### Transboundary Aquifer Information Sheet

#### AF1 – Karoo Sedimentary Aquifer

**Geography**
- Total area TBA (km²): 135 000
- No. countries sharing: 2
- Countries sharing: Lesotho, South Africa
- Population: 4 700 000
- Climate Zone: Marine
- Rainfall (mm/yr): 680

**Hydrogeology**
- Aquifer type: Multiple layered hydraulically connected system
- Degree of confinement: Mostly semi-confined, but some parts unconfined
- Main Lithology: Sedimentary rocks – sandstone

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**Legend**
- Transboundary aquifer
- Confirmed aquifer boundary

**Others symbols**
- Rivers
- Lakes
- Political Borders
- TBA Location

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**Geological Cross-section showing the geological setting in which the main aquifers are situated**

Map and cross-section are only provided for illustrative purposes. Dimensions are only approximate.
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TWAP Groundwater Indicators from Global Inventory

<table>
<thead>
<tr>
<th></th>
<th>Recharge (mm/y)/(1)</th>
<th>Renewable groundwater per capita (m³/y/capita)</th>
<th>Natural background groundwater quality (%) (2)</th>
<th>Human dependency on groundwater (%)</th>
<th>Groundwater depletion (mm/y) (3)</th>
<th>Groundwater pollution (%) (4)</th>
<th>Population density (Persons/km²)</th>
<th>Groundwater development stress (%) (5)</th>
<th>Transboundary legal framework (Scores) (6)</th>
<th>Transboundary institutional framework (Scores) (6)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Lesotho</td>
<td>21</td>
<td>320</td>
<td>90</td>
<td>10</td>
<td>66</td>
<td>&lt;5</td>
<td>B</td>
<td>100</td>
<td>B</td>
<td>D</td>
</tr>
<tr>
<td>South Africa</td>
<td>&lt;1</td>
<td>1</td>
<td>&lt;5</td>
<td></td>
<td>26</td>
<td>100</td>
<td>B</td>
<td>100</td>
<td>B</td>
<td>C</td>
</tr>
<tr>
<td>TBA level</td>
<td>35</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

(1) Recharge: This is the long term average recharge (in m³/yr) divided by the surface area (m²) of the complete country segment of the aquifer (i.e. not only the recharge area).

(2) Natural background groundwater quality: Estimate of percentage of surface area of aquifer where the natural groundwater quality satisfies local drinking water standards.

(3) Groundwater pollution: A. No pollution has been identified; B. Some pollution has been identified; Positive number: Significant pollution has been identified (% of surface area of aquifer).

(4) Groundwater development stress: Annual groundwater abstraction divided by recharge.

(5) Legal framework: A. Agreement with full scope for TBA management signed by all parties; B. Agreement with limited scope for TBA management signed by all parties; C. Agreement under preparation or available as an unsigned draft; D. No agreement exists, nor under preparation; E. Legal Framework differs between Aquifer States (see data at National level).

(6) Institutional Framework: A. Dedicated transboundary institution fully operational; B. Dedicated transboundary institution in place, but not fully operational; C. National/Domestic institution fully operational; D. National/Domestic institution in place, but not fully operational; E. No institution exists for TBA management; F. Institutional Framework differs between Aquifer States (see data at National level).

X A value was provided in the questionnaire, but it was considered un-realistic and therefore removed from the table.

TWAP Groundwater Indicators from WaterGAP model

<table>
<thead>
<tr>
<th></th>
<th>Recharge, incl. recharge from irrigation (mm/yr)</th>
<th>Renewable groundwater per capita</th>
<th>Human dependency on groundwater (%)</th>
<th>Groundwater development stress</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Current state (m³/y/capita)</td>
<td>Projection 2030 (% change to current state)</td>
<td>Projection 2050 (% change to current state)</td>
<td>Current state (%)</td>
</tr>
<tr>
<td>Lesotho</td>
<td>16</td>
<td>240</td>
<td>-13</td>
<td>-21</td>
</tr>
<tr>
<td>South Africa</td>
<td>41</td>
<td>1400</td>
<td>-9</td>
<td>-14</td>
</tr>
<tr>
<td>TBA level</td>
<td>35</td>
<td>930</td>
<td>-11</td>
<td>-17</td>
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</table>

TWAP Groundwater Indicators from WaterGAP model

<table>
<thead>
<tr>
<th></th>
<th>Groundwater depletion (mm/y)</th>
<th>Population density</th>
<th>Groundwater development stress</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Current state (Persons/km²)</td>
<td>Projection 2030 (% change to current state)</td>
<td>Projection 2050 (% change to current state)</td>
</tr>
<tr>
<td>Lesotho</td>
<td>0</td>
<td>69</td>
<td>17</td>
</tr>
<tr>
<td>South Africa</td>
<td>0</td>
<td>29</td>
<td>10</td>
</tr>
<tr>
<td>TBA level</td>
<td>0</td>
<td>38</td>
<td>13</td>
</tr>
</tbody>
</table>
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Key parameters table from Global Inventory

