Executive Summary of Technical Brief: Mapping and Assessment of Deep Pool Refugia Along the Main Rivers in the Lake Chilwa Catchment

Fisheries Integration of Society and Habitats (FISH)

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CONTACT ADDRESS

Pact Malawi,

1st Floor, Amina House,

P.O. Box 1013,

Lilongwe, Malawi,

Phone: +265-1751220; +265-1751201,

e-mail: infomw@pactworld.org

Pact Inc.

1828 L Street NW,

Suite 300,

Washington, DC 20036,

USA

+1-202-466-5666.

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Preface

This document has been written for technical staff at the District and National Government level working on water flow, fisheries and agriculture/irrigation schemes so that they can be informed, store the data, identify follow-up research needs and influence decision makers.

Abbreviations and Acronyms

BVC	Beach Village Committee
CRC	Coastal Resources Center
DoF	Department of Fisheries
FISH	Fisheries Integration of Societies and Habitats
GIS	Geographical Information System
NAREC	Natural Resource and Environment Centre
RVC	River Village Committee
TTC	Teacher Training Centre
UNIMA	University of Malawi
URI	University of Rhode Island
USAID	United State Agency for International Development
WMO	World Meteorological Organization

Executive Summary

The affluent rivers of Lake Chilwa, including Domasi and Likangala, serve a vital ecological function as breeding sites and as refugia for adult fish during the dry season when the lake water quality becomes hostile to fish due to elevated salinities. The deep pools in the two rivers also serve as important refugia when the lake dries up (the lake has undergone moderate and severe recessions 11 times since 1900). During the recessions, artificial restocking is not required as the fish which seek refuge in the deep pools are able to recolonize the lake and re-establish the fishery. However, it has been observed that some of the deep pools in these rivers are silting up due to increasing soil erosion in the catchment and diversion of water for agriculture. Fish production data indicates that three years after the 2012 recession, Lake Chilwa is yet to recover suggesting changes in the resilience of the lake and the fishery. It is unknown how effective these refugia will perform under future climate conditions. The future sustainability of the fishery in Lake Chilwa therefore depends on understanding the vulnerability of this aspect of these deep hole refugia. The objective of this study was to analyze historic rainfall and river flow data to generate ecological and management information for preserving the ecological function of the deep pools to restock the Lake Chilwa fishery during extreme lake drying periods.

The study used a combination of primary and secondary qualitative and quantitative data including taking measurements in a sampling of deep pools. Historical hydroclimatic data were analyzed for trends and compared with people's perceptions regarding climate change and the status of the deep pools. A desktop reserve model was applied to assess the ecological status of the rivers (Appendix B). Water samples were collected in the rain and dry seasons of 2015/16 rain season to provide a baseline. Local communities, River Village Committees (RVCs) and Beach Village Committees (BVCs) were interviewed in April 2016 to gather local ecological knowledge and understand perceptions of existing governance structures.

Key findings

Deep Pools

- Of the 31pools in Likangala River identified from respondents, the study sampled 22.
- Of the 18 pools in Domasi River identified from respondents, the study sampled 16.
- RVC and BVC members could not identify many of the deep pools existing in their respective rivers. Most people only know about the pools in their nearby area, if at all.
- Most of the pools' depth and volume has been reduced by sedimentation though the largest pools were generally found along the Likangala River.
- Irrigation (not fishing) was the top-priority use of the river water.
- Many of the pools had elevated levels of phosphate and some of the deeper pools sampled had low dissolved oxygen values, indicating a stressful environment for aquatic life.

Climate Trends and River Flows

- The analysis shows a slight decline of rainfall between 1958 and 2012.
- This is also evident in the river discharge data where mean annual discharge is decreasing. Both rivers' discharges largely depend on their groundwater storage and baseflow. Of the two rivers, the Domasi River baseflow seems to be more stable. Groundwater contribution seems to be increasing for both cases.
- As large volumes of river water are consumed by uses such as irrigation, the Domasi and Likangala Rivers are closing in relation to their available water. Relatively small volumes remain for ecological functionality. Some decline in river flows can be attributed to river-water consumption. Respondents perceived this decline and attribute it primarily to siltation, climate change, and upstream abstractions that, in turn, affect the functionality of the deep pools.
- Declining contributions of the groundwater reserves over the years, due to catchment degradation pose a serious challenge and need immediate attention.

