Application of SWAT Model in land-use change in the Nile River Basin: A Review

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Outlines

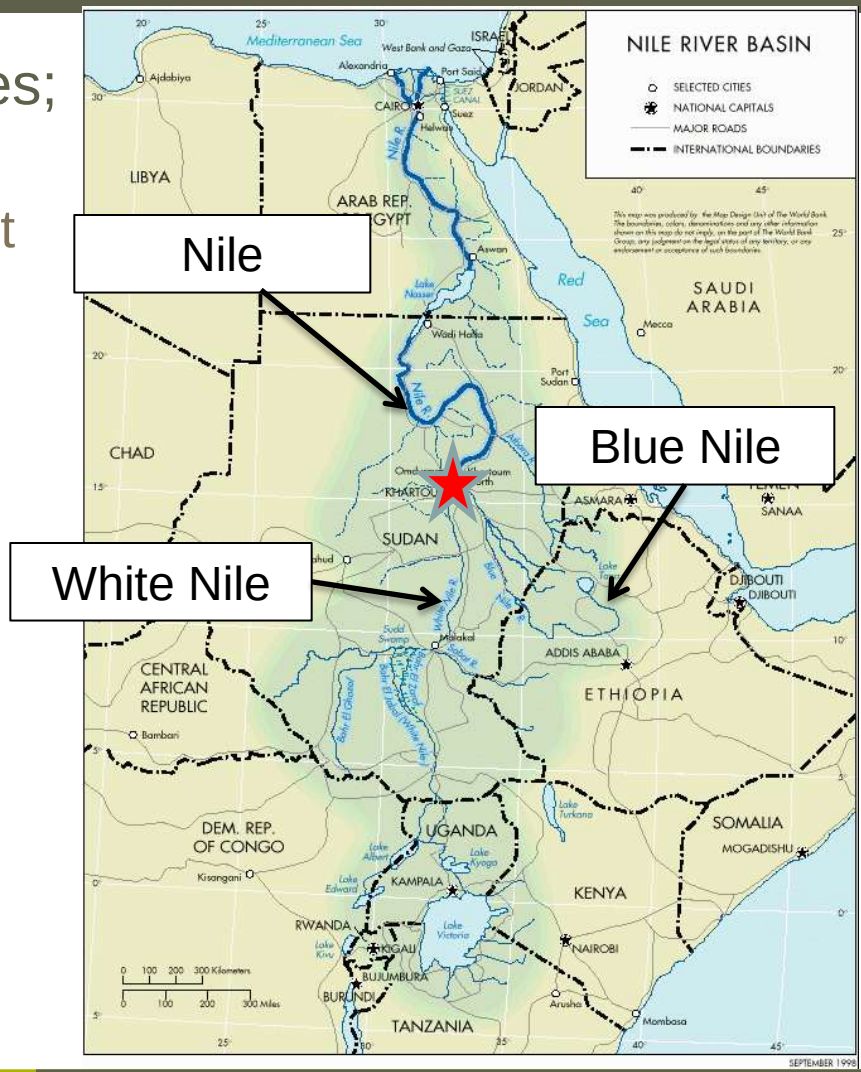
- Introduction
- Problem statement and objectives
- Dynamic land-use studies
- Conclusion and Recommendations

Introduction

- Nile River is the longest river in the world with 6,825 km in length
- A drainage area of about 10% of the area of Africa
- In 2005 supports about 200 million people.
- Estimated in 2030 about 300 million persons.

Introduction

- It has two different hydraulic regimes;
  - The White Nile which has constant flow over the year
  - The Blue Nile which has large flow variability between summer and winter and



