Quantification of water uses along the Blue Nile River network using a one dimension (1D) hydrodynamic model

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In the Nile River Basin, upstream runoff variability is an acute issue to downstream countries, since these countries are almost entirely dependent on Nile waters. Cooperative management of the Nile waters has become urgent, considering climate variations (Conway, 2005; Yates & Strzepek, 1998 a) and the necessity to use the water resource for irrigation and hydropower. The Grand Ethiopian Renaissance Dam is currently under construction in Ethiopia not far from the border with Sudan (The dam speech, 2011; Hassaballah et al., 2011).
The water resource in the Blue Nile River Basin is under increasing pressure due to rapid population and economic growth, which is often aggravated by a lack of coordinated management and governance. Incomplete knowledge of water uses and needs is the main obstacle for proper management of the water resource in poorly studied river basins. Hydrodynamic models, supported by field measurements, are often the most appropriate tool to study the water distribution in river networks, under high and low flow conditions, taking into account water uses, presence of structures, like weir and dams, as well as physical features, like the complex river network geometry. The objective of this research is to study the water distribution along the entire Blue Nile River system to quantify the availability of the water resource at all flow conditions.

A One-dimensional model using Sobek River package was developed for the Blue Nile River network (Figure 1) including all water uses for irrigation and hydraulic structures in Ethiopia and Sudan. The input data were provided by Ministry of Irrigation and Water Resources in Sudan and Ministry of Water Resources in Ethiopia. Due to lack of data field work was conducted to measure river cross sections, flow velocity, as well as bed and banks soil characteristics. The model was calibrated and validated for both water levels and discharges, measured at selected gauging stations (Figure 1). The model performance extensively assessed against field measurements using correlation coefficient and root mean square error.
Calibration and validation show correlation coefficient between 0.93 - 0.999 for water levels and value range between 0.894 - 0.972 for discharge. The root mean square error for calibration and validation result is less than 50% of the standard deviation.

The comparison between modeled and measured water levels and discharges during the calibration period are shown in Figure 2a and Figure 2b for water levels at Hag Abdalla station and discharge released downstream Sennar Dam respectively.

This basin hydrodynamic model was able to simulate the water uses for irrigation in Sudan during the high and low flows. Moreover, the model will be able to simulate the water uses after constructing of large dams on the Blue Nile in Ethiopia.

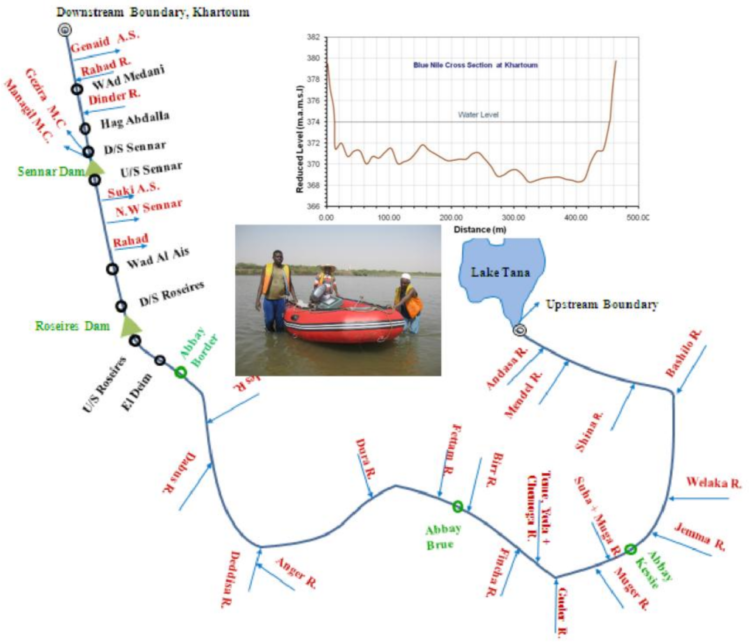

Figure 1 *Blue Nile River model domain* **-** *main gauging stations and examples of field measurement*

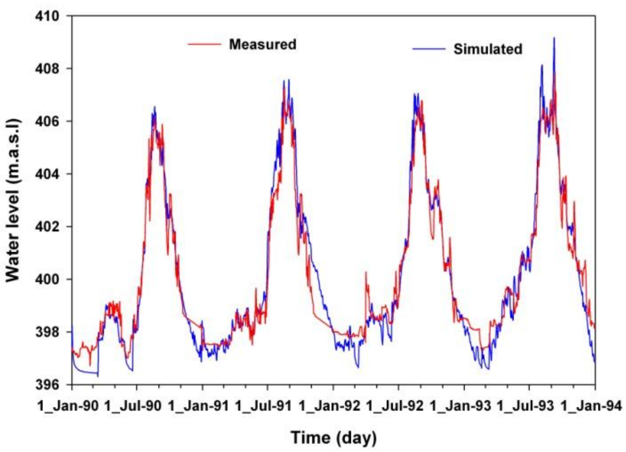

Figure 2 a *Water levels at Hag Abdalla station.*

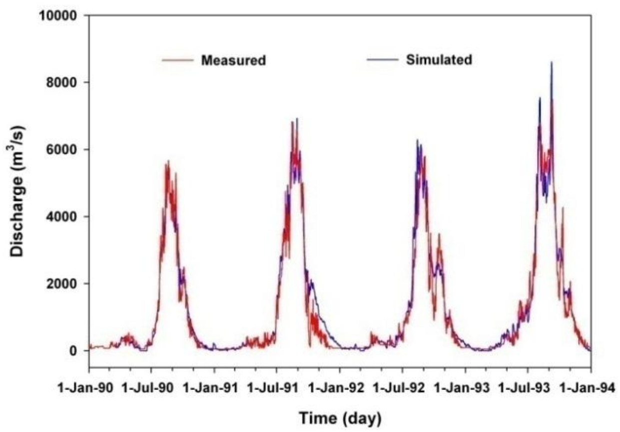

Figure 2 b *Discharge released downstream Sennar Dam*

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