

TERMS OF REFERENCE FOR CARRYING OUT GROUNDWATER ASSESSMENT OF THE PANGANI RIVER BASIN

1. Background

The Ministry of Water and Irrigation has secured financial support from development partners for implementation of the National Water Sector Development Program (WSDP), 2006-2030. The WSDP targets four broad areas of support as follows:

- i. Water Resources Management and Development (WRMD);
- ii. National Rural Water Supply and Sanitation (NRWSS);
- iii. Urban Water Supply and Sewerage (UWSS); and
- iv. Sector Institutional Strengthening and Capacity Building.

The objectives of the WRMD component are to develop a sound water resources management and development framework in nine river and lake basins in mainland Tanzania. The WRMD component also aims at promoting good governance of water resources.

To fulfil the objectives of the WRMD component, the Ministry of Water and Irrigation intends to develop Integrated Water Resources Management and Development (IWRMD) Plans for the nine River Basins in Tanzania. The basin plans are aimed at supporting the attainment of National Strategy for Growth and Poverty Reduction, MDGs and Tanzania's Vision 2030 targets.

The Pangani Basin Water Board (PBWB) is planning to develop an IWRMD Plan for the entire administrative basin including Pangani River and other small catchments (Umba, Zigi, Mkulumzi, Msangazi, and Coastal Rivers) that has a time horizon to 2030 was planned to be undertaken with National Water Sector Development Programme (WSDP) support. Within the IWRMD planning process there are specific tasks that need to be undertaken including groundwater assessment.

Through the Pangani River Basin Management Project (PRBMP), the PBWB intends to carry out a groundwater assessment which will then be used within the broader IWRMD planning process. This document outlines the Terms of Reference (ToR) for carrying out groundwater assessment to support the process of developing an IWRMD Plan for the Pangani River Basin and its small catchments.

The PRBMP is an initiative of the Government of Tanzania, The International Union for Conservation of Nature (IUCN), through its Water & Nature Initiative (WANI), the Global Environmental Facility (GEF) through UNDP, and the European Commission. The Project goal is to mainstream the approaches to deal with the negative effects of climate change into Integrated Water Resources Management (IWRM) in the Pangani River Basin, in order to support the equitable provision of freshwater for the environment and for livelihoods for future generations.

1.1 Pangani Basin

The Pangani Basin is one of 9-river and lake basins gazetted in Tanzania according to the Water Utilization (Control and Regulation) Act No. 42 of 1974 and its amendment Act No 10 of 1980. It is the first basin in the country formed in 1991. The basin is now managed according to the New Water Resources Management Act No 11 of 2009.

It covers an area of about 58,510 km² hydrologically of which 5% lies in Kenya (Figure 1). It includes the main Pangani River Basin (43,650 km²) and the four smaller river basins of Umba River Catchment (8,070 km²), Zigi River Catchment (1,050 km²), Msangazi River Catchment (5,030 km²), Mkulumuzi and other coastal rivers (1,360 km²). About 3.7 Million people live in the basin with 0.041 million in Kenya.

Tanzanian part of the basin is spread over eighteen (18) administrative districts in four regions of Arusha, Kilimanjaro, Manyara and Tanga. Transboundary water hotspots in the basin include L. Chala, L. Jipe and Umba River which are shared with Kenya.