Problem statement

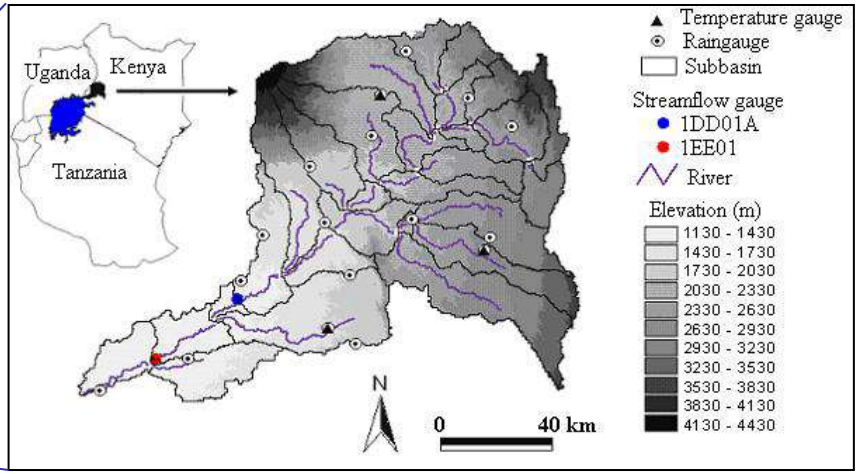
- Increasing population,
- Increasing water demand,
- Increasing the irrigation and hydropower demand
- High vegetation degradation in Ethiopia, i.e. deforestation
- Results in land use change and ecosystem degradation

Objective

- provides a review of studies performed with SWAT on the impact of land-use changes on the hydrology and erosion in Nile River Basin

- How land-use changes have immediate effect

White Nile: Nzoia River Basin



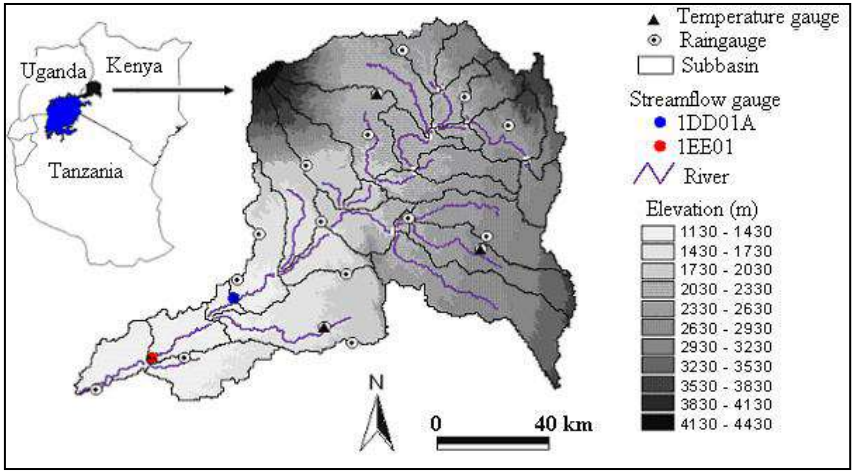
Source: UNEP

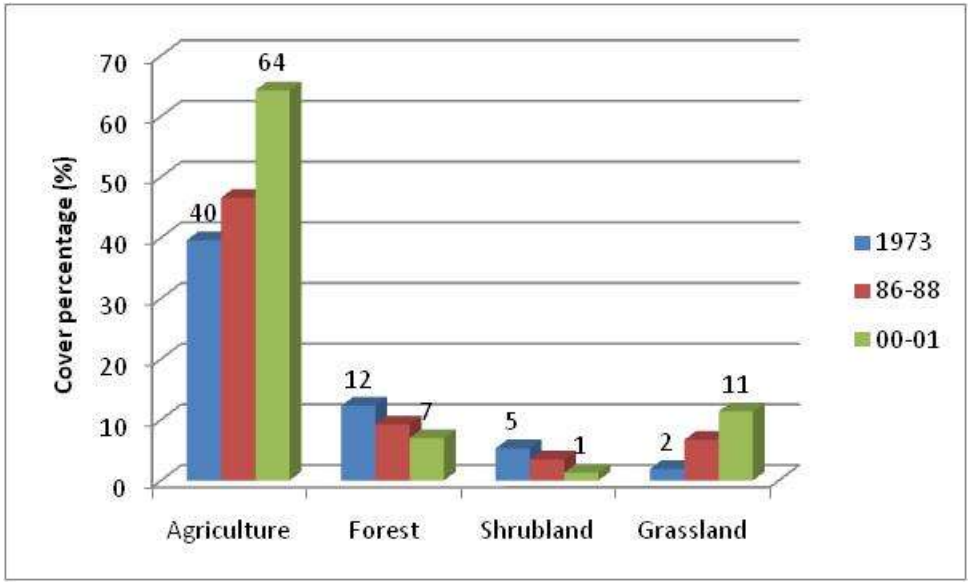
- Nzoia River Basin is one of the main tributaries of the White Nile, it drains into Lake Victoria.