Ecological

- Fish counts were very low and only 40% of the sampled deep pools had any fish.
- Low fish counts may be due in part to the severe drought of 2014/15 and to a diminished rainy season in 2015/16, which resulted in critically low river flows as sampling occurred. Illegal fishing practices by locals is also a contributing factor.

Linkages

- Many people were unaware that river flows and lake levels are intimately linked with a change in one affecting the other.
- All the survey respondents in Domasi River and 91% in Likangala River indicated that it is rather the lake that depends on the rivers depths. This finding is very important as it demonstrates the level of the people's knowledge in terms of river-lake interactions as a one-way process and not bi-way.
- A determination must be made as to the influence of irrigation schemes on delivery of adequate volumes of water to the lower river system and lake.

Governance

- The respective RVC and BVC responsible for managing the deep pools have low capacity and are largely unknown by the communities.
- Geography makes governance more complicated as the rivers cross several political boundaries. District boundaries affect the efficacy of governance.
- Concerns are rising that current management styles for the rivers and their deep pools, as they face climate change and other pressures, threaten the sustainability of river resources. 95% of respondents fear both rivers will eventually dry up.
- To improve governance and compliance, communities hope that new committees will be formed that can partner with government and NGOs.

Recommendations

There is a need to assess the abundance of fish in pools during non-drought conditions. Also a more detailed environmental flows analysis, including the influence of irrigation, can determine if there is adequate volume and timing of water to meet the needs of the fisheries.

There is sufficient information for communities and government to move forward with improved management actions. Targeted education and awareness campaigns can improve general knowledge of the location and value of deep pools. RVCs and BVCs should be supported to lead the community actions and identify compliance strategies to protect the priority deep pools for each river.

Findings

Locating and Characterizing Deep Pools

- In Likangala River 31 deep pools were identified by respondents (Figure 1).
- In Domasi River 18 deep pools were identified by respondents (Figure 2).
- RVC and BVC members, who are expected to be more knowledgeable due to their leadership roles, could not identify many of the deep pools existing in their respective rivers. Most people only know about the pools in their nearby area, if at all.
- Most of the pools' depth and volume has been reduced by sedimentation though the largest pools were generally found along the Likangala River.
- Deep pools in Likangala River that are considered deep with a lot of fish were Sambaimfa, Namisinde, Mizonje, Kankhandwe, Thunya, Namchimba, Chigumukile and Namaboyi. The Namisinde and Mizonje deep pools were identified as more resilient because they do not dry up in times of drought.

