



NILE BASIN INITIATIVE
INITIATIVE DU BASSIN DU NIL



Paper at the **NBDF7**

Webinar

Surafel Mamo – PhD, ENTRO

Water, Energy and Food Nexus Approach

for

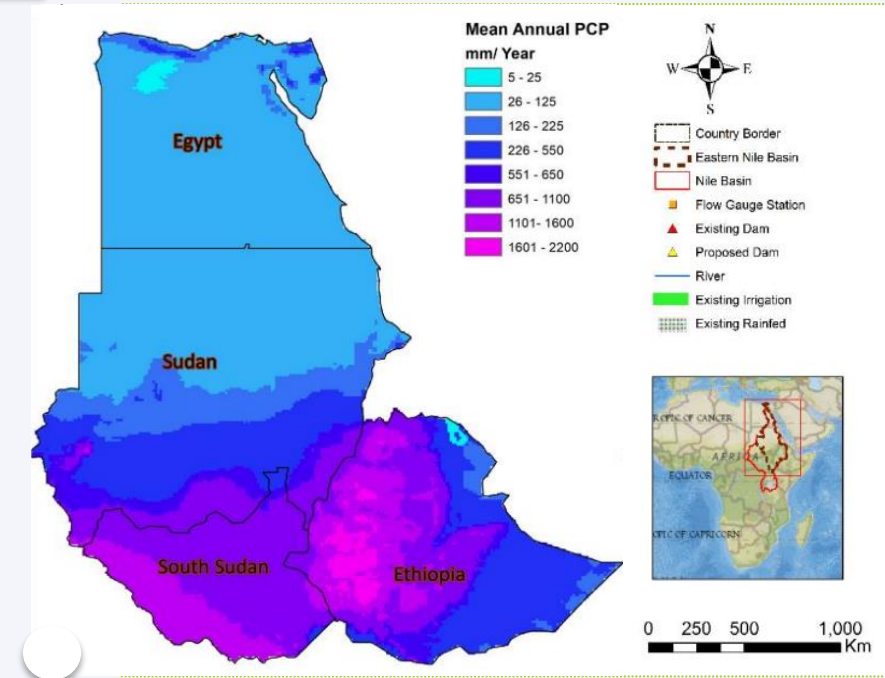
Transboundary Water Resources Developments in the Eastern Nile

- Introduction
- Data and Methods
- Results Framework
- Challenges and Lessons Learned
- Way Forward



Introduction

- The **Water–Energy–Food (WEF) Nexus** approach is central to natural resource management and climate change policies to cope with the WEF Nexus concept that requires the multi-sectoral use of water which puts emphasis on system analysis and dynamic feedbacks across water-intensive sectors.
- **Study area: Eastern Nile Basin**
 - Location: 27^o/40^o E longitude and 4^o/32^o N latitudes.
 - Elevation: ranges 0 m from Mediterranean Sea delta to 4000 m asl of Ethiopia highlands.
 - Temperature: 17^oC Ethiopia highlands to 45^oC central and northern Sudan.
 - Precipitation: ranges from 0 mm to 1800mm
- **Objective:** WEF Nexus approach for the Analysis of Transboundary Water Resources Management and Developments in the Eastern Nile Basin.



| Sub-basins | Catchment Area(km2) | Share in EN basin (%) | Annual Precipitation(mm) | Average Flow(BCM)* |
|-------------------------------|---------------------|-----------------------|--------------------------|--------------------|
| Abay-Blue Nile | 311,548 | 18.7 | 500 – 1800 | 54 |
| Baro-Akobo-Sobat & White Nile | 468,216 | 28.1 | 500 – 1750 <300 – 500 | 28 |
| Tekeze-Setit-Atbara | 227,128 | 13.7 | 200 – 1500 | 12 |
| Main Nile | 656,398 | 39.5 | 0 – 200 | 84 |

| Variables | Ethiopia | Sudan | South Sudan | Egypt |
|--|----------|-----------|-------------|---------|
| Total country area (Km ²) | 1104300 | 1879360 | 644330 | 1001450 |
| Area part of the Nile basin (Km ²) ^a | 365,318 | 1,396,230 | 620,626 | 302,452 |
| Area within the Nile basin as % of country area ^a | 33.1 | 74.3 | 96.3 | 30.2 |
| Area within Nile basin as % of basin area ^a | 11.5 | 43.9 | 19.5 | 9.5 |
| Arable land (Km ²) | 151190 | 172200 | - | 27380 |
| Cultivated area (Km ²) | 162590 | 173650 | - | 37610 |
| Cultivated total country area (%) | 14.72 | 9.24 | - | 3.756 |
| Long-term average annual precipitation (BCM /year) | 936.4 | 469.8 | 579.9 | 51.07 |
| Total renewable surface water (BCM /year) | 120 | 35.8 | 49.5 | 56 |
| Total renewable groundwater (BCM /year) | 20 | 3 | 4 | 2.3 |
| Total renewable water resources (BCM /year) | 122 | 37.8 | 49.5 | 58.3 |
| Water dependency ratio (%) | 0 | 96.13 | 65.79 | 96.91 |