- Its flow regime from 20 m^3/s, to extreme floods may exceed 1100 m^3/s.

White Nile: Nzoia River Basin

- Githui, (2008) meant to assess the past and potential future environmental changes, and their impact on the hydrology of the Nzoia catchment.





- Results showed that runoff was highest from agricultural lands, followed by shrubland, grasslands and forest.

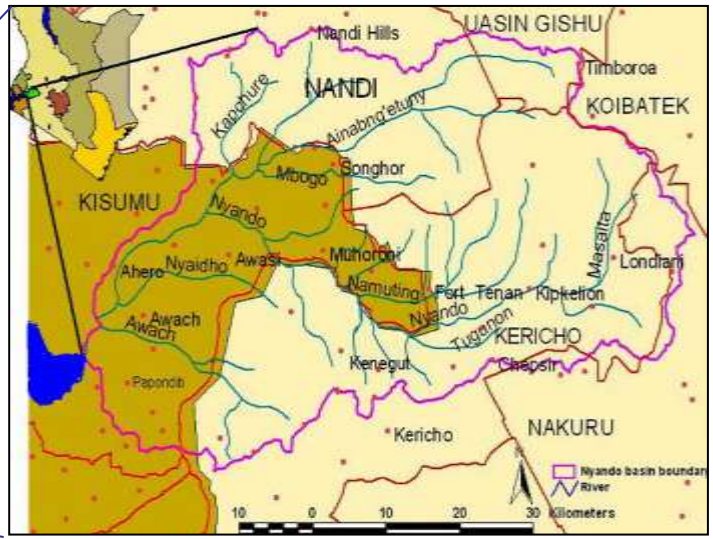
White Nile: Nzoia River Basin

- Odira et al. (2010). aimed to simulate the streamflow changes as a result of the land-use/cover status
- Between 1973 and 1986 a decrease of 48.3% in forest cover.
- There was increase of forest cover of 41.3% between 1986 and 2000.
- The agricultural area decreased between 1973-1986 with 22.4% and1986-2000 and 4.6% .

Scenarios	Forest Cover (%)	Agriculture (%)	Urban (%)	others (%)
Situation 1986	8.7	90.9	0.1	0.3
Senario (2)	0	75	20	3
Senario (3)	100	0	0	0
Senario (4)	50	13	35	2

- The simulated discharges were compared to the baseline scenario. All the four scenarios gave an increase in discharge during wet months and a decrease during dry periods.