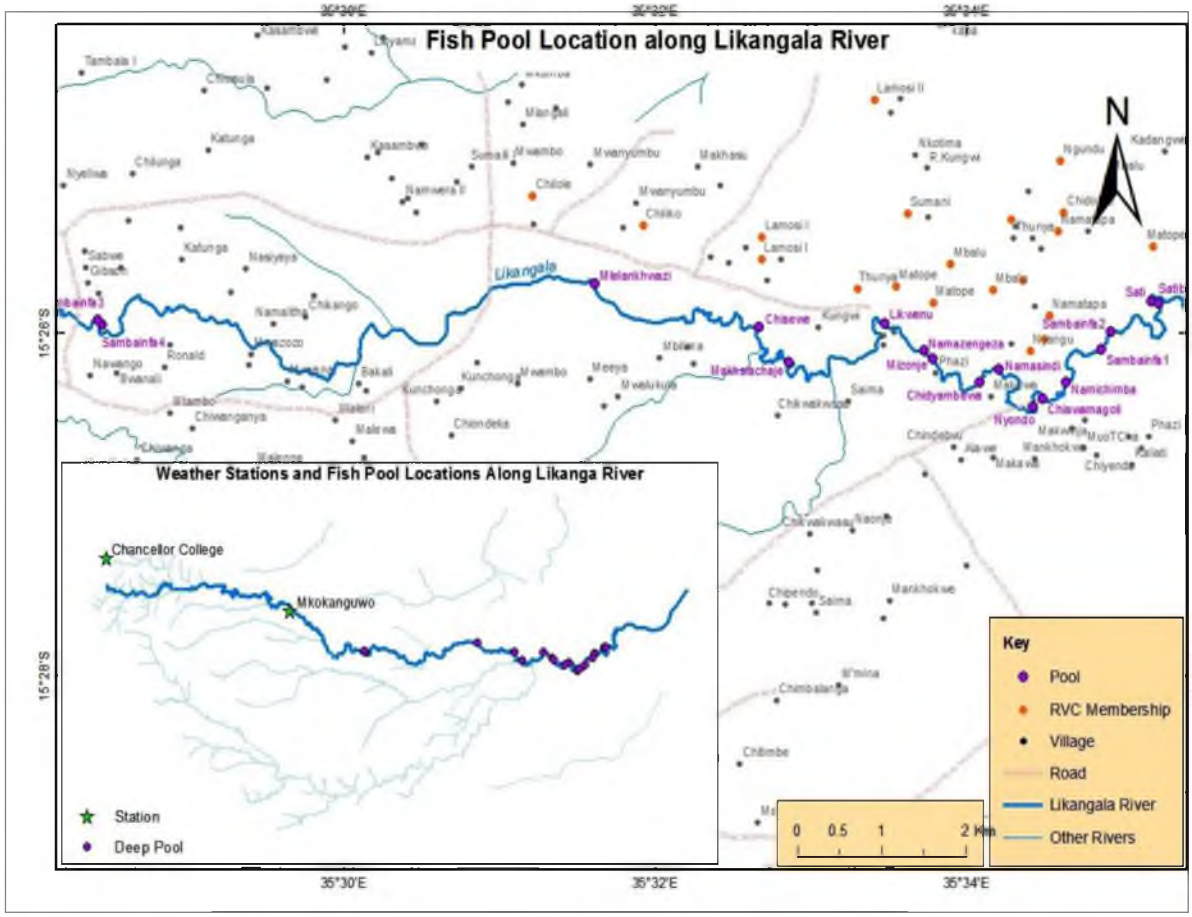

Figure 1. Locations of deep pools along Likangala River.

- Irrigation (not fishing) was the top-priority use of the river water. Deep pools are also utilized for fishing, drinking water, washing, bathing, waste removal, and livestock drinking. These uses can all impact the ability of deep pools to serve as critical refugia habitat for the lake fisheries during times of drought. Droughts have resulted in upland crop failure, forcing communities to survive by over-fishing and over-consumption of water from deep pools for food security, irrigation, and livelihoods.
- Half of respondents in Domasi felt all deep pools deserve protection as they are breeding sites for various species, provide natural habitats, and are integral to the river's survival in times of drought. Protection for Kubowu deep pool was recommended as it is considered the most reliable with high quantities of fish and water for irrigation.

