



# Lower Mara River Environmental Flow Assessment

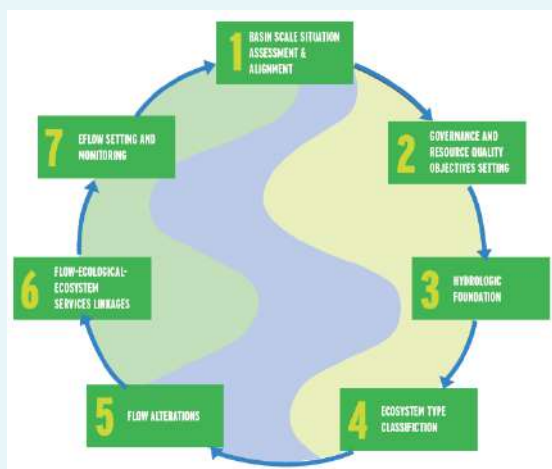
POLICY BRIEF 2020-01

APRIL 2020

A SECTION OF THE LOWER MARA RIVER IN TANZANIA

## Determining the Reserve in the Lower Mara River Basin

Final Resource Quality Objectives and Reserve Assessment Report



Summary of Steps Involved in the NBI E-Flows Framework (NBI, 2016b)

### KEY MESSAGES AND FINDINGS

• The Mara River Basin is transboundary and of international importance, shared by Tanzania and Kenya and draining into Lake Victoria. It is home to nearly 1 million people dependent on modest water resources that also sustain Maasai Mara National Reserve in Kenya, Serengeti National Park in Tanzania, and biodiverse wetlands bordering Lake Victoria. Increasing water demands place both people and nature at risk.

• Environmental flow allocations are an important management tool for ensuring that the water needs of ecosystems are protected alongside the needs of people. Environmental flows, are explicitly protected in the countries' national water laws, and trans boundary



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TEAM OF EXPERTS CONDUCTING E-FLOW REQUIREMENT FOR VEGETATION AT MID LOWER MARA RIVER REACHES LOW FLOWS

protections are featured in the treaty of the East African Community and the NBI. Detailed guidance on the determination of environmental flows in compliance with national laws and regulations is provided in the NBI Nile Basin E-Flows Framework.

- This brief summarises the results of an application of the Nile Basin E-Flows Framework in the Lower Mara River Basin of Tanzania. The assessment determined Resource Quality Objectives (RQOs) and reserve flow requirements using a team of experts, partners, and stakeholders.

- The final RQOs prioritized a balance between protection of the ecosystem and using it for their daily needs. The exception to this was in the Serengeti area, where environmental protection was the priority.

- Basic human needs reserve, was estimated based on the human population and a demand of 25 liters/person/day, resulting in a required flow between 0.006 m<sup>3</sup>/s and 0.030 m<sup>3</sup>/s for each sub-basin, and a total flow at 0.114 m<sup>3</sup>/s for the entire Lower Mara River Basin.

- Environmental flows reserve found that the mainstem sites had the highest requirements (2.4 to 15 m<sup>3</sup>/s), followed by the wetland site (3 to 12 m<sup>3</sup>/s), and then the tributaries (0.1 to 0.8 m<sup>3</sup>/s). Due to physical and knowledge limitations in the most downstream site in the Mara Wetlands, water depth values were recommended instead (2.7 to 3.3 meters).

- Implementation of the RQOs and the reserve requires integration into water allocation planning, as well as a reliable system of

monitoring, adaptive management, and enforcement of permits. Efforts are currently underway to finalize a water allocation plan for the Mara River Basin of Tanzania and begin a process of trans boundary harmonization in water allocation planning.

## BACKGROUND

The Mara River is a transboundary river basin shared between Tanzania and Kenya, and supporting the well-being of both a large wildlife population and the needs of a growing human population. The 2018 human population of the Lower Mara River Basin in Tanzania is estimated to be 396,000 and is projected to grow to more than 700,000 by 2030. To develop sustainably, this population must share the basin's limited water resources with ecosystems of Serengeti National Park, the Mara Wetland, and the river corridor extending along the main-stem Mara and up into each of the river's tributaries.

