Using Satellite Rainfall Data to Estimate Direct Flow

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Overview

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Introduction

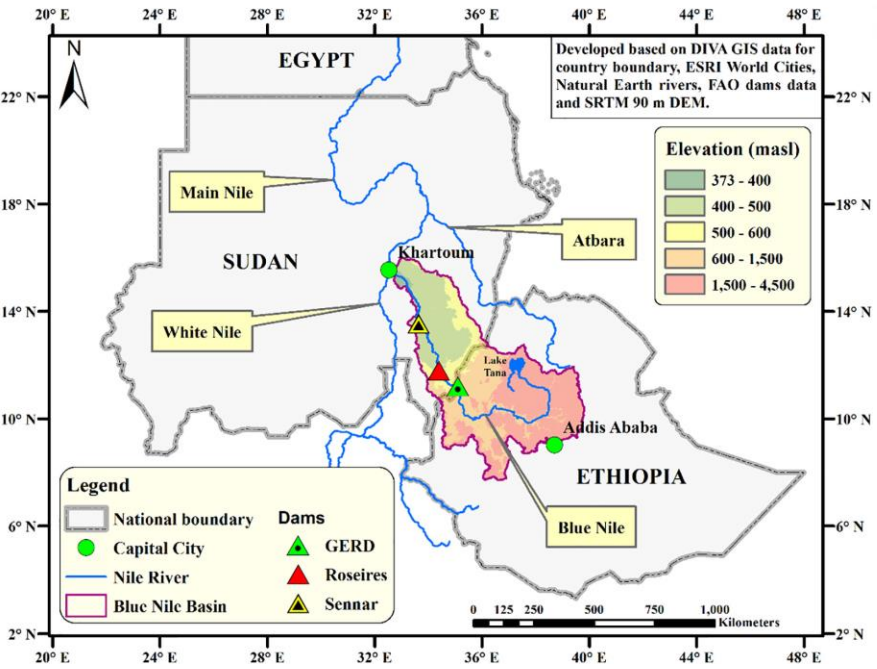
- As water is a resource which ignores political boundaries, fluctuates both in space and time, has different and conflicting demands on its use.
- The lack of a basin-wide agreement on water development projects poses a problem for both U/S countries (those concern of their development) and D/S countries (concern of their water security).
- A common challenge in modelling watershed hydrology is obtaining accurate weather input data.

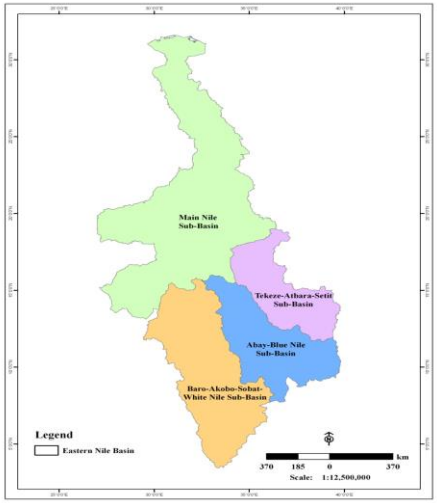
- The overall objective of this study is to contribute to the sustainable management of the BNRB through the establishment of a reliable data base hydrological and climatic information system.