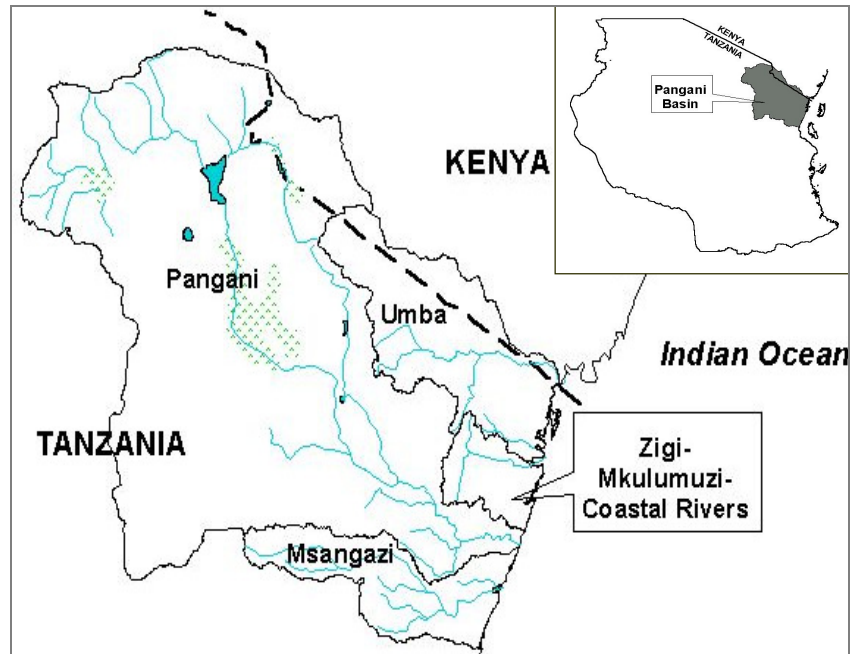


Figure 1: The Pangani Basin and its Sub basins (Pangani River, Umba River, Zigi River, Mkulumuzi and other coastal River Catchments)

1.2 Groundwater Resources Availability in the Basin

Volcanic sediments and rocks around Mt. Kilimanjaro and Meru, weathered and fractured metamorphic rocks on foot hills of Pare and Usambara Mountains and Masai Steppes and sediments and sedimentary rocks in coastal areas form major aquifers in the basin.

High groundwater yields have been witnessed in volcanic and coastal aquifers (boreholes with yields >100 m³/hr are available with, 88% abstraction is for irrigation). Water quality is generally good, with exceptions of high fluorides contents in some areas.

1.3 Water Resources Management Challenges

- Deforestation – causing water retention problems, increases runoff and hence promoting erosion, flooding and increased silt loads.
- Development: unmanaged development in the Basin is a concern given the potential for pollution and inadequate waste disposal that it represents.
- Water quality: this is threatened by pollution, but also damaged by localised geological characteristics that may give rise to fluoride contamination.

- Mining: uncontrolled mining activities in the Basin threaten its landscape and the future productivity of its land. It also has serious pollution potential. Sand mining along rivers undermines the stability of riverbanks.
- Lack of environmental awareness amongst the Basin's inhabitants.
- Political expediency: politicians, eager to obtain votes from their constituents may sometimes encourage the wholesale exploitation of vulnerable resources.
- Inadequate policies: policies that appear perfectly reasonable and carefully developed may be rendered impotent because their implementation cannot be monitored, and offenders are not sanctioned.
- Funding problems: these arise at virtually every point of the Basin's administration and range from difficulties in providing adequate remuneration to the purchase of technology to assist with Basin monitoring.
- Lack of management integration: the divisions between regional and national level administration coupled with 'sectoral' management approaches, ensures that much of the Natural Resources Management (NRM) in the Basin is not integrated, with one sector or level of administration pursuing objectives and management styles different to the other levels or sectors of the Basin. This difficulty also occurs across international frontiers: no mechanism exists for Kenya and Tanzania to co-ordinate their management of the Pangani River Basin.
- Uncontrolled groundwater developments: there is a rapid growth of groundwater development activities in the basin due to shortages of surface water, which have resulted into an uncoordinated drilling of boreholes and shallow dug wells.
- Fragmented groundwater data: geophysical and other hydrogeological data are being collected and kept by various private, NGOs, public and other institutions. There is a need for establishing mechanisms, formats and standards for collection and storage of the data centrally.

1.4 Geology and Geomorphology

The northern part of the basin (Arusha - Moshi areas) is predominated by neogene volcanics resulting from the eruption of Mt. Kilimanjaro, Mt. Meru and numerous other peaks of parasitic cones. These areas display several conical topography aligning in the Kilimanjaro-Meru (NW-SE) major direction. The lower lying parts of these areas are dominated by neogene volcanoclastics that goes down to 150 to 200 m.

The central part of the basin displays a grabben morphology with the trough dominated by neogene sediments. Both sides of the grabben is overlain by granulitic metamorphic rocks of the Usagaran System (Mozambican belt) stretched in the NW-SE trend of the major Pare faulting. To the east are the Pare and Usambara mountain ranges of the famous eastern arc mountain ranges. The West and South West of the Basin is predominated the Lelatema mountain ranges and vast Massai Steppes consisting of the Basement Rocks Precambrian metamorphic rocks overlain by the Neogene sediments.

The basin ends in Tanga region where it pours water in the Indian Ocean around which the geology is dominated by coastal sediments, limestones and sandstones of the Karoo System..

Faults, fractures, dykes and other geological structures are found at various parts of the basin.

2. Purpose and Objective of the Groundwater Assessment

The purpose of the groundwater assessment is to complete an evaluation of groundwater resources in the Pangani Basin and produce information that can be incorporated into an IWRM plan for the whole basin. Groundwater resources assessment should be carried out for the whole basin including quantification of potential yields from the aquifers. A hydrogeological analysis should also be carried out as part of the assignment and should include classification of hydrogeological characteristics of the basin.