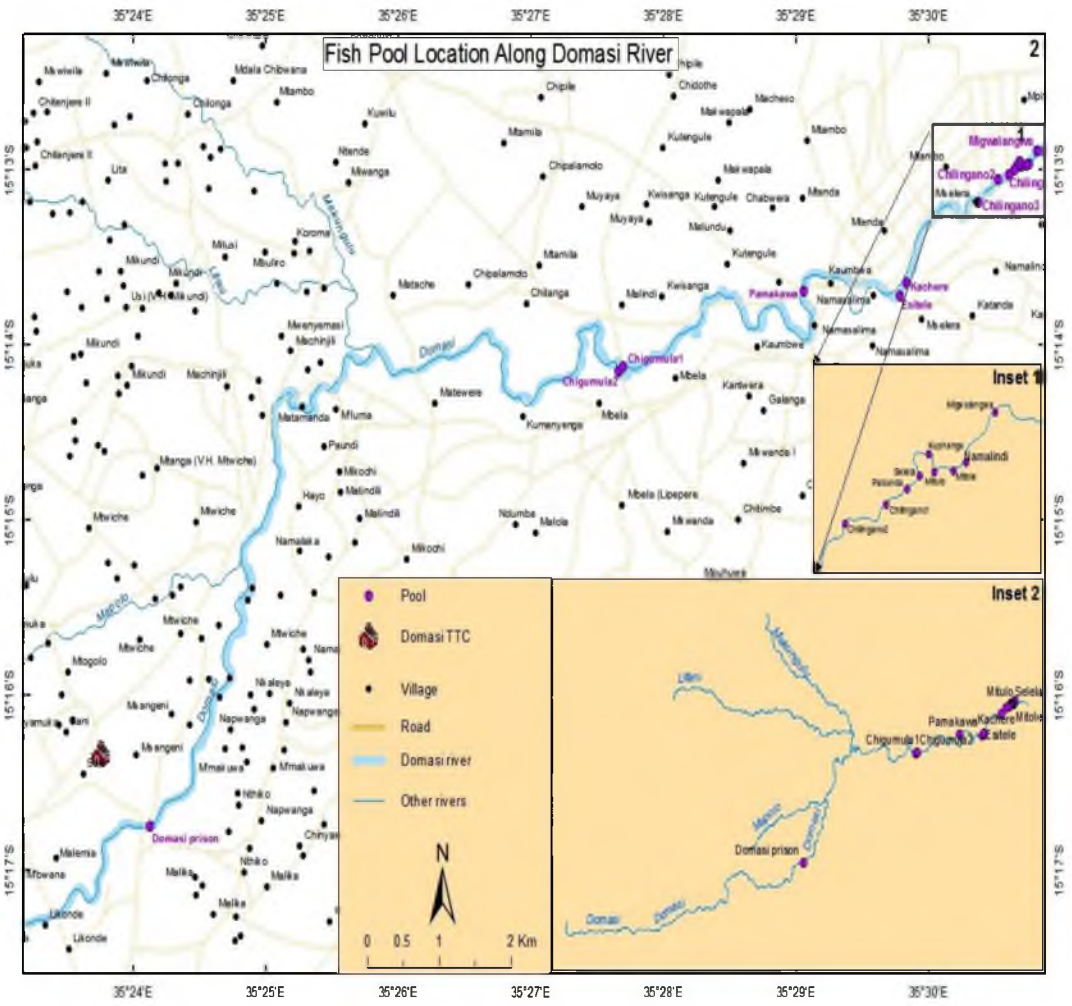

Figure 2. Locations of deep pools along Domasi River.

Understanding Climate Trends

- Empirical data on rainfall, collected from 1958 to 2012, shows a pattern of decline.
- As large volumes of river water are consumed by uses such as irrigation, the Domasi and Likangala Rivers are closing in relation to their available water. Relatively small volumes remain for ecological functionality.
- Some decline in river flows can be attributed to river-water consumption. Most survey respondents from both river basins perceived this decline. They attribute it primarily to siltation, climate change, and upstream abstractions that, in turn, affect the functionality of the deep pools. Empirical data on rainfall and river flow confirm the respondents' perceptions.

River Discharge and Ecological Flow Assessments from the Desktop Reserve Model

- A declining rainfall pattern observed from 1958 to 2012 is also evident in the river discharge data where mean annual discharge is decreasing (Figures 3 and 4).
- The Domasi River flows seem to be more stable in the low flow regime as it registers higher low flows than the Likangala and only a small proportion of the discharges are zero.
- Both rivers' discharges largely depend on their groundwater storage and baseflow. Declining contributions of the groundwater reserves over the years, due to catchment degradation, pose a serious challenge and needs immediate attention.