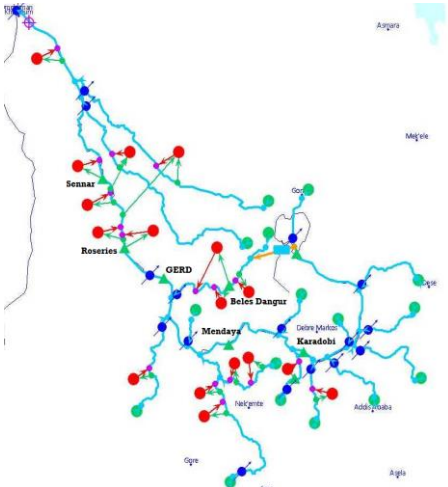
Research Objectives

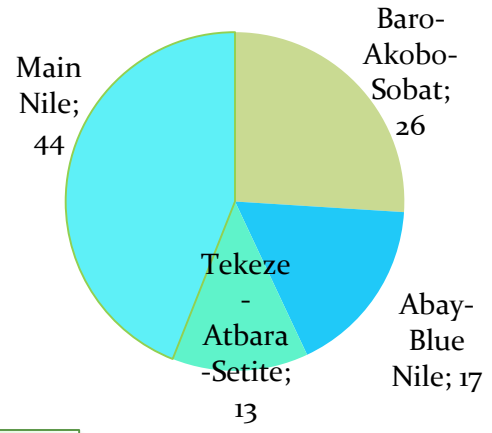
- Improve hydrologic prediction through development and refinement of hydrologic models and use of advanced observations, particularly from open sources.
- As to determine whether CFSR-derived rainfall data can be reliably used as input data instead of traditional rainfall station data in simulating discharge from a watershed.