Objectives of the groundwater assessment include:

1. Determine the availability of groundwater, demand for groundwater and its development potential by considering (but not limited to) the following:

- Volume and distribution of available groundwater in the basin;
- Groundwater recharge mechanisms in the basin;
- Annual safe yield of groundwater;
- Groundwater quality and its limitations;
- Cost effectiveness of developing groundwater resources;
- Hydro-geological modeling and mapping;
- Environmental and other non-economic factors; and
- Protection of potential vulnerable aquifers with consideration of water related risks including climate change.

2. Design a groundwater management framework which integrates with IWRM planning

3. Build capacity of PBWB and key stakeholders in groundwater assessment and management

3. Tasks and Outputs of the Groundwater Assessment

Result 1. Completed assessment of groundwater resources in the Pangani Basin is produced

Output 1.1 Existing data and information on groundwater in the Pangani Basin in compiled and analysed as part of the groundwater assessment.

Task 1.1.1 Collect, interpret and analyze existing data and review information related to groundwater availability and current and future sectoral demands

Task 1.1.2 Compile information into a draft report (to be part of the final report) for review by PBWO and IUCN

Output 1.2 Gaps in groundwater information identified and plan produced to ensure completion of groundwater assessment

Task 1.2.1 From existing information (under output 1.1), identify gaps that need to be addressed to complete the groundwater assessment

Task 1.2.2 Prepare a plan for bridging gaps to be reviewed by PBWO and IUCN

Output 1.3 Detailed groundwater assessment is completed which includes:

- ***A comprehensive hydrogeological report in relation to the above activities***
- ***Pangani Basin Hydrogeological Map***
- ***Groundwater models for respective aquifer systems and well fields***

- ***Robust groundwater database***

Task 1.3.1 Determine the geology, geomorphology and stratigraphy of the basin;

Task 1.3.2 Carry out hydrogeological investigation and determine hydrogeological condition by geological unit this includes:

- Identify aquifer systems and well fields, map and establish their respective extent and potential
- Produce GIS based geological and hydro-geological maps of the basin

Task 1.3.3 Drill exploratory boreholes in order to obtain missed data

Task 1.3.4 Carry out pumping and recovery tests where needed and evaluate their results

Task 1.3.5 Collect and analyse water samples for physical and chemical parameters and interpret their results in relation to sectoral water uses

Task 1.3.6 Map potential groundwater recharge and discharge areas. This includes:

- Delineation of:
 - Aquifer spatial coverage in different sections of the basin;
 - Areas with high groundwater recharge potential;
 - Areas with high infiltration potential;
 - Areas with high groundwater yields;
 - Spatial groundwater quality changes and sources of pollution; and
 - Land use changes over the period not less than 10 years.

Task 1.3.7 Identify groundwater recharge mechanisms, abstraction and demand for respective major aquifer systems and well fields using scientifically recognized and cost effective methodologies;

Task 1.3.8 Identify boundary conditions of the aquifer systems or well fields

Task 1.3.9 Establish GW Resources Inventory which is compatible to GIS;

Task 1.3.10 Prepare groundwater models and simulate flows for the respective aquifer systems and well fields this includes:

- Assessment of impacts of climate change on the groundwater resources;
- Develop water allocation scenarios considering short, medium, long-term and conjunctive use strategies for both surface and groundwater resources;
- Use the configured system model to assess water allocation implications of the short-list of scenarios.

Task 1.3.11 Determine groundwater safe yields for respective aquifer systems and well fields

Task 1.3.12 Identify and map groundwater vulnerable areas in accordance with the Water Resources Management Act No. 11 of 2009

Task 1.3.13. Production of draft and final reports with information from all tasks within groundwater assessment.

Result 2. Groundwater management framework which integrates with IWRMD planning process is produced

Output 2.1 Completed groundwater management framework which provides guidance for integration into IWRMD planning process

Task 2.1.1 Review IWRMD planning terms of reference and assess how information from groundwater assessment will be integrated.

Task 2.2.2 Produce a framework which guides the PBWB on the process of integrating the information produced into the IWRM planning process

Result 3. Capacity of PBWB to carry out and use information from a groundwater assessment is strengthened

Output 3.1 PBWB staff have capacity to use information from groundwater assessment to effectively groundwater sources

Task 3.1.1 Involvement of PBWB in all tasks

Task 3.1.2 Clear documentation of all tasks is produced and presented to PBWO staff

Task 3.1.3 Workshops and workshop reports to present key findings and process with PBWO and identified stakeholders.