Protecting aquatic ecosystems is not only a requirement of the law, it is also important to people's health and livelihoods as communities rely on these ecosystems for many services that support their livelihoods.

Setting Resource Quality Objectives (RQOs) and the reserve in the Lower Mara River Basin is a priority because of the need to balance the growing water needs of the human population with the conservation of world-class ecosystems of the basin.

When the amount of water required for the reserve is determined, it can be used an input to water allocation plans both in Tanzania and the entire Mara River Basin.





E-FLOW REQUIREMENT ASSESSMENT FOR MACRO INVERTEBRATES

## DEFINITION OF RQOS AND RESERVE IN TANZANIAN POLICY

RQOs and the reserve are a requirement as stipulated in the Protection of Water a Resources of the 2009 National Water Resources Management Act of Tanzania. RQOs are qualitative statements intended to guide management actions to protect water and related aquatic biological resources at levels needed to meet the needs of resource users while maintaining ecosystems in a desired condition. They include statements on management objectives for water quantity, water quality, habitat, and biota. They also assign a desired management class utilizing the Tanzanian draft classification for water quantity management objectives. This classification system ranges from A to C, where A is near-natural conditions, B is somewhat altered conditions, and C is significantly altered conditions. The results from the RQO process are used to guide the development of the reserve.

The reserve is defined as the quantity and quality of water required for; (a) satisfying basic human needs by securing a basic water supply for people who are now or who shall in the reasonably near future, be (i) relying upon (ii) taking water from; or (iii) supplied from the relevant water resources; and (b) protecting aquatic ecosystems in order to secure ecologically sustainable development and use of the relevant water resources. From this definition, the reserve entails; basic human needs, which can be considered a component of the domestic water demand, and protecting aquatic ecosystems, also known as environmental flows. The RQO statements and desired management classes guide the amount of flow required for the reserve. When the reserve is implemented, it ensures the RQOs are being met now and into the future.

## NATIONAL AND TRANSBOUNDARY WATER ALLOCATION PLANNING

In water allocation planning, the amount of available water is assigned (or allocated) to different water users. These water users include the environment, domestic and livelihood needs for humans, and consumption by socioeconomic activities such as for industrial needs or hydropower generation.

The outcomes of the environmental reserve assessment will be incorporated into a water allocation plan for the Mara River Basin in Tanzania, along with the outcomes from water availability and water demand assessments, which will help to ensure sustainable and equitable water use now and into the future.

In 2015, the governments of the Republic of Kenya and the United Republic of Tanzania signed the “Memorandum of Understanding for Joint Water Resources Management of the Transboundary Mara River Basin”.

This policy synopsis lays out the responsibilities of both countries when it comes to the joint management of the Mara River Basin. While the reserve is not specifically stated in the Memorandum of Understanding, it is a critical component of water allocation planning. When appropriate, the government of Kenya has been involved in the reserve assessment in Tanzania and outcomes from previously completed activities in Kenya have been incorporated into the process.





E-FLOW WATER QUALITY REQUIREMENT ASSESSMENT

## METHODOLOGY AND PROJECT ACTIVITIES

The determination of the RQOs and the reserve was completed using the NBI's Environmental Flows Framework. This framework was developed to ensure a standard process is followed for the increasing number of environmental flow assessments being conducted in the Nile Basin. Lower Mara E-Flow assessment through RQOs setting marks domestication of the framework in Tanzania for the first time as well as the first full implementation of the Environmental Flows Framework. The framework details seven main steps, (Figure 1)

**Phase 1: Basin Scale Situation Assessment and Alignment Process.** Completed policy review related to the reserve in Tanzania; compiled available information related to environmental flows; ensured integration with on-going water resources related work in the Mara River Basin; and focused on strengthening and capacity building of partners.

**Phase 2: Resource Quality Objectives Setting.** Worked with local partners to select stakeholders for RQO workshop; determined eight resource units for the RQO process; and held RQO stakeholder workshop in Tarime, Tanzania on November 7 & 8, 2018.