Study Area



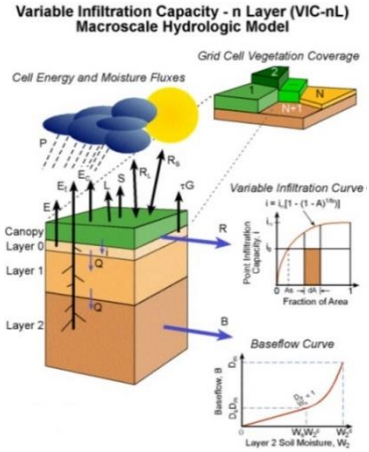




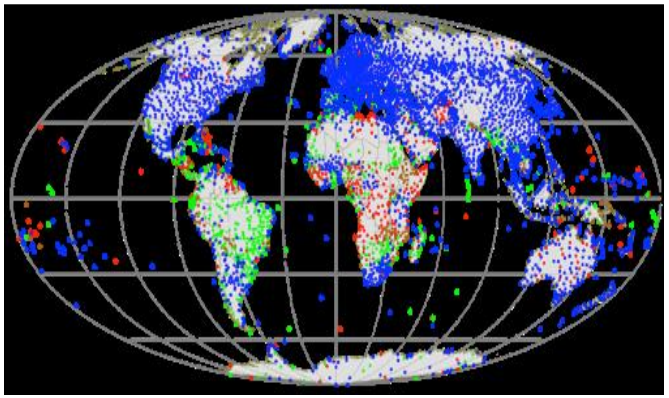


Blue Nile River Basin

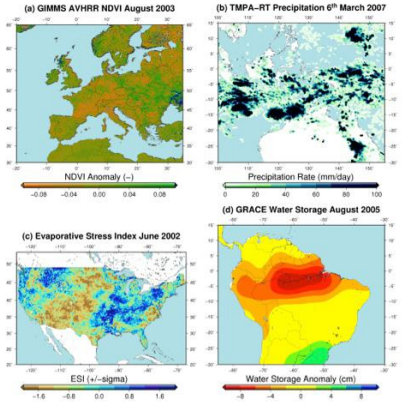
Data and Tools



Hydrological Modelling

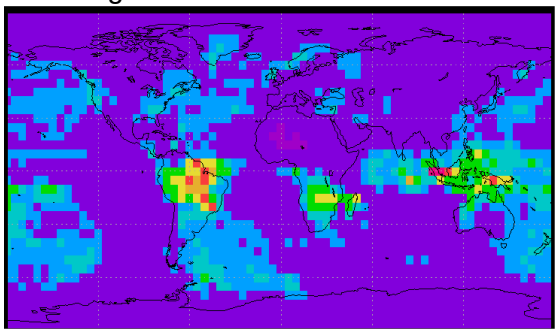


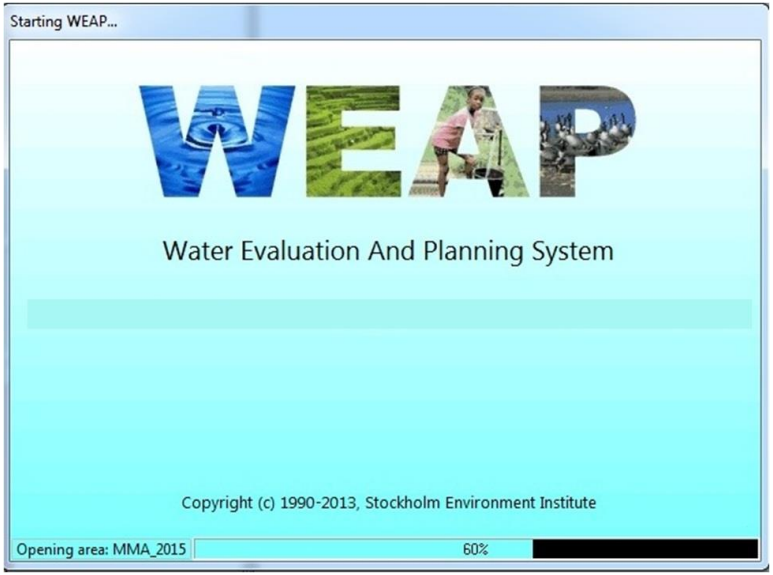
Ground Observations

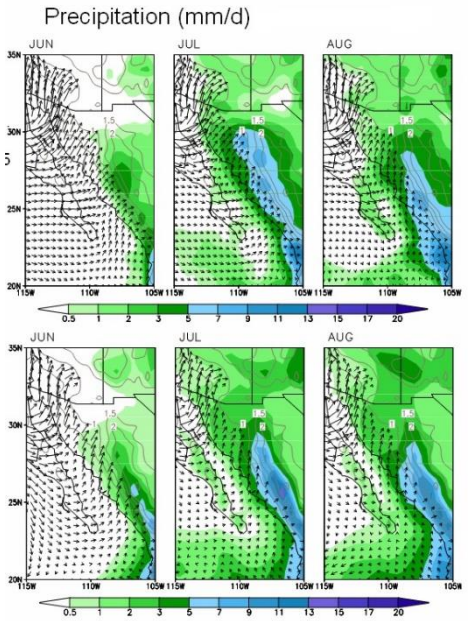


Satellite Remote Sensing

Regional/Global Climate Models





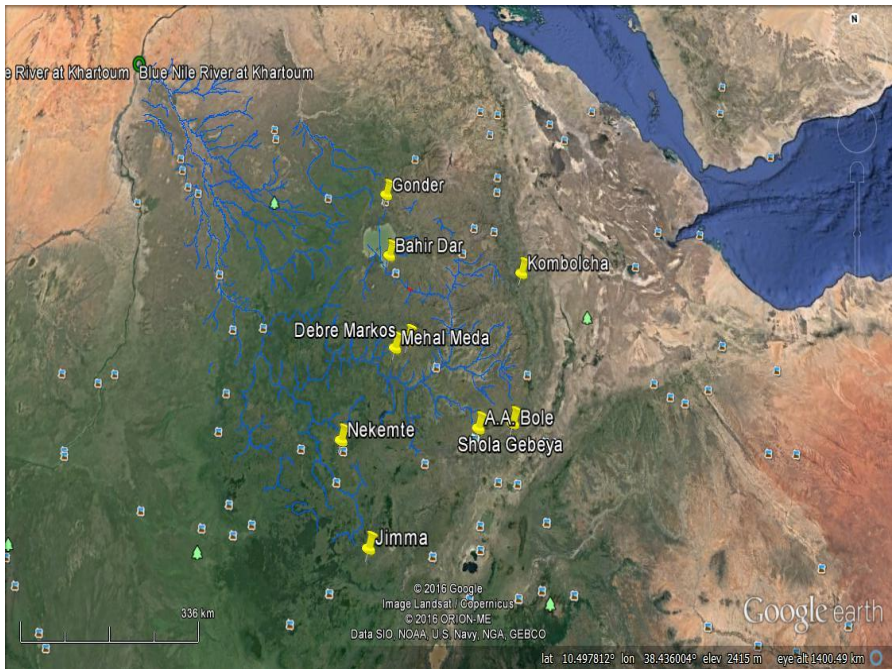


Reanalysis, Analysis

Methodology

- This study presents a method for using the Climate Forecast System Reanalysis (CFSR) global meteorological dataset to obtain historical weather data and demonstrates the application to modelling 16 watersheds. CFSR data are available globally for each hour since 1979 at a 38-km resolution.
- Satellite rainfall data has been used to improve the quality of ground stations data (conventional data).

