

Research question	Data collection program year 1 (or indicators)	Key means	Output (with datasets)
<p><b>Groundwater governance, power relations (RQ1.1 and 1.2)</b></p>	<p><u>Mapping water points:</u></p> <ul style="list-style-type: none"> <li>• Water point coordinates</li> <li>• Type of technology</li> <li>• Water uses and other users</li> <li>• Alternative sources</li> <li>• Payment for water – prices</li> <li>• Technology Preference – level of service</li> <li>• Investment cost, O&amp;M cost, replacement cost</li> <li>• Water quality – visual and taste</li> </ul> <p><u>Household Survey:</u></p> <ul style="list-style-type: none"> <li>• Household characteristics</li> <li>• Water technology types, household storage, water consumption, water quality</li> <li>• Water prices and affordability</li> <li>• Water-related diseases and health cost</li> <li>• Household sanitation and sanitary conditions</li> <li>• Perception on water access</li> </ul>	<p><u>Arusha:</u></p> <ul style="list-style-type: none"> <li>• 2 UNESCO-IHE MSc students (Hans and Michelle supervision).</li> <li>• Field visit Michelle in Feb.</li> <li>• Field visit Maryam in May/June</li> </ul> <p><u>Dodowa:</u></p> <ul style="list-style-type: none"> <li>• Data collection via household survey in Oct.</li> <li>• Field visit Maryam to coordinate with drilling in late Nov/Dec.</li> </ul> <p><u>Kampala:</u></p> <ul style="list-style-type: none"> <li>• Review of secondary sources by Robinah/Jennifer.</li> <li>• Review and data collection by Maryam, Robinah, and Jennifer.</li> <li>• Field visit by Maryam in June 2016, to be coordinated with Robinah.</li> </ul>	<ul style="list-style-type: none"> <li>• Review paper. Applying Political Ecology and Multi-Level Perspective to conceptualize urban groundwater systems and issues of access/equity (Maryam and Michelle, to be co-authors with others).</li> <li>• Paper. Application of transition management, e.g. taking transition management to the global South (Maryam, to be co-authored with others).</li> <li>• Paper. Human right based approach to groundwater systems in Dodowa (Jenny, to be co-authored by others).</li> </ul>

<p><b>Economics of groundwater (RQ1.3)</b></p>	<p>Same as above.</p>	<p><u>Arusha:</u></p> <ul style="list-style-type: none"> <li>• Field visits and data collection by Jennifer in Nov-Dec 2015.</li> <li>• Field visit Sampson.</li> </ul> <p><u>Dodowa:</u></p> <ul style="list-style-type: none"> <li>• 1 KNUST MSc student (Sampson, Meine Pieter supervision).</li> <li>• Field visit Meine Pieter.</li> </ul> <p><u>Kampala:</u></p> <ul style="list-style-type: none"> <li>• Field visits and data collection by Jennifer in Jan-Feb 2016.</li> <li>• Field visit Sampson July 2016.</li> </ul>	<ul style="list-style-type: none"> <li>• Financial analysis of groundwater sources in Sombetini, Bwaise, and Dodowa.</li> </ul>
<p><b>Groundwater flow systems analysis (RQ1.4)</b></p>	<ul style="list-style-type: none"> <li>• Drill 20 shallow boreholes (5-50 m) for geology and install 2 inch piezometers.</li> <li>• For each piezometer: triplicate slug tests to map permeability field.</li> <li>• Groundwater level observations with pressure transducers.</li> <li>• Groundwater chemistry: major cations, anions, tracers (e.g. 15N).</li> <li>• Sum geochemical parameters organic carbon, iron oxides, CEC, carbonates.</li> <li>• Indicative 2D or 3D groundwater flow modelling.</li> </ul>	<p><u>For each focal area:</u></p> <ul style="list-style-type: none"> <li>• Drilling rig (rotary mud, air, and/or DTH).</li> <li>• Consumables: 2 inch piezometers.</li> <li>• Pressure transducers.</li> <li>• 1 UNESCO-IHE MSc student (Jan Willem supervision).</li> <li>• Field visit Jan Willem November 2015.</li> </ul> <p><u>In addition:</u></p> <ul style="list-style-type: none"> <li>• 1 KNUST MSc student for Dodowa (George and Jan Willem supervision).</li> <li>• 1 team of Makerere BSc students on springs (Frank and Jan Willem supervision).</li> </ul>	<p><u>Arusha:</u></p> <ul style="list-style-type: none"> <li>• Paper on groundwater flow systems analysis of Sombetini and Unga Limited. (Jan Willem, co-authored by others).</li> </ul> <p><u>Dodowa:</u></p> <ul style="list-style-type: none"> <li>• Paper on groundwater flow systems analysis of Dodowa (George, Jan Willem).</li> <li>• Paper on the geology of the Dodowa regolith (George, Jan Willem).</li> </ul> <p><u>Kampala:</u></p> <ul style="list-style-type: none"> <li>• Paper on groundwater flow systems analysis of Makerere Hill and Bwaise slum as part of Lubigi catchmen (Philip, Jan Willem).</li> <li>• Paper on the springs of Kampala (Frank, Jan Willem, others).</li> </ul>

