EFFECTS OF MONSOON VARIABILITY ON DISCHARGE DYNAMICS IN THE UPPER BLUE NILE BASIN UNDER CLIMATE CHANGE CONDITIONS

J. Tecklenburg *, Fred Hattermann *

*** Potsdam Institut for Climate Impact Research**

Precipitation remains the most important factor for maintaining a high quality of life in Ethiopia. There is an urgent need to gain a better understanding of climate induced changes on the hydrological system. The aim of our study is to analyse the effect of monsoon variability on the discharge behaviour under climate change conditions in order to better quantify climate feedbacks across the hydrology-vegetation-climate system.

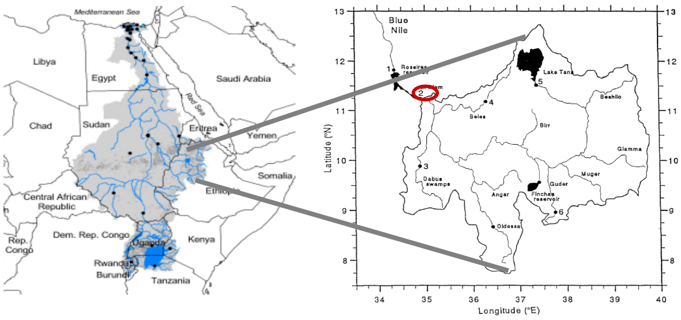

Figure 1: The Upper Blue Nile basin with gauge El Deim (red circle). The catchment area covers 17% of Ethiopia (Nile Basin Initiative, Conway, 1997).

Approach for Climate Change Analysis:

Discharge is the hydrological component which describes the system's response to its input. The process based eco-hydrological model SWIM is used as an integrated system analysis tool to

- better understand the system response on input variabilities
- analyse the water conservation within the catchment
- estimate the change and feedback of coupled flow processes

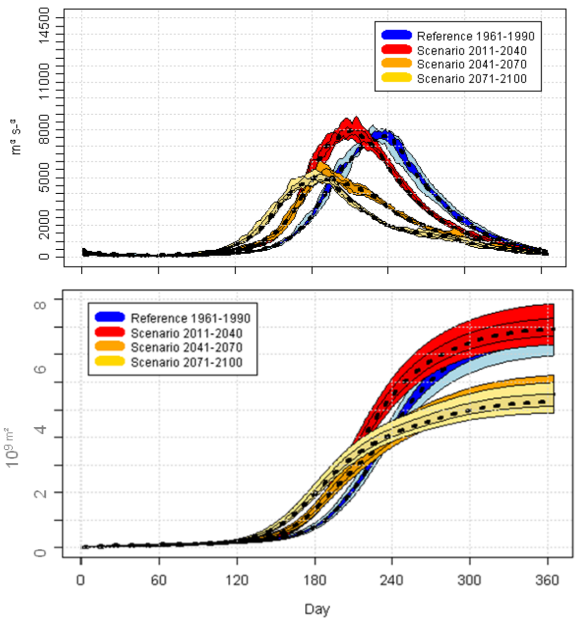

Figure 3: Application of A1B scenario: the discharge curve shifts towards an earlier time (top) while the annual flow cumulation is reduced by 30 % at the end of the simulation period in the year 2100.

Ethiopias

agricultural production, 90% of which is rainfall dependent smallholder farming is important for the livelihood of the society and is strongly correlated with the charcteristic of the monsoonal precipitation patterns (amount, temporal variability). Drought and flood events are responsible for failure of crop harvests and caused famine during the 1970s and 1980s.

Climate change

conditions may shift the current behavior of natural processes and may affect the frequence of extreme events. ECHAM 5 driven outputs of the statistical regional climate model WETTREC (based on the IPCC A1B storyline) are used as climate input in our study.

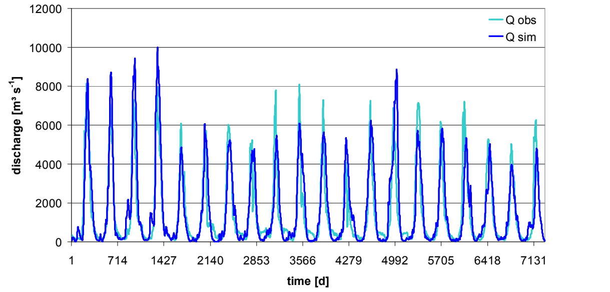

Figure 2: Observed against predicted discharge: the seasonal dynamic is reproduced quite well by SWIM, but peak flows are temporally over- or underestimated during the period from 1961 until 1980 at the outlet El Deim.

Discharge Dynamics:

Running the model under climate change conditions shows a significant impact on flow dynamic:

- the form of the discharge curve is changing during the simulation period: simulated curves show reverse **flow volume distribution**. Higher flow volumes are forming the falling limb, indicating a longer residence time within the catchment
- a significant reduction in the total volume V_{total} is modeled at the end of the simulation period (2071 – 2100)

Table 1: Characteristic time and flow rates of the simulated discharge curve.

IPPC A1B	PEAK TRAVLE TIME [d]	VOLUME V [$10^9 m^3$]		
PERIOD	Date (simulation day) of max. discharge d_{Vmax}	before d_{Vmax}	after d_{Vmax}	V_{total}
1961 – 1990	28th August (240)	36.86	29.99	66.85
2011 – 2040	29th July (210)	29.42	39.13	68.56
2041 – 2070	4th July (185)	13.98	34.02	48.00
2071 – 2100	8th July (189)	20.67	25.05	45.72

CONTACT: JULIA TECKLENBURG
TELEGRAPHENBERG A31, D-14473 POTSDAM
tecklenburg@pik-potsdam.de

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