- The satellite rainfall data for all Blue Nile sub-basins were downloaded from satellite data from the CFSR in a monthly basis for the period 1980-2010, which was calibrated with the ground rainfall stations (1993-1999).



	Sub-basin	Longitude	Latitude	Elevation
١	Anger	٣٦,٥٦٢٥	٩,٥٢٢٩٨	١٥١٠
٢	Beles	٣٥,٩٣٧٥	١١,٠٨٤١	٨٠٦
٣	Bosheilo	٣٨,١٢٥	١١,٣٩٦٤	٢٣٩٩
٤	Dabus	٣٥	٩,٥٢٢٩٨	١٤٧٢
٥	Didessa	٣٦,٢٥	٨,٨٩٨٥٢	١٧٩٢
٦	Finchaa	٣٧,٥	٩,٨٣٥٢١	١٥٤١
٧	Guder	٣٧,٥	٩,٢١٠٧٥	٢٠٦٧
٨	Jemma	٣٨,٧٥	٩,٨٣٥٢١	١٨٩٤
٩	Muger	٣٨,٤٣٧٥	٩,٥٢٢٩٨	٢٠٦٧
١٠	N. Gojam	٣٨,١٢٥	١٠,٤٥٩٧	٢٥٣٢
١١	S. Gojam	٣٧,١٨٧٥	١٠,٤٥٩٧	١٦٦٨
١٢	Tana	٣٧,٥	١٢,٠٢٠٨	١٧٨٤
١٣	Weleka	٣٨,٧٥	١٠,٤٥٩٧	١٦٢٥
١٤	Wonbera	٣٥,٦٢٥	١٠,٤٥٩٧	١٥٥٩
١٥	Dinder	٣٥,٣١٢٥	١٢,٠٢٠٨	٥٢٣
١٦	Rahad	٣٤,٦٨٧٥	١٣,٢٦٩٧	٤٣١

Analysis

- The research used WEAP model ability to simulate runoff in the basin, the record was split into two parts. The data for the first 16 years (1980 - 1995) were used for calibration purposes and the second 15 years (1996 - 2010) for validation.

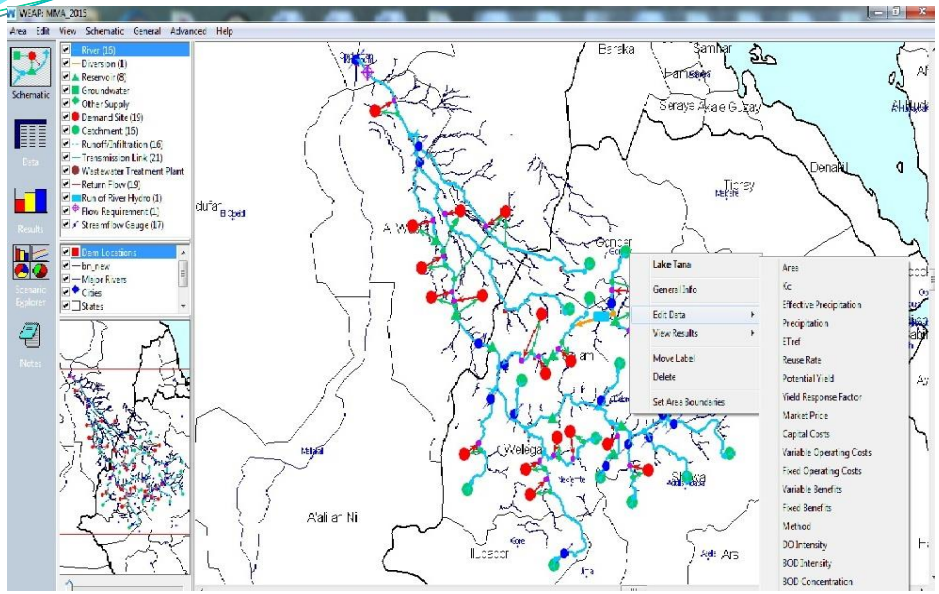
Station	River	Nash-Stucliffe Efficiency (NSE) %	Coefficient of Determination (r2) %	Index of agreement (d) %
Eldeim	Blue Nile	89	95	97
Giwasi	Dinder	96	98	99
Hawata	Rahad	88	95	97
Khartoum	Blue Nile	67	88	92