<table>
<thead>
<tr>
<th></th>
<th>Distance from ground surface to groundwater table (m)</th>
<th>Depth to top of aquifer formation (m)</th>
<th>Full vertical thickness of the aquifer system* (m)</th>
<th>Degree of confinement</th>
<th>Predominant aquifer lithology</th>
<th>Predominant type of porosity (or voids)</th>
<th>Secondary Porosity</th>
<th>Transmissivity (m²/d)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Lesotho</td>
<td>33</td>
<td>22</td>
<td>2250</td>
<td>Aquifer mostly semi-confined, but some parts unconfined</td>
<td>Sedimentary rocks - sandstone</td>
<td>High primary porosity fine/medium sedimentary deposits</td>
<td>Secondary porosity: Fractures</td>
<td>43</td>
</tr>
<tr>
<td>South Africa</td>
<td>20</td>
<td>10</td>
<td>630</td>
<td>Aquifer mostly semi-confined, but some parts unconfined</td>
<td>Sedimentary rocks - sandstone</td>
<td>Low primary porosity inter-granular porosity</td>
<td>Secondary porosity: Fractures</td>
<td>20</td>
</tr>
</tbody>
</table>

TBA level
* Including aquitards/aquicludes
X A value was provided in the questionnaire, but it was considered un-realistic and therefore removed from the table.

Aquifer description

Aquifer geometry
It is a multi-layered system (5 layers within Lesotho and 4 layers within South Africa) that is mostly semi-confined, but some parts are unconfined. The average rest water level is between 20m and 33m and the average depth to the top of the aquifer is 22m within Lesotho. The thickness of the aquifer system within Lesotho is 2 250m whereas in South Africa this is reduced to 630m (Lesotho is the so-called mountain kingdom, with the Drakensberg – Maluti range peaking at nearly 3500 m above sea level). Appendix 1 shows the Drakensberg basalts and Clarens sandstones (within the South African part of the TBA) which make up the high mountain peaks and the lower plateaus respectively.

Hydrogeological aspects
The predominant lithology is sedimentary sandstones that are characterized by a low to high primary porosity, with secondary porosity (fractures) and there is generally a low horizontal and vertical connectivity. The transmissivity values are low with an average value varying between 20 m²/d (South Africa) and 43 m²/d (Lesotho). The mean annual recharge is 650 Mm³/annum. The size of the recharge area over the aquifer is 76 078 km².

Linkages with other water systems
The predominant source of recharge is through precipitation over the aquifer area. The predominant discharge mechanism is through springs within Lesotho.

Environmental aspects
Within Lesotho about 10 % of the aquifer is not suitable for human consumption; mainly in the superficial layers; due to high fluoride contents. Within South Africa there are localities with brackish water but this has not been quantified. Some pollution within the superficial layers has been observed but the extent has not been specified. No information was recorded on shallow...
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groundwater or on groundwater dependent ecosystems. A number of South Africa’s major rivers have their source in the high-altitude peat lands in Lesotho (see Appendix 2).

Socio-economic aspects
During 2010 the total annual groundwater abstraction from the aquifer was 25 Mm³. The information that was supplied by Lesotho was based on a summation based on data from a database and/or through a dedicated study. The total amount of fresh water abstraction over the aquifer area within Lesotho over the same period was 223 Mm³.

Legal and Institutional aspects
A ratified multi-lateral River Basin Agreement with limited scope does exist through ORASECOM. Although a dedicated Transboundary River Basin Institute is in place, this does not currently include the aquifer management. The National Institutes have a full mandate but the capacity is limited within Lesotho.

Emerging Issues
Although ORASECOM does have a ratified multilateral agreement with limited scope, a committee that will focus on the groundwater requirements needs to be formed in order to make this effective.