**Phase 3: Hydrological Foundation.** Regionalization analyses completed for the Lower Mara River Basin to develop monthly and average annual discharge, minimum and maximum discharge values; annual and monthly flow duration curves; and maximum daily flow frequency.

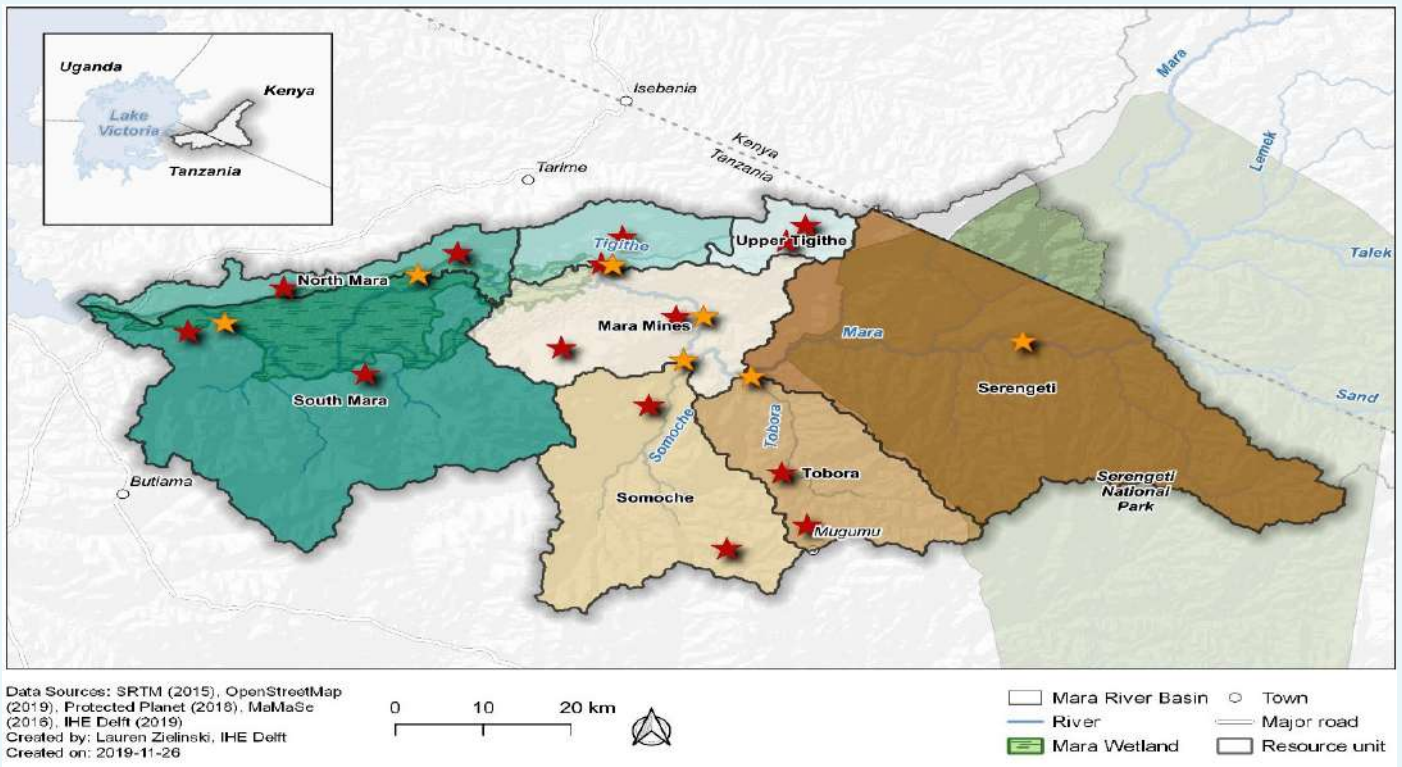
**Phase 4: Ecosystem Type Classification.**

Reviewed existing ecosystem and river classification systems or maps used in Tanzania, and completed an ecological, biological, and geomorphology assessment to determine the classification of the project area (main stem, tributaries, and wetlands).