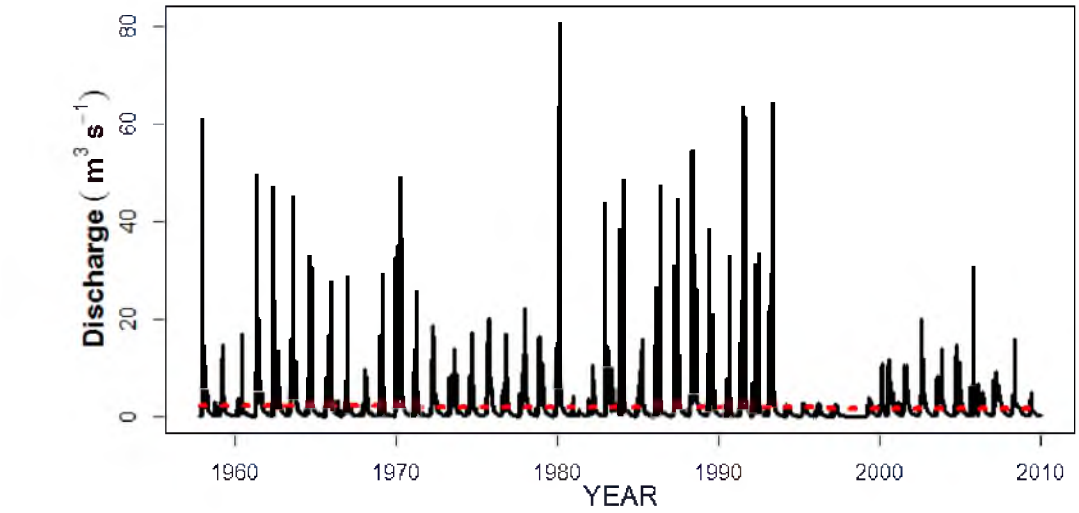

Figure 3. Daily Hydrograph of Domasi River at Domasi TTC from 1957 to 2010. (Red dotted line is linear regression trend line).

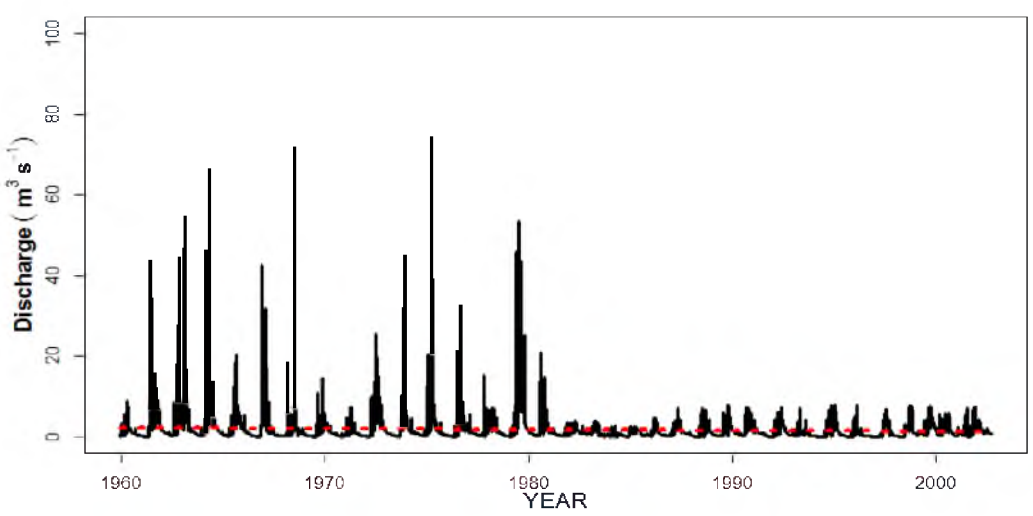

Figure 4. Daily Hydrograph of Likangala River at Mkokanguwo 1958 to 2002. (Red dotted line is linear regression trend line).