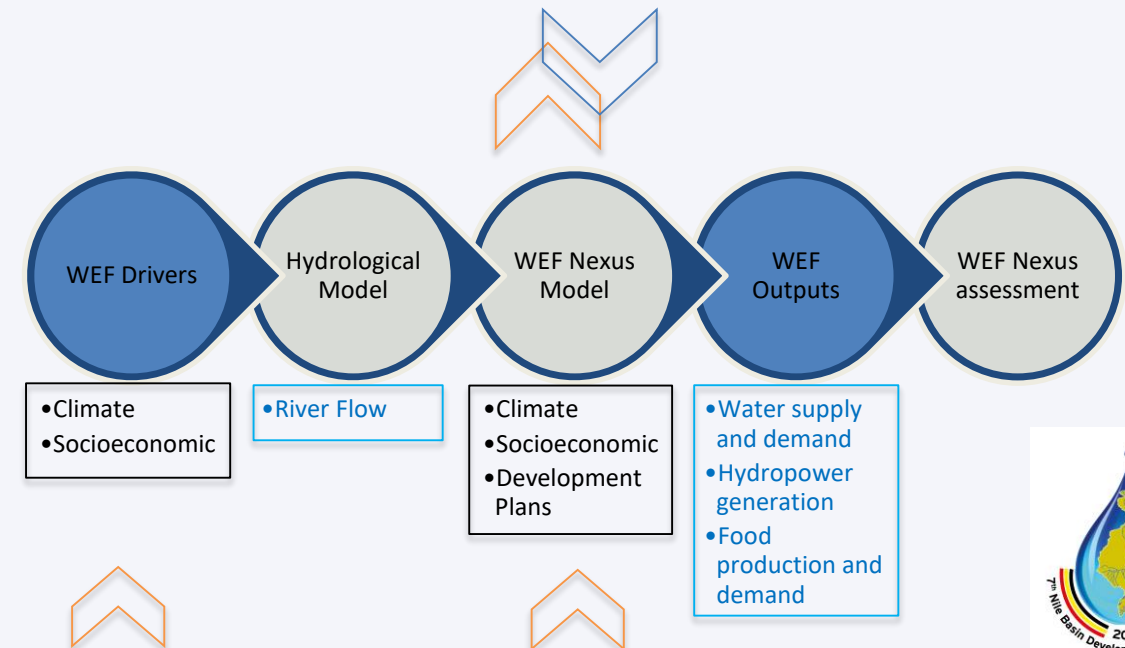
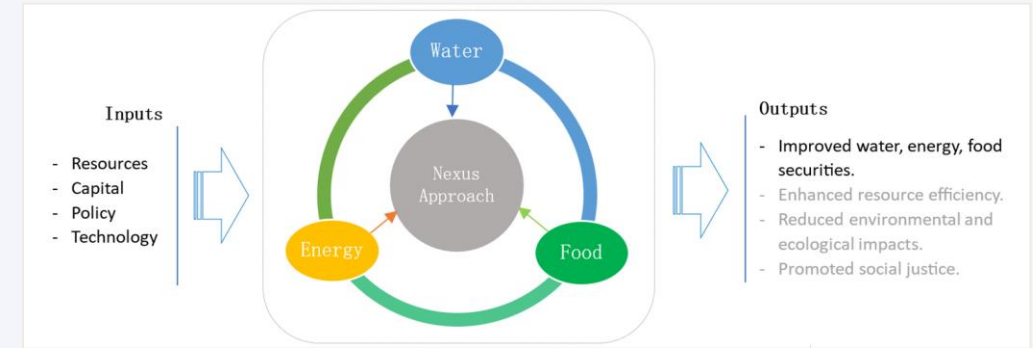
Data and Methods

Data

- Strategic Plans: Previous (2006–2010, 2012–2018, 2018–2022) and future (2022–2027), and Indicators.
- Literatures review on WEF Nexus approaches in the Eastern Nile basin (climate, topography, land use and soil, reservoirs operation rules), etc.