**Phase 5: Flow Alterations.** Analysis of alteration in river flow regimes. However, no major flow alterations have occurred in the Lower Mara River Basin. Degradation in ecological condition likely from non-flow related pressures.

**Phase 6: Flow-Ecological-Ecosystem Services Linkages.** Implemented a modified Building Block Methodology, which combines existing knowledge and field data to determine the flows required in different "building blocks" of the hydrological year. These include base flows, freshets (small flow pulses), and floods (large flow pulses) across a hydrological year in both maintenance (normal) and drought conditions. A detailed starter document was developed for each environmental flow component (hydrology, hydraulics, water quality, geomorphology, fish, macroinvertebrates, riparian vegetation, and social use) which describes the field work conducted and the ecological or social relationships to flow.

**Phase 7: E-Flows (Reserve) Setting and Monitoring.** Developed reserve values by calculating needs for basic human needs for each resource unit and environmental flow requirements for each study site; recommended monitoring activities for compliance and effectiveness monitoring and how to include monitoring data into short- and long-term adaptive management cycles; and discussed uncertainties and special considerations.



MAP OF THE STUDY SITES FOR THE SOCIAL SURVEY, BIOPHYSICAL FIELD CAMPAIGNS, AND RESOURCE UNITS

## STUDY AREAS

The Lower Mara River Basin was divided into distinct study areas, labelled resource units. The boundaries of these resource units were developed to align with the existing management structure in the basin (such as the boundaries of water users associations) as well as the natural hydrological boundaries. This resulted in 8 resource units, aligned to the 6 water users associations and the approximate boundaries of Serengeti National Park.

These resource units were combined with the ecosystem type classification to select seven environmental flow study sites (the Upper and Lower Tigithe resource units were combined into one). These boundaries were also used to select the villages for the social survey, with two villages per resource unit. Figure 2 shows the outlines of the resource units as well as the locations of the environmental flow study sites and social survey villages.

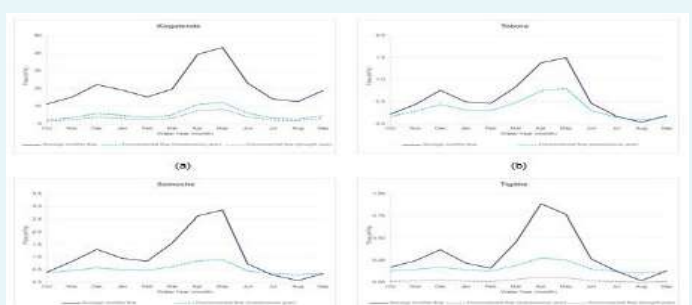
## FIELD CAMPAIGNS

Three field campaigns were completed to capture the biophysical (hydrological and ecological) and social components of the Lower Mara River Basin. The biophysical field campaigns were completed in February and May of 2019, gathering data from the seven study sites. This included two sites on the main-stem Mara River (Kogatende and Mara Mines), three sites on important tributaries (Tobora, Somoche, and Tigithe), and two sites on the Mara Wetland (Bisarwi and Mara Wetland). Specific study sites were selected based on accessibility, diversity of physical habitats, presence of natural conditions, proximity to existing river gauging stations,

safety, and alignment with previous eflows assessments. Field studies were conducted for hydrology, hydraulics, water quality, geomorphology, fish, macroinvertebrates, and riparian and wetland vegetation.

The social assessment was conducted in early 2019 and included surveys of two villages within each resource unit (excluding Serengeti), with 14 villages surveyed in total. The selection of the villages was based on accessibility, diversity of economic activities, proximity to the river or wetland, and population. The total number of participants in each village was about 40, selected using the village register with the assistance of the village leader. The selection was random but the gender and age of the participants were taken into consideration. Focus Group Discussions addressed different themes, including general village profiles, social and economic issues, natural resources available and their environment, and biophysical analysis of water bodies.

