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Water Allocation Planning for the Lower Mara River Basin in Tanzania

A WATER SECURITY CASE STUDY

Challenge: Meeting Increased Demand for Water in the Mara River Basin

The Mara River Basin, home to 1.2 million people, covers nearly 14,000 square kilometers, providing water for domestic use, productive economies, including agricultural production – both subsistence rainfed and irrigated, in Kenya and Tanzania, and also sustains the region's stunning biodiversity, from forest ecosystems to the wildebeests migrating between Serengeti National Park and Maasai Mara National Reserve. Water demand in the basin has increased in recent decades due to increases in population, the area of irrigated crops, livestock and tourism. These demands, combined with increased frequency and duration of extreme events, has put a stress on this vital resource which resulted in a memorandum of understanding (MOU) between the two countries in 2015 for the joint management of the transboundary Mara River Basin. The government of Tanzania developed a water allocation guideline for the development of a water allocation plan (WAP) for the lower Mara basin to address water scarcity which intensifies during dry periods.

KEY STRATEGIES FOR WAP DEVELOPMENT AND IMPLEMENTATION

- Maintain stakeholder engagement throughout the WAP development process
- Establish and follow government guidelines for the WAP
- Engage stakeholders in the development of potential scenarios for robust decision making
- Perform frequent monitoring and reporting of river flows and permit compliance of water users
- Update the WAP every 5 years per guidelines, or as deemed necessary based on new flow and water abstraction data, and when conditions in the basin significantly change

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In Tanzania's Mara basin, the Lake Victoria Basin Water Board (LVBWB) is the government agency responsible to issue water user permits. Currently water is allocated to users based on an estimate of their demand. However, the LVBWB lacks information on the amount of water needed in the reserve to support ecological functions. As a result, the agency is vulnerable to over-allocation of water to some users and illegal abstractions from users that are not allocated sufficient water.

Intervention: Developing a Water Allocation Plan

Beginning in 2018, SWP supported the government of Tanzania in developing a WAP for the Lower Mara River Basin. A basin WAP is called for by the 2009 Tanzania Water Resources Management Act and takes into account environmental, social, political and economic development requirements and basin-scale scenarios that could affect decisions on the water to be allocated for different uses at a particular site. To this end, and with a stakeholder engagement process in place, in 2019 SWP conducted studies on water availability, water demand, water abstractions, and implemented a hydrologic water planning model to understand how future changes in land use, demographics and water abstractions need to be factored in current basin plans. The final WAP will serve as a guide to the LVBWB to issue and revise water permits.

What is Water Allocation Planning?

Water allocation planning is a process by which communities and basin managers can determine water use and distribution priorities under different scenarios to resolve or avoid conflicts among water users in situations of water scarcity. Water allocation planning can take place at transboundary, regional, or local scales, and can feature specific rules about water allocation to users by sector at a basin or sub-basin level. The Tanzania WAP was prepared based on guidelines approved by Tanzania's Ministry of Water with underlying principles such as public participation, equity among water users, international cooperation, and ecosystem integrity, among others. An important step in water allocation planning is balancing water availability and demand for each sub-basin.

Water Balance = Available Water - (Reserve + Transfers + Summation of Available Water Allocations)

The water balance is calculated as the amount of water available in the basin from rainfall (which results in river runoff and groundwater storage) minus the water in reserve and other allocations or transfers outside the basin. A positive balance at a given time or location means that the available water satisfies all demands, whereas a negative balance means there is not enough available water to meet the demands. To meet unmet demands, restrictions, water transfers, and other demand management options need to be put in place. For the Tanzania WAP, the reserve is the water needed at all times for basic human needs (25 liters per second per person) plus the water reserved to maintain required environmental flows in the river.

Development of the WAP in Tanzania consisted of four main elements (Figure 1): 1) stakeholder engagement, 2) water balance assessment, 3) robust decision formulation and scenario analysis, and 4) WAP drafting, approval and implementation.

Stakeholder Engagement

The WAP for Tanzania started with the development of a stakeholder engagement plan, which was followed from the inception of the WAP through its finalization and approval. Stakeholders included participants from the government and political sectors, water users, NGOs, other civil society organizations, and international donors. At the inception workshop, stakeholders agreed to a process for regular consultation during the development of the WAP, and established a technical task force committee for review and validation of WAP supporting studies, and the final drafting of the WAP.