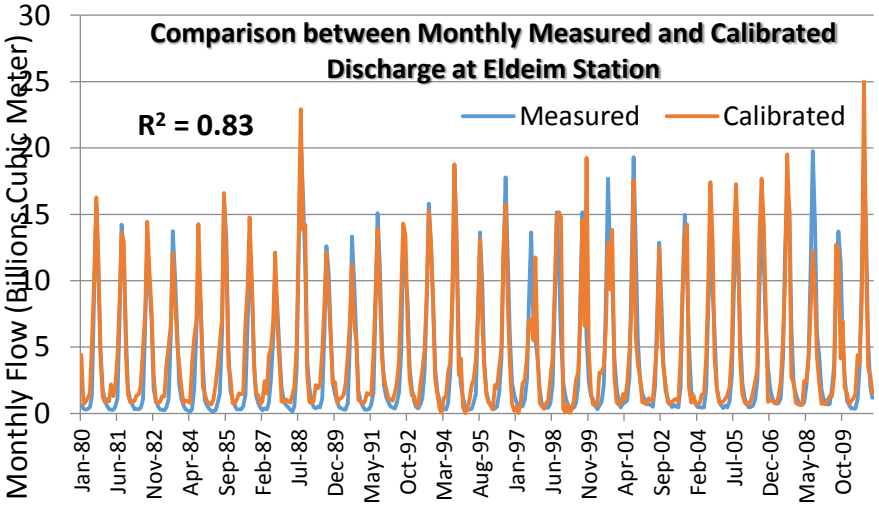
Calibration (1980-1995)

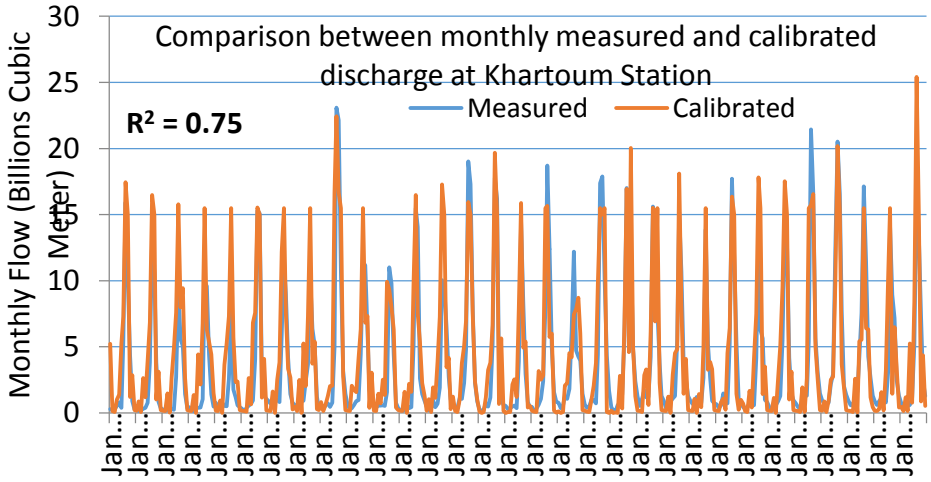
Station	River	Nash-Stucliffe Efficiency (NSE) %	Coefficient of Determination (r^2) %	Index of agreement (d) %
Eldeim	Blue Nile	80	90	95
Giwasi	Dinder	62	84	85
Hawata	Rahad	86	93	96
Khartoum	Blue Nile	72	88	93

Validation (1996-2010)