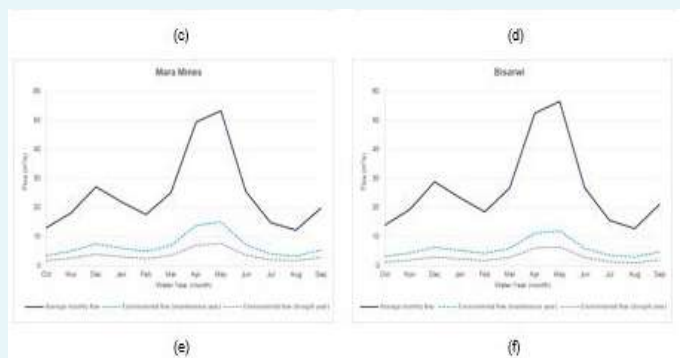
Figure 3a - 3f: Monthly low flow requirements of the ecological component of the reserve for riverine study sites. Because of expected no-flow conditions during drought in the Tobora and Somoche tributaries, drought flow levels were not set for these sites.







WATER DISCHARGE ASSESSMENT DURING LOW FLOWS AT LOWER MARA MID REACHES



### CAPACITY BUILDING AND STAKEHOLDER ENGAGEMENT

The reserve assessment was carried out in close collaboration with local and international partners. NELSAP/NBI led the process with technical and financial support from GIZ. The field work was conducted by the environmental flows technical team. The eflows technical team was also assisted by staff from the Tanzanian Ministry of Water, the Musoma District Fisheries Department, Serengeti National Park, local government leaders from the wards and villages, members of the water users associations, and community members.

Capacity building was incorporated into all major activities through hands-on learning and interaction with experts. During the field campaigns, local participants were encouraged to work with different experts to learn about their field of study and gain hands-on experience conducting different field work methodologies. In particular, knowledge exchange between the water authority staff in Kenya and Tanzania was considered a high priority. Community members contributed to the effort by providing

the technical experts with information about the local conditions and recent changes in ecosystem condition.

Two main stakeholder events were held. First, an RQO stakeholder forum was held on November 7th and 8th, 2018, in Tarime, Tanzania. The objective was to develop draft narrative RQOs for the RUs of the Lower Mara River Basin with local stakeholders. Participants were guided to this objective working through a series of activities designed to develop understanding of the process, gather needed information, and articulate the narrative RQOs. It was also a chance to encourage knowledge exchange and build relationships between different types of stakeholders in the basin through small group discussions.

The second stakeholder event was the Flow Setting Technical Meeting, which was held from 1st to 4th of July 2019 in Musoma, Tanzania. This meeting included a focused group of stakeholders, including the eflows technical team, partners from the Lake Victoria Basin Water Board, the Tanzanian Ministry of Water, the Nile Basin Initiative, and World Wide Fund for Nature Tanzania. The objective of this meeting was to set the environmental flow recommendations for each hydrological building block at each eflows study site.

Using the information from the detailed starter documents and technical expertise from the participants, technical discussions were conducted and group consensus was reached to develop draft environmental flow recommendations.



WATER QUALITY REQUIREMENT ASSESSMENT FOR THE E-FLOW AT UPPER LOWER MARA RIVER REACHES

## RESULTS

The results of the project consisted of RQOs recommended flow values for the reserve for both basic human needs and environmental flows. In the final RQOs, the stakeholders prioritized a balance between protection of the ecosystem and using it for their daily needs. This resulted in a desired management class of B. The exception to this was in the Serengeti area, where environmental protection was the priority with a management class of A. Meeting the basic human need component of the reserve required a flow between 0.006 m<sup>3</sup>/s and 0.030 m<sup>3</sup>/s for the sub-basins, and a total flow of 0.114 m<sup>3</sup>/s for the entire Lower Mara River Basin.

