and planning authorities on future management and regulation of groundwater resources.
Groundwater Database (1)

Groundwater Data (Sep 2007)
- 3116 Water Points
- 1620 (drilled) boreholes
- 1150 hand-dug (shallow) wells
- 13 thermal springs
- 159 reported unsuccessful (dry) boreholes
- 697 water points with hydraulic information
- 519 boreholes with lithological description
- 671 water points with (any) hydrochemical data
- 108 water points with comprehensive hydrochemical data
Groundwater Database (2)

- Database Information
  - Groundwater Quality
  - Groundwater Hydraulics
  - Geology and Borehole Design
  - General Water Point Information

GReSP - Groundwater Resources for Southern Province
Digital Mapping - GIS

- GIS, Seamless Layers
  - Digitized Topographic Map 1:250,000
  - Digitized Topographic Map 1:50,000 (in parts)
  - Digitized Geological Maps 1:1Mio. and 1:100,000 incl. tectonic features
  - Zambian Soil Map
  - Digital Elevation Model based on 90x90m cell size
  - River Catchments
  - Groundwater Vulnerability
  - Rainfall Distribution
  - Regional Groundwater Contours and Flow Direction
  - Groundwater Salinity
  - Etc.
## Aquifer Potential (1)

### Aquifer Categories: Hydraulic Characterisation

1. Descriptive Statistics of hydraulic parameters
2. DWA- Field experience from drilling campaigns

<table>
<thead>
<tr>
<th>Category</th>
<th>q [L/s/m]</th>
<th>T [m²/d]</th>
<th>K [m/d]</th>
<th>Q [L/s]</th>
<th>Potential</th>
</tr>
</thead>
<tbody>
<tr>
<td>A, C</td>
<td>&gt; 1</td>
<td>&gt; 75</td>
<td>&gt; 3</td>
<td>&gt; 10</td>
<td>High: Withdrawals of regional importance (supply to towns, irrigation)</td>
</tr>
<tr>
<td>B, D</td>
<td>0.1 – 1</td>
<td>5 – 75</td>
<td>0.2 - 3</td>
<td>1 - 10</td>
<td>Moderate: Withdrawals for local water supply (smaller communities, small-scale irrigation etc.)</td>
</tr>
<tr>
<td>E</td>
<td>0.001 – 0.1</td>
<td>0.05 – 5</td>
<td>0.002 – 0.2</td>
<td>0.01 - 1</td>
<td>Limited: Smaller withdrawals for local water supply (supply through handpump, private consumption)</td>
</tr>
<tr>
<td>F</td>
<td>&lt; 0.001</td>
<td>&lt; 0.05</td>
<td>&lt; 0.002</td>
<td>&lt; 0.01</td>
<td>Essentially none: Sources for local water supply are difficult to ensure</td>
</tr>
</tbody>
</table>

Modified after Krásny, 1993 and Struckmeyer & Margat, 1995

q: specific capacity  
T: Transmissivity  
K: Permeability, Hydr. Conductivity  
Q: Recommended Yield
Aquifer Potential (2)

- Aquifer Categories Map symbols

AQUIFER CATEGORIES

- A: Extensive and highly productive aquifers
- B: Local or discontinuous productive aquifers or extensive but only moderately productive aquifers
- C: Extensive and highly productive aquifers
- D: Local or discontinuous productive aquifers or extensive but only moderately productive aquifers
- E: Minor aquifers with local and limited groundwater resources
- F: Strata with essentially no groundwater resources

GReSP - Groundwater Resources for Southern Province
Aquifer Classification

- **Karoo Sandstone**

  **Specific Capacity**

<table>
<thead>
<tr>
<th>Frequency</th>
<th>Specific Capacity [L/s/m]</th>
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<tr>
<td>30</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>25</td>
<td>0.001 - 0.01</td>
</tr>
<tr>
<td>20</td>
<td>0.01 - 0.1</td>
</tr>
<tr>
<td>15</td>
<td>0.1 - 0.5</td>
</tr>
<tr>
<td>10</td>
<td>0.5 - 1</td>
</tr>
<tr>
<td>5</td>
<td>1 - 5</td>
</tr>
<tr>
<td>3</td>
<td>&gt;5</td>
</tr>
</tbody>
</table>

  **Recommended Yield**

<table>
<thead>
<tr>
<th>Frequency</th>
<th>Recommended Yield [L/s]</th>
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<tbody>
<tr>
<td>70</td>
<td>dry</td>
</tr>
<tr>
<td>60</td>
<td>0.01 - 0.1</td>
</tr>
<tr>
<td>50</td>
<td>0.1 - 1</td>
</tr>
<tr>
<td>40</td>
<td>1 - 5</td>
</tr>
<tr>
<td>30</td>
<td>5 - 10</td>
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<tr>
<td>20</td>
<td>10 - 50</td>
</tr>
<tr>
<td>10</td>
<td>&gt;50</td>
</tr>
</tbody>
</table>

**Box Chart of Specific Capacity**

- Max
- Mean
- 75th pc
- Median
- 25th pc
- Min

**Box Chart of Recommended Yield**

- F
- E
- D
- C

**GReSP - Groundwater Resources for Southern Province**
Publications

- Hydrogeological Map 1:250,000 (3 sheets)
- Hydrological Map 1:100,000 (Prototype)
- Technical Report → Geologists, Hydrogeologists, Engineers
- Explanatory Brochure & Manual → Planner, Interested Layman
Conclusions: Groundwater Quantity

- The aquifers are composed to 65% of hard rock formations and 35% of unconsolidated, interbedded clastic sediments.
- Most groundwater systems are extremely heterogeneous.
- **Groundwater potential of aquifers in SP is overall limited!**
  - Exceptional high yields (Specific Capacity>1 L/s/m) are rarely found regardless the aquifer lithology.
  - Localised occurrences of aquifers with higher (moderate) potential exist, especially within the Karoo sandstones, carbonate rocks and the alluvium of Kafue Flats.
- Groundwater is usually sufficient for RWS, and may be sufficient for supply to smaller towns or to supplement irrigation if siting is carried out professionally.
- Planning of future groundwater investigations and exploration can be based on:
  - Detailed information on boreholes/drilling sites in the vicinity
  - Expected range of yield
  - GIS-based presentation of information
  - Groundwater quality risks and vulnerability at selected sites