Methods:

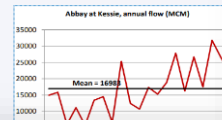
- Review the WEF Nexus analysis in line with the previous and future strategic plans.
- Hydrological model to estimate flows (SWAT model).
- WEF Nexus assessment in the Eastern Nile basin water supply and demand, food production, and to estimate hydropower generation.



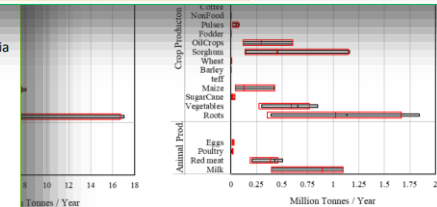
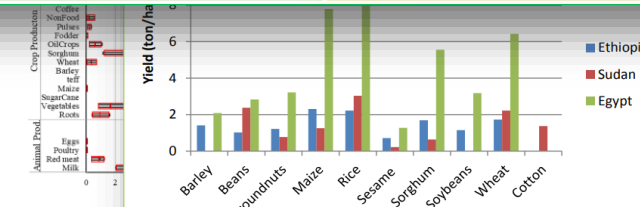
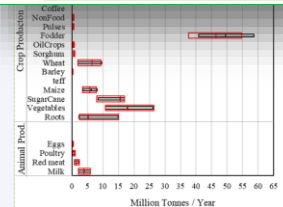
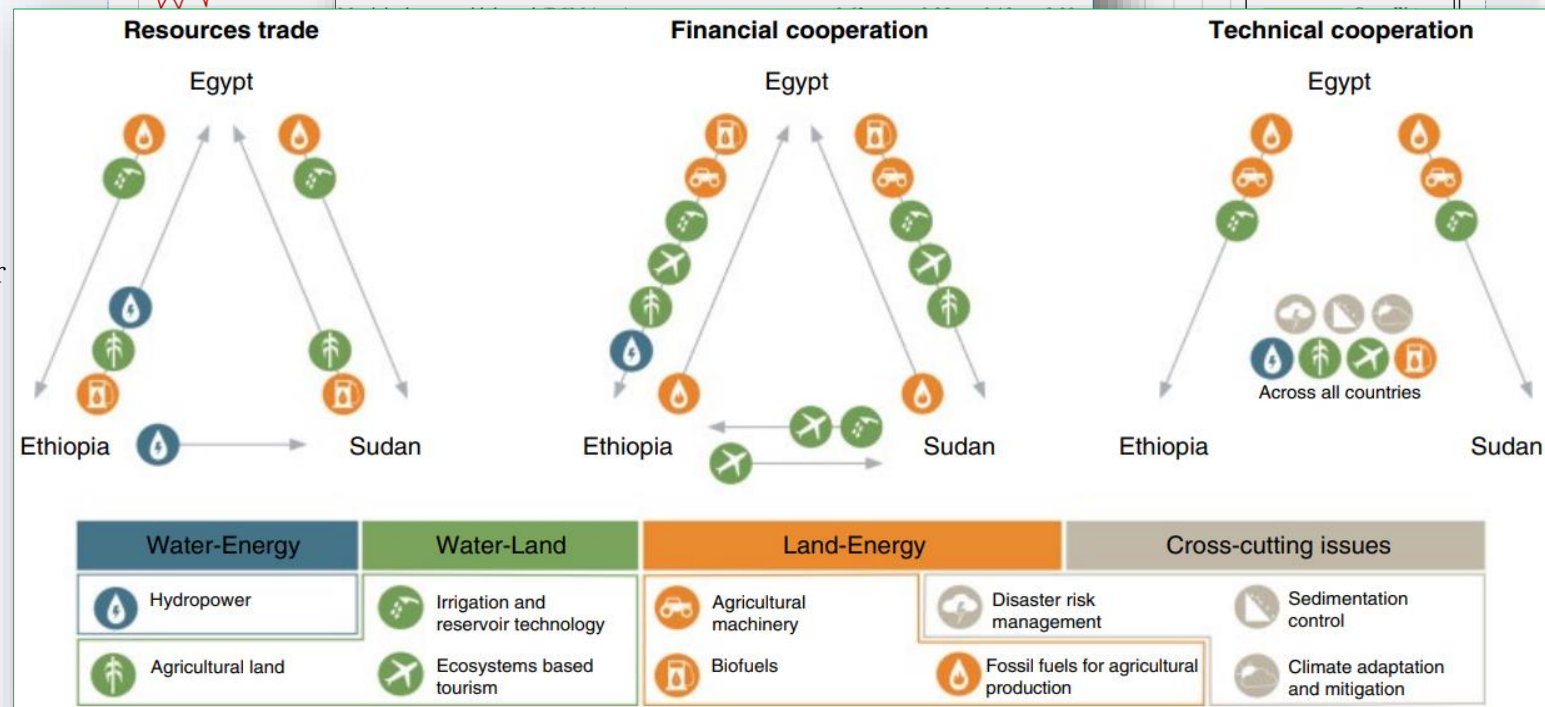
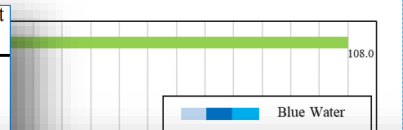
Results Framework