Estimation of Water Balances

To estimate the basin's water balance, a water availability assessment, water abstraction survey, water demand analysis, and environmental flow assessment were completed.

Water Availability was determined from historical data sets of daily precipitation and river flows which were aggregated by month at different points of the basin. Mean annual and monthly values for precipitation, evaporation, and river flows were estimated for each sub-basin of the Lower Mara River Basin (Figure 2). From these estimates, flow duration curves were generated which show the percent of time a given river flow is equaled or exceeded. For instance, Q80 is the flow which is exceeded 80 percent of the time and, according to the guidelines, normal flow volumes between this value and the reserve are available for water allocation. In addition, the reserve flow should not be less than Q95 per WAP guidelines.

A **Water Abstraction Survey** was conducted in the Lower Mara River Basin to determine the volume of water abstracted by different users directly from the river, boreholes, dug wells, spring sources, rainwater harvesting, water pans, and small dams. Using the mWater platform, staff from the LVBWB conducted the survey after receiving training from mWater. Stakeholders including district

WATER BALANCE DATA NEEDS AND OUTPUTS

WATER RESOURCES AVAILABILITY

- Topographic data for delineation of basins and sub-basins
- Land use and river networks
- Precipitation and river flows from hydrometeorological and hydrometric stations
- Hydrogeology and soil properties
- Ground water recharge and interactions with surface waters

OUTPUTS
Mean monthly and annual river flows, and flow duration estimates by river segments

WATER ABSTRACTION SURVEY

- Abstractions by source type (spring, river, rainwater harvesting, dug well, water pan, borehole)

OUTPUTS
Volume of water abstracted by source, and sub-basin

WATER DEMAND ANALYSIS

- Population by district/basin
- Livestock population by type
- Small-scale irrigation demand
- Large-scale irrigation demand
- Tourism water demand
- Wildlife water demand by species

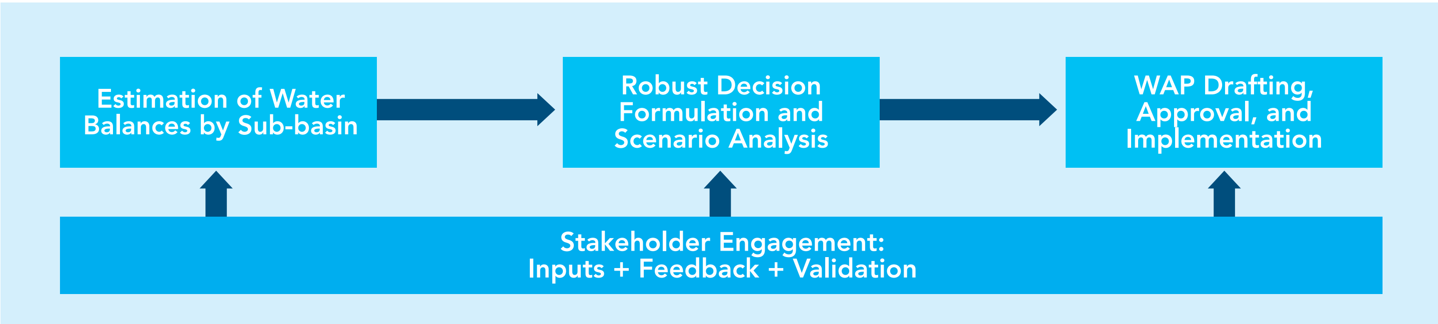
OUTPUTS
Total water demand by type and sub-basin

ENVIRONMENTAL FLOW ASSESSMENT

- River flows
- Water quality assessments
- Geomorphology
- Fish habitats and macroinvertebrates
- Riparian vegetation

OUTPUTS
Flow and river depth requirements for dry and wet periods by sub-basin

FIGURE 1: WATER ALLOCATION PLANNING PROCESS



officials and officials from Water User Associations (WUAs) participated in the survey and assisted the survey team by providing information on water abstraction locations and, in the case of the WUAs, supporting data collection in the field. A total of 499 abstraction points were identified, of which 30 percent were non-functioning. Of the functional abstraction points, more than 90 percent did not have a permit.