Contributors to Global Inventory

<table>
<thead>
<tr>
<th>Name</th>
<th>Organisation</th>
<th>Country</th>
<th>E-mail</th>
<th>Role</th>
</tr>
</thead>
<tbody>
<tr>
<td>Greg Christelis</td>
<td>CHR Water Consultants</td>
<td>Namibia</td>
<td><a href="mailto:gregchristelis@gmail.com">gregchristelis@gmail.com</a></td>
<td>Regional coordinator</td>
</tr>
<tr>
<td>Phaello Leketa</td>
<td>Ministry of Energy, Meteorology and Water Affairs</td>
<td>Lesotho</td>
<td><a href="mailto:rmphae@gmail.com">rmphae@gmail.com</a></td>
<td>Contributing national expert</td>
</tr>
<tr>
<td>Kahliso Leketa</td>
<td>Ministry of Energy, Meteorology and Water Affairs</td>
<td>Lesotho</td>
<td><a href="mailto:kleketa@gmail.com">kleketa@gmail.com</a></td>
<td>Contributing national expert</td>
</tr>
<tr>
<td>Bokang Makututsa</td>
<td>Ministry of Energy, Meteorology and Water Affairs</td>
<td>Lesotho</td>
<td><a href="mailto:makututsa@gmail.com">makututsa@gmail.com</a></td>
<td>Contributing national expert</td>
</tr>
<tr>
<td>Maseatile Motoho</td>
<td>Engineering</td>
<td>Lesotho</td>
<td><a href="mailto:maseatlem@yahoo.co.uk">maseatlem@yahoo.co.uk</a></td>
<td>Contributing national expert</td>
</tr>
<tr>
<td>Matsolo Migwi</td>
<td>Ministry of Energy, Meteorology and Water Affairs</td>
<td>Lesotho</td>
<td><a href="mailto:migwimatsolo@gmail.com">migwimatsolo@gmail.com</a></td>
<td>Lead National Expert</td>
</tr>
<tr>
<td>Thabang Phori</td>
<td>Ministry of Energy, Meteorology and Water Affairs</td>
<td>Lesotho</td>
<td><a href="mailto:thabangphori@gmail.com">thabangphori@gmail.com</a></td>
<td>Contributing national expert</td>
</tr>
<tr>
<td>Kwaziwkakhe Majola</td>
<td>Department of Water Affairs (South Africa)</td>
<td>South Africa</td>
<td><a href="mailto:MajolaK@dwa.gov.za">MajolaK@dwa.gov.za</a></td>
<td>Contributing national expert</td>
</tr>
<tr>
<td>Wilhelm Ernst Bertram</td>
<td>Department of Water Affairs (South Africa)</td>
<td>South Africa</td>
<td><a href="mailto:bertrame@dwa.gov.za">bertrame@dwa.gov.za</a></td>
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</table>

Considerations and recommendations

Most data in the tables and text above have been provided by national and regional experts (listed above) or have been derived from the global WaterGAP model. See colophon for more information, including references to data from other sources.
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Both TBA countries contributed to the information. Information was adequate to describe the aquifer in general terms. Some quantitative information was also made available, but this was insufficient to calculate the indicators at the TBA level.

Data gaps and also differences between data from national experts (Global Inventory) and data derived from WaterGAP highlight the need for further research on transboundary aquifers.

Appendix 1: AF1

Karoo Sedimentary Aquifer: Map showing some Geological formations of the Drakensberg-Maluti range (Please note: Information on this map has only been provided for the South African part of the aquifer)

Appendix 2: AF1

Karoo Sedimentary Aquifer: Map showing major wetlands on the mountain escarpment in Lesotho
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Colophon

This Transboundary Aquifers information sheet has been produced as part of the Groundwater Component of the GEF Transboundary Water Assessment Programme (GEF TWAP). GEF TWAP is the first truly global comparative assessment of transboundary groundwater, lakes, rivers, large marine ecosystems and the open ocean. More information on TWAP can be found on: www.geftwap.org. The Groundwater component of TWAP carried out a global comparison of 199 transboundary aquifers and the groundwater systems of 41 Small Island Developing States. The data used to compile this transboundary aquifer information sheet has been made available by national and regional experts from countries involved in the TWAP Groundwater project. For aquifers larger than 20 000 km² and which are not overlapping, additional data are available from modelling done by the Goethe University Frankfurt (Germany) as part of TWAP Groundwater. All data were compiled by UNESCO-IHP and the International Groundwater Resources Assessment Centre (IGRAC – UNESCO Category II Institute). Values given in the fact-sheet represent an approximate guide only and should not replace data obtained from recent local assessments. The editors of this information sheet are not responsible for the quality of the data.

For more information on TWAP Groundwater and for more data, please have a look at the TWAP Groundwater Information Management System which is accessible via www.twap.isarm.org or www.un-igrac.org.

Request:
If you have additional data or information about this transboundary aquifer that can improve the quality of this information sheet and the underlying database, please contact us via email at info@un-igrac.org. If appropriate, the information will be uploaded to the database of transboundary aquifers and will also be used in new versions of this information sheet.

References:
- Climate: Climate indicates the major climate zone which occurs in the aquifer area. If more than 1 climate zone is present the zone with the largest surface area was selected. Source climate data: ArcGIS Online (2015), Simplified World Climate zones. Owner: Mapping Our World GIS Education. Original map: National Geographic World Atlas for Young Explorers (1998).
- All other data: TWAP Groundwater (2015).

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