White Nile: Nyando Basin

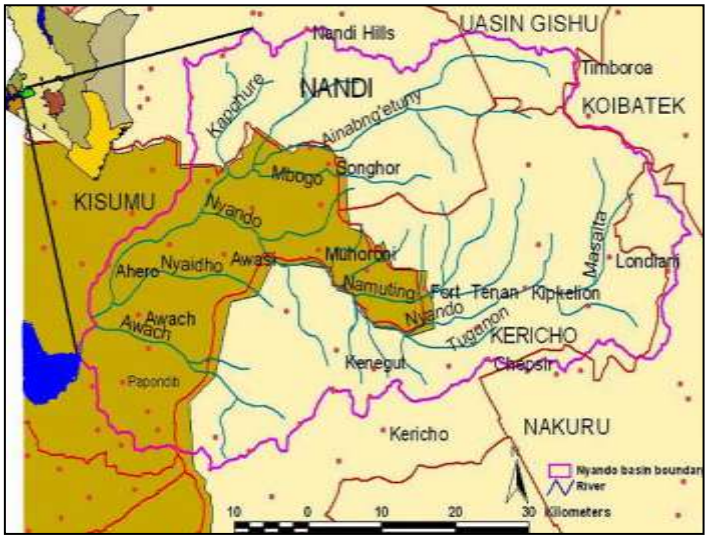


- It is located in western Kenya and drains into Lake Victoria

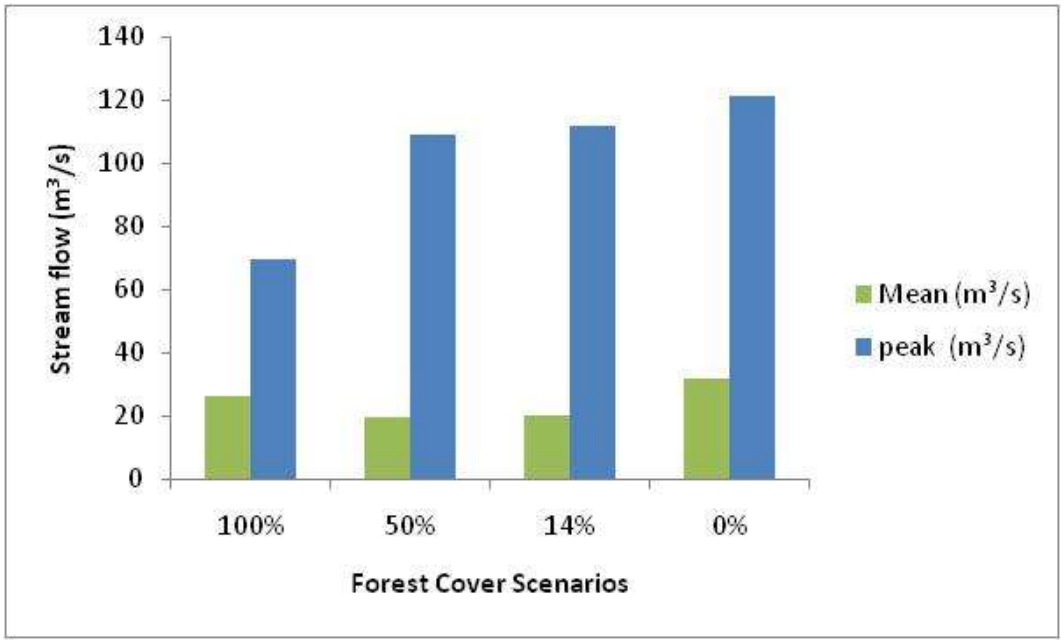
Source: UNEP

White Nile: Nyando Basin

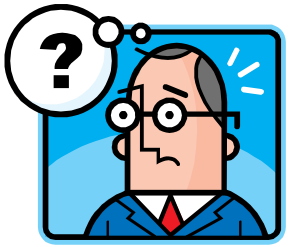
- Sang (2005), aimed to evaluate the impact of changes in land-use, climate and reservoir storage on flooding.



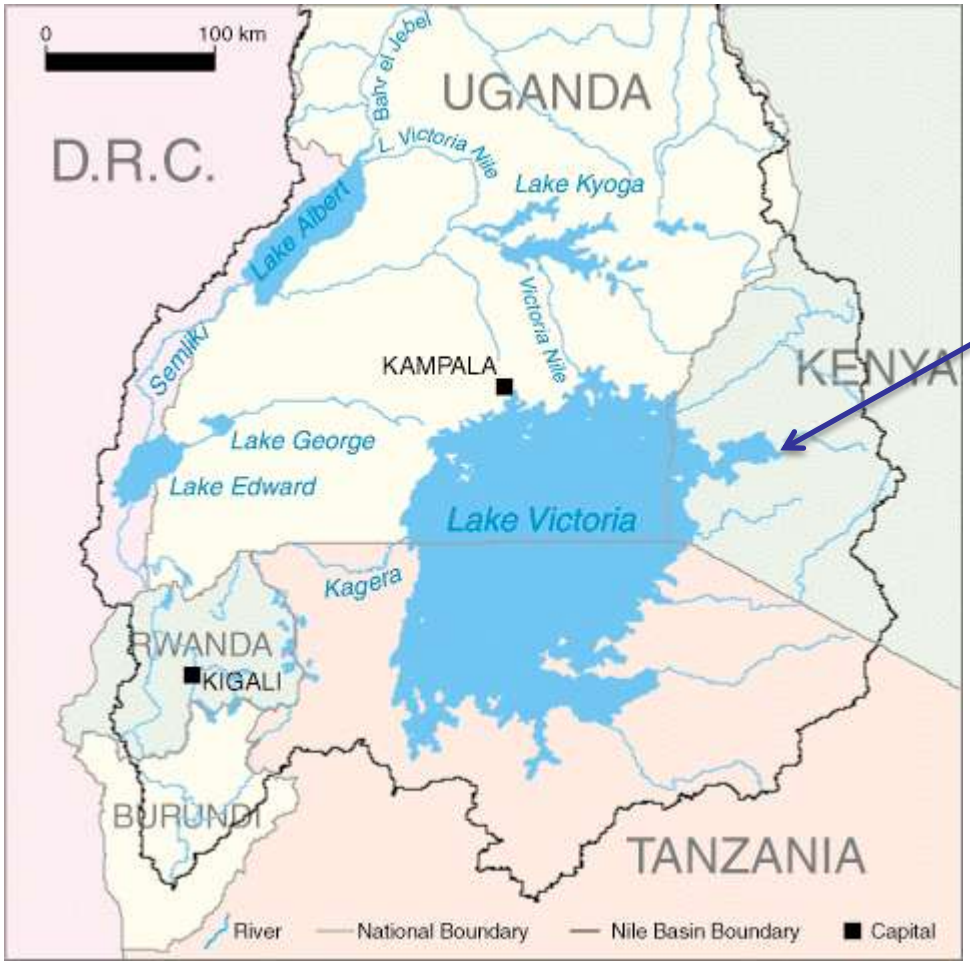
- land-use maps for 1980 and 2003 were used