Water Demand was estimated following the WAP guidelines for all sectors including domestic, irrigation, livestock, mining, tourism, aquiculture and wildlife under present conditions and planning horizons for 2023, 2028, and 2038. Projected monthly demands in cubic meters per day were calculated for each sub-basin of the Lower Mara River Basin.

The Environmental Flow Assessment was based on the Lower Mara Environmental Flow Assessments (IHE Delft 2019) which followed the Nile Basin Initiative (NBI) Environmental Flows Framework (NBI, 2016). That framework includes detailed assessments of flow variations from baseline conditions, river depths and flood plain areas based on river hydraulics models, and analyses of water quality, geomorphology, fish habitats, macroinvertebrates, riparian vegetation, and social use. To this end, detailed biophysical surveys were conducted in seven representative areas of the basin to determine the required water levels and flows in the river to preserve the integrity of the river ecosystem.

Robust Decision Making

Robust decision support (RDS) is an analytic framework that identifies critical uncertainties, the goals of the people in the basin, and potential robust strategies (Figure 4). Components of Robust Decision Support (RDS) are based on the RAND Corporation's RDM framework (Lempert et al. 2003). These components of RDS are identified via a series of workshops with stakeholders, and then incorporated into a quantitative and/or qualitative model to characterize the vulnerabilities of such strategies, and evaluate trade-offs among them. Ultimately, robust strategies are identified that best achieve the goals given the uncertainties. For the Mara river basin, the Water Evaluation And Planning (WEAP) model was used to look across multiple possible future scenarios of land use, climate, water abstractions, upstream development, and demographics to identify which scenarios may result in water stresses in the basin and to formulate potential WAP scenarios. Stakeholders identified four main uncertainties: 1) climate variability and change, 2) land use change, 3) ecological change, and 4) upstream development. Performance metrics identified were related to healthy ecosystems, equitable water use across the basin, resilience to climate change, and the achievement of water-related development potential.

FIGURE 3: THE ROBUST DECISION SUPPORT ANALYTIC FRAMEWORK

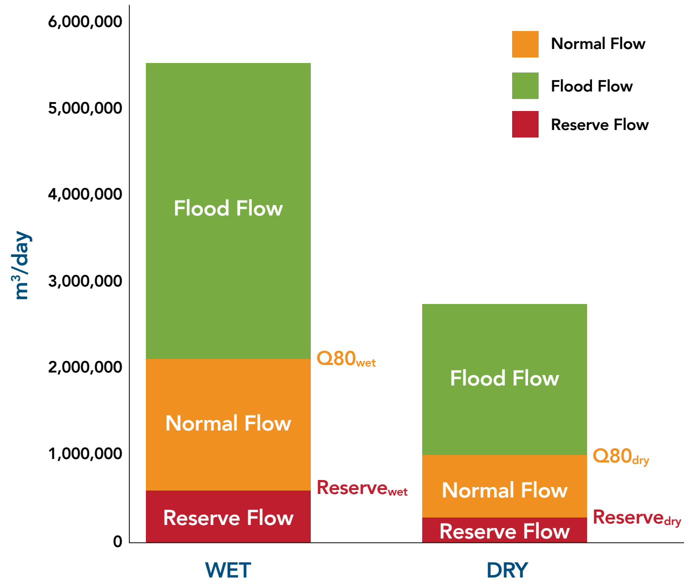
X: Uncertainties	L: Management strategies (levers)
Represents uncertainties outside the control of decision makers	The management actions that can be taken to improve outcomes
R: Relationships (models)	**M: Performance metrics**
Models defined and applied to depict relationships between uncertainties and management actions	Metrics used to measure outcomes

Scenario Analysis

Based on stakeholder input, three main scenarios were analyzed under 20 different climate projections: 1) baseline, 2) Tanzania enforcement of the reserve flows, and 3) upstream development. The baseline scenario is considered business as usual (BAU), with expanded irrigation and no enforcement of the reserve flows. The second scenario assumes enforcement of the reserve flows. The third scenario assumes upstream development and enforcement of the reserve flows both in Kenya and Tanzania.

Results from these scenario analyses indicate that by 2040-2050 there will be unmet demands and some months will be in the reserve. Water storage is needed to address unmet demands, in particular for domestic use and agriculture, while preservation of ecosystem integrity will require enforcement of reserve flows.