4. Deliverables of groundwater assessment

The main deliverables of the Ground Water Resources Assessment component are soft (editable) and hard copies of the following:

Result 1

Draft report of groundwater assessment which includes:

- Existing data and information on groundwater in the Pangani Basin in compiled and analysed as part of the groundwater assessment.
- Gaps in groundwater information identified and plan produced to ensure completion of groundwater assessment
- A comprehensive hydrogeological report in relation to the tasks under Output 1.3
- Pangani Basin Hydrogeological Map (and detailed report on quantity, quality and pollution conditions) with the necessary GIS-based data and information for planning, development and management of the groundwater in the basin;
- Groundwater models for respective aquifer systems and well fields
- Robust groundwater database

Provide recommendations on:

- The protection measures of the associated aquifers;
- Groundwater management scenarios;
- Safe yield of groundwater in different sections of the basin;
- Environmental and other non-economic benefits from groundwater; and
- Consideration of climate change in the management of the groundwater resources

Result 2

Groundwater management framework which provides guidance for integration into IWRM planning process

Result 3

- Comprehensive compilation of documentation to complete all tasks
- Workshop reports
- Guidance manual if needed

5. Composition of Assessment Team

It is suggested that this assignment be undertaken by a team rather than an individual. This assessment team should ideally be comprised of established individuals within their field of specialization. The project team will include an international and local team of consultants. The team will consist of international and local hydrogeologists, and local technicians.

Team members should have a strong background in hydrogeological assessments, preferably in Eastern Africa. The team leader should have experience in integrating groundwater information into IWRM plans.

6. Accountabilities and Responsibilities

This assessment assignment will be led by the Regional Water and Wetlands Coordinator in IUCN, ESARO. The Regional Coordinator, together with the Programme Offices in ESARO and PBWD Officers will be responsible for:

- Coordinating with the Team Leader and other members of the team those additional tasks related to detailed up-front planning.
- Reviewing, providing comments upon and approving the assessment deliverables.
- Tracking of progress of tasks within time frames and assessment of quality of product.
- Spot checking on fieldwork and authorization of payments.

The Assessment Team Leader, on the other hand, will be responsible for all the process of the groundwater assessment including providing regular progress reports to the Regional Water and Wetlands Coordinator, coordination and timely submission of outputs and ensuring a high quality of work is produced.

Knowledge Transfer and Capacity Building

The consultant will build the capacity of all participating and implementing institutions for on groundwater resources assessment (including data processing and analysis, database development and updating, hydrogeological modeling, Decision Support System (DSS) development and updating. Short and medium term training programme will be prepared by the consultant. The Consultant will work in close collaboration with local and counterpart staff to facilitate transfer of ideas, concepts, techniques and baseline information.

Data, Local Services, Personnel, and Facilities to be Provided by the Client

PBWO and IUCN will make available existing hydrological, groundwater, climate, and water quality data in available format (digital and/or hard copy format), topographical maps, transport for official travel, office accommodation, and some local counterpart staff and technicians. The consultant will be expected to collect from the field any other additional data that would be required for the assignment.

7. Deliverable / Reporting

7.1 Assessment Work Plan

The Team Leader shall prepare a work plan detailing how the groundwater assessment will be undertaken, and provide, among other things, the methodology, data collection tools and bring refinements and elaboration on these Terms of Reference. This work plan shall entail:

- Specific set of issues and questions to be addressed by the assessment
- Indicators and data to be used in addressing the assessment
- Work schedule in a Gantt chart format
- Budget according to result areas

7.2 Draft Development Effectiveness Report

The appointed service provider will be expected to provide IUCN with a draft report on a date specified and agreed to in the work plan. The same report shall be presented by the service provider in a workshop to be organized by the IUCN and PBWO.

7.3 Final Development Effectiveness Report

The Team Leader will submit a complete final report (hard copy and an electronic copy in a CD). This report shall adhere to the agreed format. As this is the final report it should incorporate all the comments that would have come from the workshop wherein the draft report was presented.

8. Duration and Location of the Assessment

The assignment will be conducted in a time frame of 12 months. All time expert inputs are to be fulfilled in the 12 months period. However, the team leader will liaise with the PBWO and IUCN to determine the exact timeframe for delivery of the groundwater assessment.

The project will be located at the offices of the Pangani Basin Water Office in Moshi.

9. Budget

The budget for the groundwater assessment is in the region of 400,000 USD.

Output	2010												2011			
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Mar	Apr
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Output 3.1 PBWO staff have capacity to use information from groundwater assessment to effectively groundwater sources																

9. Contact Information

All inquiries and proposals should be addressed to:
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