Opera et al. (2011), came up with the exact results



White Nile: Sondu River Basin



Source: UNEP

- It has drainage a land area of 3050 km^2 into Lake Victoria
- It is located in the mountainous regions of western Kenya near the equator.

White Nile: Sondu River Basin

Jayakrishnan e al. (2005); assessed the environmental impacts of changes in land-use.

Combination of population data and demographic survey data of 1960–90

Three scenarios

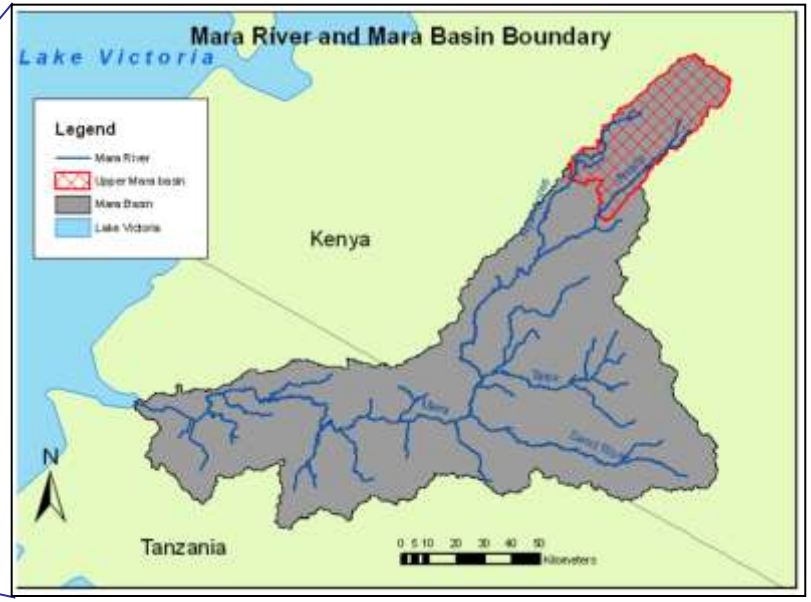
(1) Napier grass area was zero

(2) 45% of the native grass area was converted to Napier grass

(3) 60% for the future adoption scenario

Both the traditional and the future adoption scenarios resulted in reduced stream flow compared to the current adoption scenario.

White Nile: Mara River Basin



- It is a transboundary river shared between Kenya and Tanzania With a basin area of 13,750 km².