Local Ecological Knowledge of Hydrology

- In Domasi River basin, 55% (n=17) of survey respondents indicated that upstream rainfall causes runoff and sedimentation, which contributes to the siltation in the deep pools. Forty percent (n=12) observed that water forces remove sediments and dredge the river, increasing its depth.
- In Likangala, 94.1% (n=28) felt upland rainfall has a significant impact on the depth of the river and deep pools.
- Significantly, people do not believe that lake levels affect river flows in any way.
- Most respondents reported a decline in river flows over the years, which has had a negative impact on their livelihoods.
- There are conflicting views as to the contribution of heavy rainfall and upland flooding to sedimentation in the two rivers.

Water Quality

- In the Domasi, high levels of phosphates and nitrates were recorded from the Misangu deep pool, and high levels of phosphates were recorded in the Mitolo and Padala deep pools.
- The source of the nitrates could be runoff from cultivated land. Researchers noted riverbank cultivation present in the vicinity of the Misangu deep pool.
- Some of the deeper pools sampled had low dissolved oxygen values, indicating a stressful environment for aquatic life.
- Numerous fish species inhabit the rivers and deep pools. Most people believe juveniles are found in the deep pools.

Ecological Conditions and Fish Counts

- There is a considerable level of degradation that is typical of closing basins. Extractive irrigation commitments left little water for the environment and down-stream use.
- Fish counts were often very low and only 40% of the sampled deep pools had any fish at all.

- Low fish counts may be due in part to the severe drought of 2014/15 and to a diminished rainy season in 2015/16, which resulted in critically low river flows as sampling occurred. Sampling was conducted at the peak of the dry season following that severe drought. Illegal fishing practices by community members is also a contributing factor.

Linkages

- Many people were unaware that water flow is both downstream and upstream—from the lake to the deep pools in the river.
- Geography makes governance more complicated as the rivers cross several political boundaries.
- A determination must be made as to the influence of irrigation schemes on delivery of adequate volumes of water to the lower river system and lake.

Strengthening Governance

- A Village Committee for both the Domasi and Likangala Rivers is responsible for managing the deep pools. These committees have low capacity and are largely unknown by the communities.
- District boundaries affect the efficacy of governance.
- Concerns are rising that current management styles for the rivers and their deep pools, as they face climate change and other pressures, threaten the sustainability of river resources. 95% of respondents fear both rivers will eventually dry up.
- To improve governance and compliance, communities hope that new committees will be formed that can partner with government and NGOs.

Recommendations

Based on input form the community and field data analysis this report recommends the following next steps to learn more and to begin taking action with the community:

Research

- Assess the abundance of fish in pools during non-drought conditions to validate the presence of fish in moderate conditions.
- Conduct a more detailed environmental flows analysis to learn if there is adequate volume and timing of water to meet the needs of the fisheries.
- Determine the influence of irrigation schemes on delivery of adequate water volumes to the lower river system and lake. Can irrigation be reduced during drought so enough water reaches the lower river system when the lake can't back-feed deep pools?

Community Action

- Conduct widespread education and awareness campaigns centered on the value and role of the deep pools, which promotes local development of innovative compliance strategies. While survey respondents favored enforcement of strict rules and regulations, there is limited enforcement capacity. A compliance approach may be more effective.
- Apply conflict-resolution approaches that can slowly rebuild support and compliance.
- Enhance environmental monitoring (e.g. more river flow and weather stations) to make intervention more effective.
- Empower RVCs and BVCs through training and equipment (e.g. compliance strategy development and outreach, boats, uniform, identification tools)
- Host stakeholder forums to discuss the health, ecosystem services, resilience of the river and adaptation of uses in the face of change. Reflect on governance structures and improvements going forward.
- Rehabilitate the catchments and riparian areas
- Develop partnerships with district governments and locally active NGOs so that multiple actors can reinforce the rules and cultural respect for the rivers.