Cooperation Framework (with/without) Scenarios Analysis, WEF Nexus:

- Water:** Flows in Eastern Nile
 - Annual flows (MCM): Gambela, Embamadre, Kesie, Khartoum, Atbara, Dongola stations.
 - Blue and Green water uses.
 - Energy:** Hydropower generation
 - Cooperation adds an average of 547 GWh/year at the basin level - GERD operation modes.
 - In Sudan, average hydropower increases by 6% without, 12% with cooperation.
 - Food:** Irrigation yields by countries
 - Low flows periods improve food security with/without cooperation - GERD improved.
- Water supply, hydropower generation and food production are likely improved during dry seasons with cooperation.
- Cooperation showed important scenarios for mutual benefits.



| Water uses | Ethiopia | Sudan | South Sudan | Egypt |
|---|----------|-------|-------------|-------|
| Agricultural water withdrawal (BCM /year) | 9.69 | 25.91 | 0.24 | 67 |
| Industrial water withdrawal (BCM /year) | 0.11 | 0.08 | 0.23 | 2.00 |



Results Framework ...

Water
Energy
Food
Nexus

Results

- Increased agricultural productivity in the project area.

Impact

- Yield per hectare for selected crops.

Indicators

Outcomes

- Irrigation Performance Assessment Study recommendation implemented by EN countries.
 - Number of irrigation schemes modernized.
- Investment ready WSM project studies implemented by EN countries.
 - Number of WSM investment ready projects implemented.

Outputs

- Guideline for Irrigation performance Assessment Study prepared.
- Availability of Guidelines.

Challenges and Way Forward

• Result Mitigation Strategies (RMS):

- RMS I – Limited CCs ENTRO (H likelihood, H impact).
- RMS II – Mission drift strategic mgt (M likelihood, M impact).
- RMS III – Political instability and insecurity (L likelihood, M impact).
- RMS IV – Failure to implement investment (M likelihood, H impact).
- RMS V – Declining of funding (M likelihood, M impact).

• Land use changes, poverty, population growth, rising demand for natural resources, and climate change and variability.

- Adapt to expected challenges and constraints and deliver results in the SP (2022–2027) implementation processes.
- Improve the WEF Nexus in the transboundary water resources management and developments issues.
- Consider future cooperation in cross-cutting issues like **climate variability**, climate-related risks, and **sedimentation** issues.
- Develop a transboundary **data and information**, access and sharing principles to improve the early warning system in the EN basin and then water, energy and food security.

- Allam MM and Eltahir EAB (2019) Water-Energy-Food Nexus Sustainability in the Upper Blue Nile (UBN) Basin. *Front. Environ. Sci.* 7:5. doi: 10.3389/fenvs.2019.00005
- Wheeler, K. G., Jeuland, M., Hall, J. W., Zagona, E., & Whittington, D. (2020). Understanding and managing new risks on the Nile with the Grand Ethiopian Renaissance Dam. *Nature communications*, 11(1), 1-9.
- ENTRO. (2014b). Eastern Nile Multipurpose Option Scoping Model (ENMOS), Addis Ababa, Ethiopia.
- Basheer, M., & Elagib, N. A. (2019). Temporal analysis of water-energy nexus 1156 indicators for hydropower generation and water pumping in the Lower Blue Nile Basin. *Journal of Hydrology*, 578, 124085.
- Al-Saidi, Mohammad & Elagib, Nadir & Ribbe, Lars & Schellenberg, Tatjana & Roach, Emma & Oezhan, Deniz. (2017). Water-Energy-Food Security Nexus in the Eastern Nile Basin: Assessing the Potential of Transboundary Regional Cooperation. 10.1002/9781119243175.ch10.
- NBI (Nile Basin Initiative) (2012), State of the River Nile Basin Report, NBI.
- <https://hdl.handle.net/20.500.11811/7982> (<https://nbn-resolving.org/urn:nbn:de:hbz:5n-53496>).
- <https://doi.org/10.1016/j.enpol.2013.03.027>



NILE BASIN INITIATIVE
INITIATIVE DU BASSIN DU NIL

THANK YOU!