Cont., Analysis



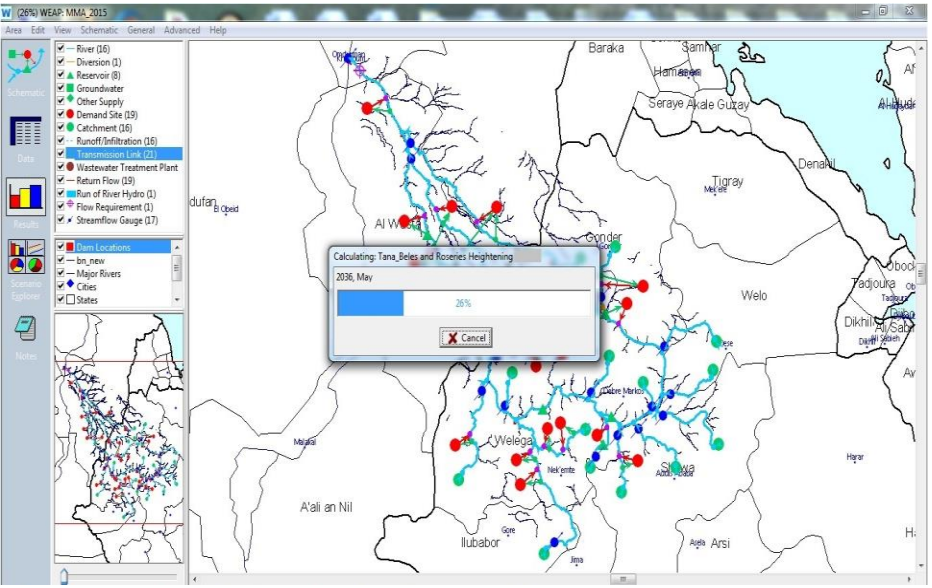


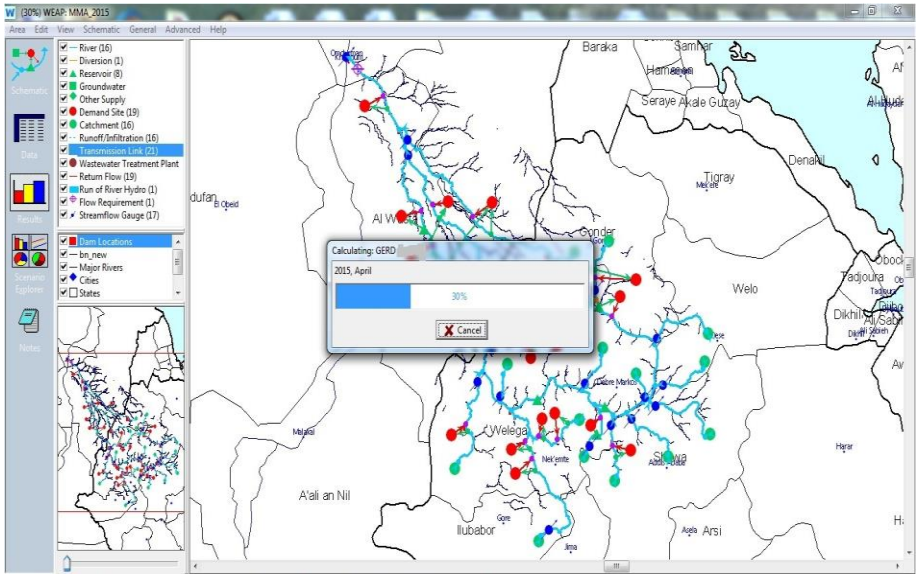


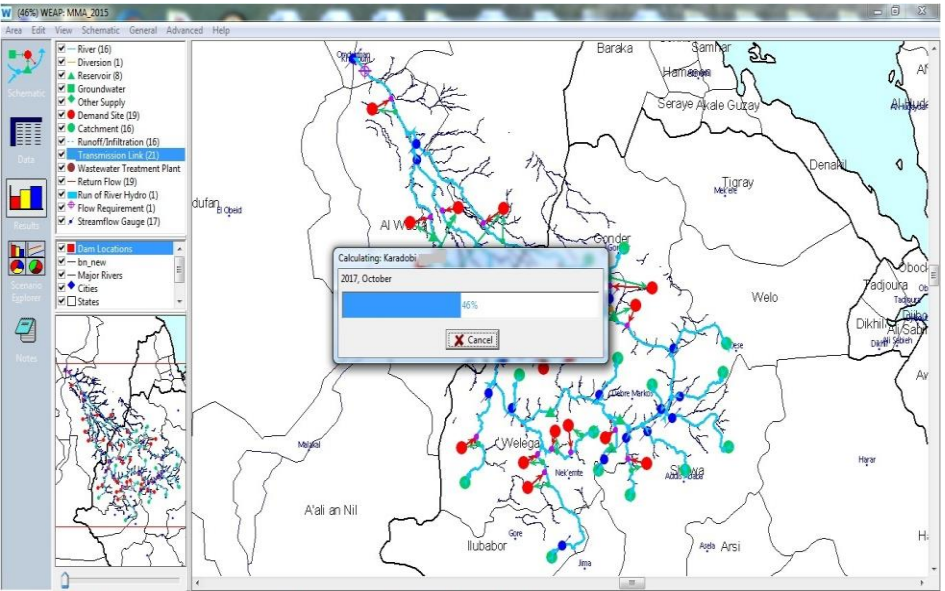
Comparison between monthly measured and calibrated discharge at Eldeim station