<p><b>Pathogens in groundwater (RQ1.5)</b></p>	<ul style="list-style-type: none"> <li>• Virus up-concentration protocol from 10-100 L samples.</li> <li>• Total RNA and DNA extraction and reverse-transcription to copyDNA.</li> <li>• Lab sequencing (miniSeq).</li> <li>• Field sequencing (minIon).</li> <li>• E. coli serotyping work.</li> </ul>	<p><u>Arusha:</u> Not in year 1.</p> <p><u>Dodowa:</u></p> <ul style="list-style-type: none"> <li>• Lab equipment (e.g. centrifuge, glass wool columns, pumps, freezer, etc.).</li> <li>• 1 UNESCO-IHE Msc student.</li> <li>• Field visit Jan Willem November/December 2015.</li> <li>• Serotyping E. coli at RIVM.</li> </ul> <p><u>Kampala:</u></p> <ul style="list-style-type: none"> <li>• Lab equipment (e.g. centrifuge, glass wool columns, pumps, freezer, etc.).</li> <li>• 1 BSc student Avans Hogeschool Breda (Jack, Jan Willem, Bart van Rotterdam supervision).</li> <li>• Field visit Jack Feb 2016.</li> </ul>	<ul style="list-style-type: none"> <li>• Paper on load and transport of bacteria and viruses in groundwater of Dodowa, Ghana (Jack, Jan Willem, George).</li> <li>• Paper on load and transport of bacteria and viruses in groundwater of Kampala, Uganda (Jack, Jan Willem, Frank/Philip).</li> <li>• Paper on influence of E. coli serotype on transport in groundwater of Dodowa (George, Jan Willem).</li> </ul>
<p><b>Spatial and temporal distribution of selected pathogenic viruses in groundwater (RQ1.6)</b></p>	<ul style="list-style-type: none"> <li>• Virus up-concentration protocol from 10-100 L samples.</li> <li>• Determine Adenovirus, Rotavirus, Norovirus copy numbers using qPCR.</li> </ul>	<p><u>Arusha:</u> Not in year 1.</p> <p><u>Dodowa:</u></p> <ul style="list-style-type: none"> <li>• Lab equipment (e.g. centrifuge, glass wool columns, pumps, freezer, etc.).</li> <li>• 1 UNESCO-IHE Msc student.</li> <li>• Field visit Jan Willem November/December 2015.</li> </ul> <p><u>Kampala:</u></p> <ul style="list-style-type: none"> <li>• Not in year 1.</li> </ul>	<ul style="list-style-type: none"> <li>• Paper on spatial and temporal variation of indicator viruses in groundwater of Dodowa, Ghana (Jan Willem, George, Jack).</li> </ul>