FIGURE 2: ILLUSTRATIVE FLOW MANAGEMENT THRESHOLDS FOR THE MARA RIVER IN TANZANIA



Results

After all the water balance studies were completed and approved, and scenarios formulated by the stakeholders, a writing team worked with local stakeholders to draft the full WAP. The WAP details water balances for the six sub-basins of the Lower Mara River Basin during dry and wet periods with projections for the years of 2023, 2028, and 2038. The WAP establishes the flows reserved for basic human needs and environmental flows during dry and wet periods. The WAP also provides management guidelines to the LVBWB for water abstraction permit decisions within each sub-basin. Finally, the WAP presents an implementation strategy which includes recommendations for further improvements in data collection for water resources assessments, stakeholder engagement, capacity building, demand management, and mobilization of financial resources.

FIGURE 4: MEETING OF STAKEHOLDERS TO SET RESOURCE QUALITY OBJECTIVES FOR THE LOWER MARA ENVIRONMENTAL FLOW ASSESSMENT, HELD IN TARIME, TANZANIA

Lessons Learned

A key benefit of the WAP process was proper representation of stakeholders throughout the process, data gaps to quantify water availability and demand, and uncertainty of future climate, land use, and development plans within the basin. Following are key lessons learned from SWP's experience creating a WAP for the Lower Mara River Basin.

Stakeholder engagement throughout the WAP development process: Consultation with stakeholders throughout the WAP development was instrumental to obtain buy-in, inputs, and validate supporting studies. In 2018, the Tanzanian government proceeded with the development of the WAP with the endorsement of the Ministry of Water. Continued engagement also provided an opportunity to build stakeholder capacity with regards to water modeling, robust decision support, and scenario planning for WAP development.

Guidelines for WAP: Establishing guidelines was an important element of the WAP development process since they set the principles and assumptions for water allocation. The guidelines delineate parameters and assumptions for water balances, including the amount of water set aside as a reserve for basic human needs and to maintain minimum environmental flows in the river. These guidelines were instrumental for focusing the discussion on the results and recommendations of the WAP and not on the assumptions to estimate water availability and demands.

Robust Decision Making: Facilitated Robust Decision Support workshops enabled stakeholders to explore the implications of specific decisions across a spectrum of uncertain future conditions. This allowed stakeholders to identify robust actions likely to deliver benefits under a wide range of future scenarios.

Addressing data gaps: A key benefit of the WAP process was the identification of data gaps, such as river flow data and hydrogeological studies. As a result of the WAP process, the LVBWB has established priorities for data collection to support future revisions of WAP.

Next Steps

The most important next step after final approval of the WAP is the operationalization of the WAP. This will include monitoring and evaluation, integration of the WAP in permitting processes, continuous update of abstraction data bases, building capacity of Tanzanian partners to use and improve WEAP and the RDS approach that will be used in periodic updates of the WAP.

Monitoring and Evaluation: For successful implementation of the WAP, daily river flows near the outlet of each sub basin should be recorded and transmitted to the LVBWB, and regular visits to water users should be implemented for compliance with permits. Periodic reports on flows and compliance should be prepared and shared with the Ministry of Water and the Lake Victoria Basin Commission for management.

Integration of the WAP in Permitting Processes: LVBWB as the government agency responsible for the review and approval of Water Use Permits, should follow the analysis and guidelines provided for each sub-basin in the WAP. The ability to integrate changes in population, agricultural area irrigated, climate change and improvements in WASH into the quantitative modeling are an essential component of understanding how much water is available now, and what are the risks going into the future.

Updates to abstraction data bases: Regular updates to the abstraction database should be done by the LVBWB in order to track the locations and amounts of abstractions and compare with the water available for allocations in the WAP.

WAP a "living document": The WAP should be updated to account for new data or changes in water abstractions. In particular, revised estimates of population should trigger an update of the WAP to guarantee water in the reserve for basic human needs. Future scenarios should also be updated as climate models become more accurate and local conditions change.

Replication: The approach followed for the development of the lower Mara river basin WAP can be replicated in other basins in Africa. The guideline developed for the WAP in Tanzania, follows best practices of WAP development applied in other parts of the world.

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This case study is part of a series of products of approaches under the Water Security Improvement (WSI) process. This series is produced by USAID's Sustainable Water Partnership (SWP) activity and can be found here: www.swpwater.org.