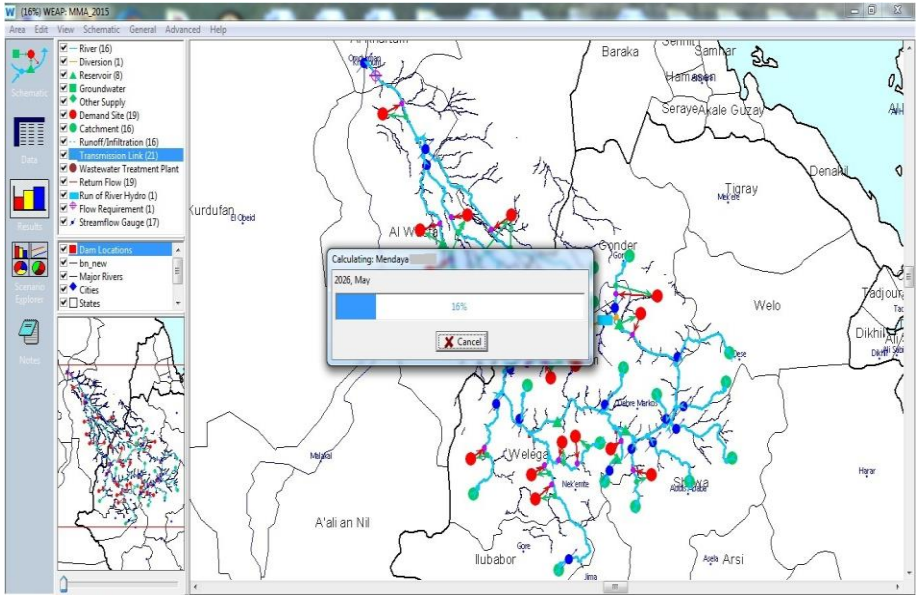
Comparison between monthly measured and calibrated discharge at Khartoum station

