IGAD CLIMATE PREDICTION AND APPLICATION CENTER (ICPAC)

WAter and COoperation within the NIle River Basin (WACONI)

Hydrology and water balance for Lake Victoria sub basin

Inception Report

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Table of Contents

Contents Page

LIST OF ABBREVIATIONS

ACE-WATER-2	African Networks of Centres of Excellence on Water Sciences PHASE II
AMCOW	African Council of Ministers on Water Affairs
AU-NEPAD	African Union - NEw Partnership for Africa's Development
BNB	Blue Nile Basin
CEANWATCE	Central-Eastern Africa Network of WATer Centers of Excellence
CHG	Climate Hazard Group
CHIRPS	Climate Hazards Group Infrared Precipitation with Station
CoEs	Centres of Excellence
NB DSS	Nile Basin Decision Support System
ICPAC	IGAD Climate Prediction and Applications Centre
IGAD	Inter-Governmental Authority on Development
JRC	Joint Research Centre
LVB	Lake Victoria Basin
MoU	Memorandum of understanding
WACONI	WAter and COoperation within the NIle River Basin
WEFE	Water-Energy-Food-Ecosystem

1. Background

The WACONI is a research collaboration project between Addis Ababa University, ICPAC, Makerere University and University of Khartoum and supported by the European Union Joint Research Center (JRC).

The **general objective** of WACONI is to assess WEFE interdependencies across the Nile River Basin, with a particular focus on the Blue Nile Basin and the Lake Victoria Basin.

Based on IGAD strategies and priorities and supported by AMCOW (declaration GA/10/2016/Dar/14) in the frame of the ACEWATER2 project, the following areas of scientific investigation relevant to WEFE nexus analysis have been identified:

1. Climate variability and extreme events
2. Hydrology, water balance and hydropower
3. Water and livelihood: agricultural water, health, quality, access, resilience

This Inception report addresses work under hydrology, water balance and Hydropower topic. The **specific objectives** to be addressed by the IGAD Climate Prediction and Applications Centre (ICPAC) on hydrology, water balance and Hydropower is;

To perform hydrological and water balance assessments, including water uses within a scenario based analysis under different climate pressures and management practices focusing on the LVB of the Nile Basin.

Given the various types of, potentially competing, uses in the LVB, sustainable management of the water resources poses a challenging task. Provision of information on the main components of the water balance is important in determining the impacts of water resources exploitation for various socio-economic uses.

2. Conceptual framework and Table of contents of the final report

In this study, water balance components will be calculated from calibrated and validated hydrological model for the Lake Victoria basins. The impact of current and future water resources availability due to climate variability and change, uses and infrastructure will be evaluated through water resources and scenario modelling.

Rainfall Runoff Modelling

A rainfall-runoff model for the LVB will be setup using the GeoSFM software. The GeoSFM is model which is lumped but has a function to process catchment parameters from gridded data of soil, land cover and slope (from DEM).

The model will be simulated on 30 year (1981-2010) period monthly datasets and calibrated and validated at river gauging and water level points where data exists. Mass balance error and Nash-Sutcliffe Coefficient will used to guide the calibration process.

Water resources and Scenario modelling

A water resources model will be set-up for the Lake Victoria sub basin, with the outputs from the rainfall-runoff model being the stream/natural flow and will include current water use/infrastructure development and Lake Victoria and associated operation rules. The other input data for the water resources model will be rainfall and evaporation/evapotranspiration over water bodies such lakes and dams.

Scenarios will be built around a combination of future socio-economic development paths such as projected future water use/infrastructure development with inputs from Makerere University colleagues who are undertaking the water and livelihood research in the sub basin. Climate variability will be implicitly taken into consideration through the modelled runoff from the previous activity.

The scenarios will be run and compared using indicators at key pre-selected points in the system. Indicator can be minimum, maximum or average flows, Lake water level, hydropower produced, and irrigation system water demand satisfaction rate. The current situation in terms of infrastructure and water use will be considered baseline against which other scenarios will be compared.

Table of Contents of Final Report

The table of content of the final report will have the following main chapter and tentative broad content under each in parenthesis.

Executive Summary
1. **Introduction** (background, study objectives and study area)
2. **Methodology** (overall concept, data processing, rainfall-runoff and water resources modelling)
3. **Hydro meteorological data availability and analysis** (Data availability, quality check and processing)
4. **Rainfall-runoff modelling** (model set-up, input data selection and processing, calibration/validation)
5. **Water Resources Modelling** (setting up of baseline model and scenarios, selection of indicators, comparison of scenarios)
6. **Results and discussions**

References

3. Data availability and Database Architecture

Data availability

Data and tools that are necessary for this study are indicated hereunder. Details of data/tool sources is also given.