The ecological component of the reserve (environmental flow) was determined for both maintenance (normal) years and drought years. Results are shown in Figures 3a - 3f. In general, the main-stem sites of Kogatende and Mara Mines had the highest requirements (between 2.4 and 15 m<sup>3</sup>/s in a maintenance year), followed by the wetland site at Bisarwi (between 3 and 12 m<sup>3</sup>/s in a maintenance year). The smallest requirements occurred in tributaries of Tobora, Somoche, and Tigithe (between 0.1 and 0.8 m<sup>3</sup>/s in a maintenance year). However, the relative percentage of the environmental flow requirements in the tributaries was higher due to their generally low flows. This is especially the case in dry months.

Due to physical and knowledge limitations in the most downstream site in the Mara Wetlands, flow values could not be determined. Instead water depth values were recommended, ranging between 2.7 and 3.3 meters.

## IMPLEMENTATION THROUGH MONITORING AND ADAPTIVE MANAGEMENT

For environmental flows, there are two main monitoring objectives: to ensure the environmental flows are being respected in the river (compliance monitoring) and to ensure that aquatic ecosystems and important ecosystem services are being protected by the current environmental flow values (effectiveness monitoring). Once monitoring data have been collected, it is important that they are incorporated into management decision making through clearly defined adaptive management cycles. To align monitoring activities to institutional capacity (including financial and staff capacity), a three-level system was proposed:

Level 1 monitoring activities should be simple tasks carried out by community groups.

Level 2 monitoring activities should be more complex tasks carried out by the Lake Victoria Basin Water Board or other government agencies, and

Level 3 monitoring activities should be highly detailed tasks carried out by experts in their field. The data collected in the lower levels should help to inform the analysis at the higher levels.





E-FLOW RIVER DISCHARGE REQUIREMENT ASSESSMENT ALONGSIDE CAPACITY BUILDING TO LOCAL WATER EXPERTS ON E-FLOW ASSESSMENT

## NEXT STEPS

An important next step is to incorporate these results into the basin water allocation plan. The water allocation plan outlines how the available water resources will be divided between the environment, domestic and livelihood needs for people, and socioeconomic development. The reserve is implemented through the proper approval of permits so that water is not over allocated, along with regular monitoring of the river levels and enforcement of illegal abstractors. These reserve values for the Lower Mara River Basin should also be harmonized with the reserve values in the Upper Mara River Basin in Kenya through the Memorandum of Understanding on the Joint Water Resources Management of the Transboundary Mara River Basin.

It is important that the water authorities share the required information to conduct proper planning to jointly implement the reserve in the entire basin. While it is estimated that the flow in the Mara River coming across the border from Kenya is sufficient to meet the reserve in Tanzania for the upcoming 5 years, changing climatic conditions and increasing demand may threaten the ability to meet the reserve in the future.

## UNCERTAINTIES

While every effort was made to collect high quality data, there were limitations which caused uncertainties in the analysis. These include:

- Lack of measured hydrological data in many parts of the basin. This resulted in the use of rainfall-runoff estimates which may not accurately represent the hydrology, particularly during low flows in the tributaries.
- The wetland hydrodynamics (the interaction between the Mara River, the wetland, Lake Victoria, and groundwater) are not well known, impacting the ability to make recommendations in the Mara Wetland.
- The impact of sustained (multiyear) low flows on the ecology and social uses of the system. Developing the final RQOs and quantifying the reserve are important steps in sustainable water resource use in the Lower Mara River Basin.

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Lower Mara Environmental Flow Assessment: Resource Quality Objectives and Reserve Assessment Report. Prepared by IHE Delft Institute for Water Education on behalf of the Nile Equatorial Lakes Subsidiary Action Program Coordination Unit (NELSAP-CU/NBI)

NILE EQUATORIAL LAKES SUBSIDIARY ACTION PROGRAM (NELSAP-CU) KIGALI CITY TOWER, 5TH FLOOR,  
P. O. Box 6759, KN 81 STREET KIGALI, RWANDA TEL: (250) 788 307 334 TWITTER: NELSAPCU, FACEBOOK: NELSAPCU/  
EMAIL: NELSAPCU@NILEBASIN.ORG WWW.NELSAP.NILEBASIN.ORG