Cont., Analysis









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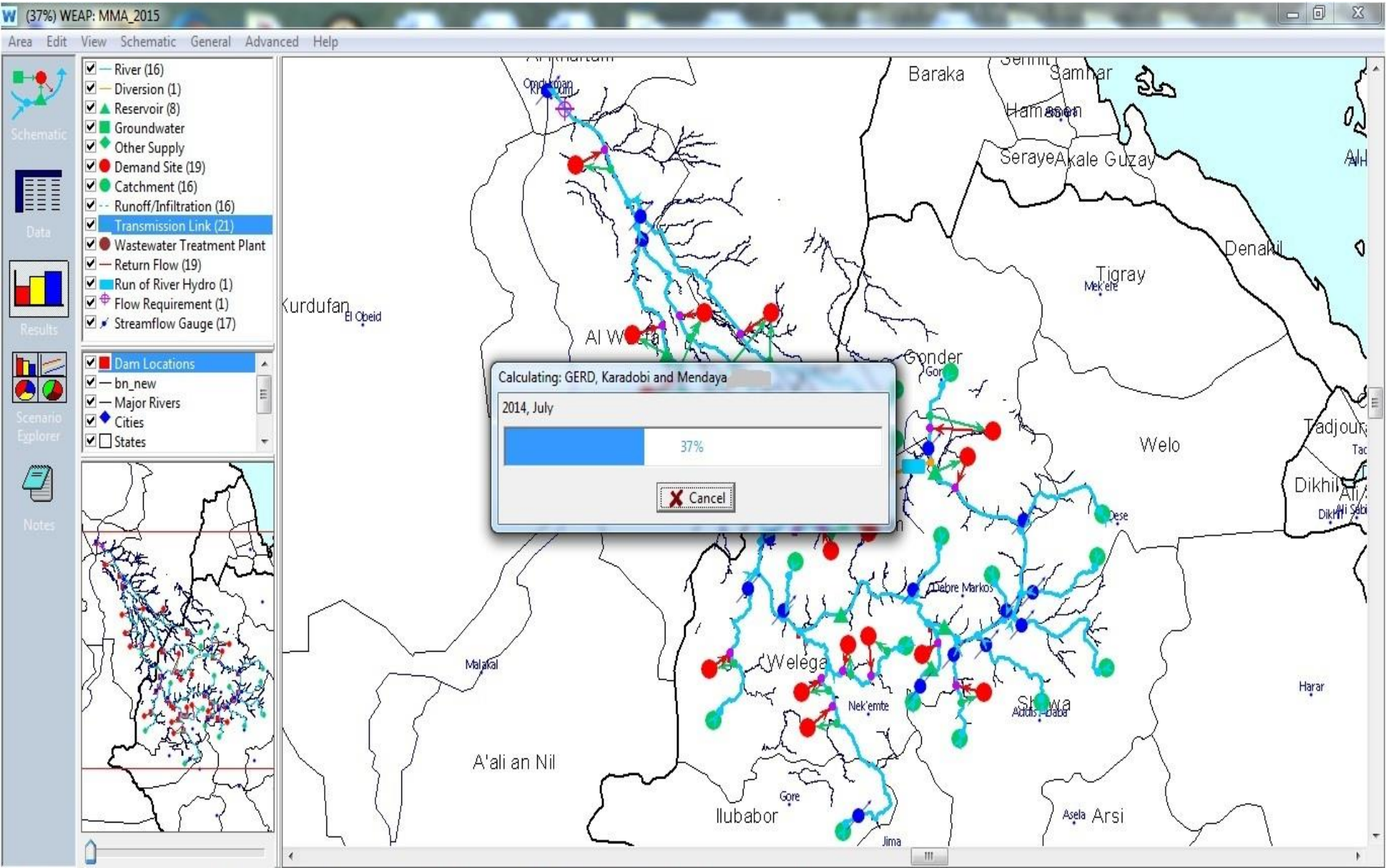

Results of WEAP Scenarios

Scenario Number	Scenario Code	Description
Scenario 1	S – 1	This scenario considered construction of Tana-Beles and Roseries Dam Heightening (TBRDH), considering all projects in Current situation, for the period 2011-2016
Scenario 2	S – 2	This scenario considered construction of Grand Ethiopian Resilience Dam (GERD), considering all projects in S-1, for the period 2017-2023
Scenario 3	S – 3	This scenario considered construction of Karadobi Dam with others future irrigation projects, considering all projects in S-2, for the period 2024-2030
Scenario 4	S – 4	This scenario considered construction of Mendaya dam, considering all projects in S-2, for the period 2024-2030, as parallel scenario to S-3
Scenario 5	S – 5	This scenario considered construction of all projects in S-3 and S-4, for the period 2031-2040

Conclusion & Recommendations

- The satellite rainfall data for all Blue Nile sub-basins were downloaded in a monthly basis for the period 1980-2010 from the Global Weather Data website for the National Centers of the Environmental Prediction (NCEP) (www.globalweather.tamu.edu).
- The satellite rainfall data was modified with the actual measured rainfall from nearby gauge stations for the period 1993-1999 by using a weighting factor depending on the distance between satellite data.
- Using simplified rainfall-runoff relationship, the research obtained the runoff in monthly time steps for each Blue Nile sub-basins at its outlet utilizing the capability of (WEAP), which gives very close estimates.

- The research give an access and easy use of continues data by establishing of regional data base between the BNRB countries for better management and to understand the current demands for water resources projects as well as to plan for future water resources projects; which include Simulated of satellite rainfall data.

Final Remarks

- CFSR shows valuable results (rainfall-runoff) with high efficiency (92%) when comparing to the measured discharges in different measured stations, their for it could represent the actual situation especially in the remotely areas and absence of measured discharged.

Acknowledgements

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Thank you!

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