Rainfall Runoff Modelling:

Software: Mike Hydro (NAM), GeoSFM.

Data: Gridded Daily CHIRPS precipitation and temperature from the CHG (Funk et al., 2014) which will be processed into timeseries data. The rainfall timeseries data will be used to create catchment areal averaged rainfall while the temperature data will be used to calculate reference Evapotranspiration using Blaney-Criddle method (Allen & Pruitt, 1986)

Soil and land cover data, Satellite based lake level altimetry data has been obtained from internet sources

River discharge data for four river gauging station in Kenya is available in ICPAC but this is not sufficient. Potential sources to be followed soon include collaborators in this study particularly the Makerere University and Global River discharge Data Centre (GRDC) (https://www.bafg.de/GRDC/EN/01_GRDC/).

Water Resources Modelling:

Software: Mike Hydro (Basin)

Nile Decision Support System: This will be requested from the Nile Basin Initiative, currently an MoU between the Nile Basin Initiative and the IGAD is awaiting signature. One purpose of the MoU is to share data and tools and this will be used in requesting the Nile Basin DSS. The IGAD secretariat will be contacted to request NB DSS.

Data: Output data from the Rainfall-runoff modelling will be used as input data for the water resources modelling, this will mainly be runoff/river discharge data at the exit of each modelled catchments.

Data for Agriculture, hydropower, population, and infrastructure will be requested/obtained from collaborators, agencies and other sources such as internet.

The data source agencies include

- National bureaus of statistics: Data on population, agricultural production
- KENGEN: Hydropower generation statistics for Sondu Miriu Hydropower project

Internet Data sources

- Theia Land datasets: Water level data (http://hydroweb.theia-land.fr/)

Database Architecture

Data for this study will be in many formats such as text files and GIS format. A folder with sub folders for each specific theme will be prepared to store the data. The following sub folders are envisaged at this stage.

- Water use/demand
- River Discharge/Streamflow
- Evaporation/Evapotranspiration
- GIS
- Models
- Rainfall
- Reservoirs
- Water Level

Some of the models and Decision Support Software (DSS) come with dedicated database system and data needs to be prepared and stored in a specified format before use, for example the Nile Basin DSS uses Postgres database.

Raw data that will have no restriction on its sharing and all model and model output will be shared to the CENWATCE members. GDRC data policy (GDRC data policy, 2018) implies no redistribution of the data by the user, as such this data cannot be distributed together with the other datasets but CEANWATCE members will be guided on how to get the data.

4. Issues, challenges and possible solutions

Non Availability of river discharge data from riparian countries: There is a risk of not getting river discharge data for the Tanzania riparian catchments of the Lake Victoria Basin, if this data is also not available in the GRDC database then parameter transfer will be used from catchments with similar geomorphological parameters. This means that this catchments will be considered as 'ungauged'.

Non Availability of the Nile Basin DSS: Scenario simulations will be done and indicator comparisons undertaken in another platform e.g. using spreadsheet. The Mike Hydro basin software is available. Different scenarios will be set up, simulation done and the results exported to a spreadsheet where further analysis can be done.

5. Work plan

Activity	Completion Date	Deliverable
Inception Report	September 15, 2018	Inception Report
Data collection and pre processing	October 31, 2018	None
Rainfall-Runoff modelling	January 31, 2019	None
Water Resources modelling	April 30, 2019	None
Consolidated Report Writing	June 30, 2019	Assessment Report on hydrological and water balance modelling framework over the LVB, under current and future scenario

Reference

Allen, Richard & O. Pruitt, William. (1986). Rational Use of the FAO Blaney-Criddle Formula. Journal of Irrigation and Drainage Engineering-asce - J IRRIG DRAIN ENG-ASCE. 112

Funk, C. C., Peterson, P. J., Landsfeld, M. F., Pedreros, D. H., Verdin, J. P., Rowland, J. D., & Verdin, A. P. (2014). A quasi-global precipitation time series for drought

GRDC Data Policy (2018) https://www.bafg.de/GRDC/EN/01_GRDC/12_plcy/data_policy_node.html;jsessionid=A4DBCEBC84301C801C9E85A82BDA975B.live11291