Source: UNEP

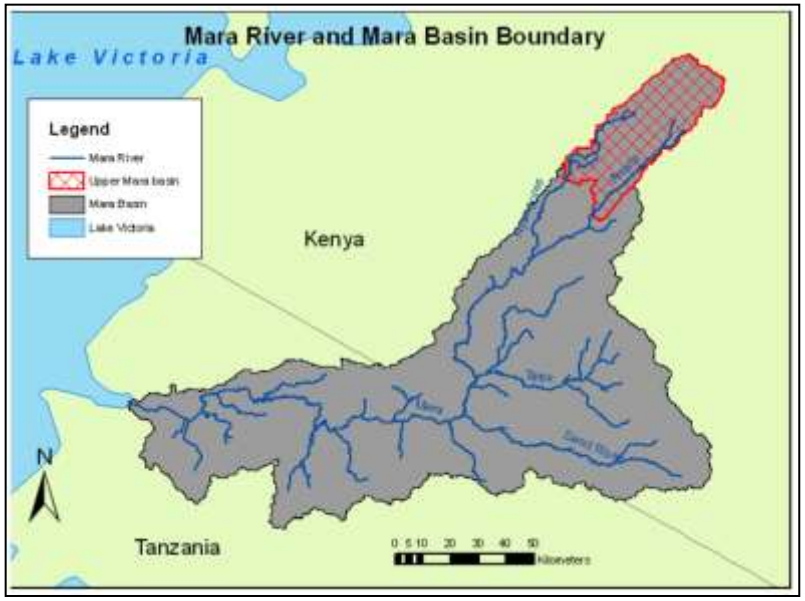
White Nile: Mara River Basin

- Mango (2010); studied the effect of land-use and climate change scenarios on the water flux of the upper Mara river flow;

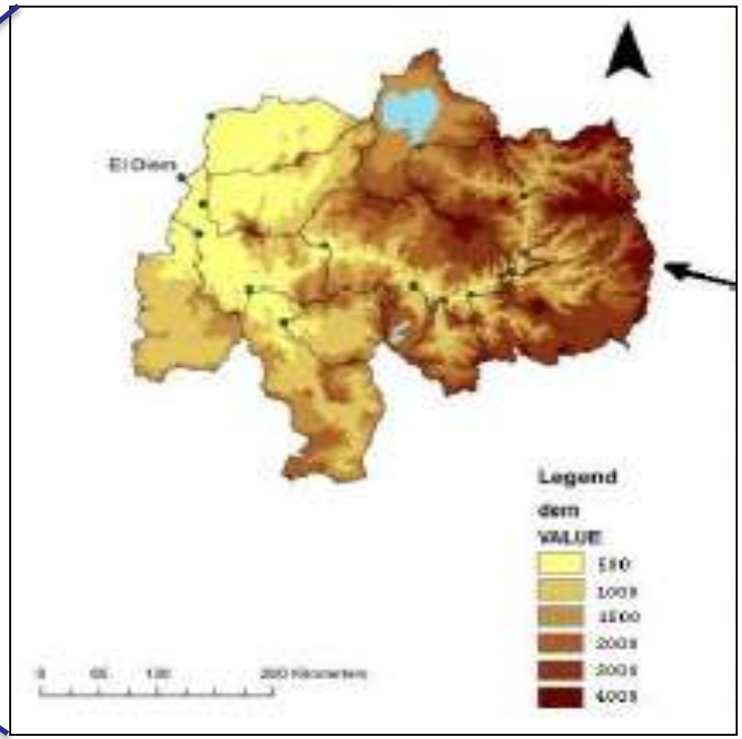
- A classified Landsat (TM) image in 2008 was used

- Three scenarios
  - Partial deforestation,
  - Complete deforestation,
  - Complete conversion of the forest to agriculture.

- Extreme high and low river flows, increased sediment load, and the highest reduction in groundwater recharge were result of complete agricultural scenario



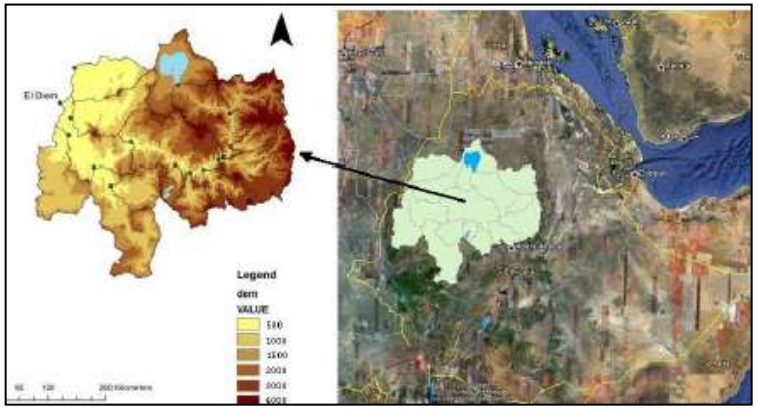
Blue Nile: Upper Blue Nile

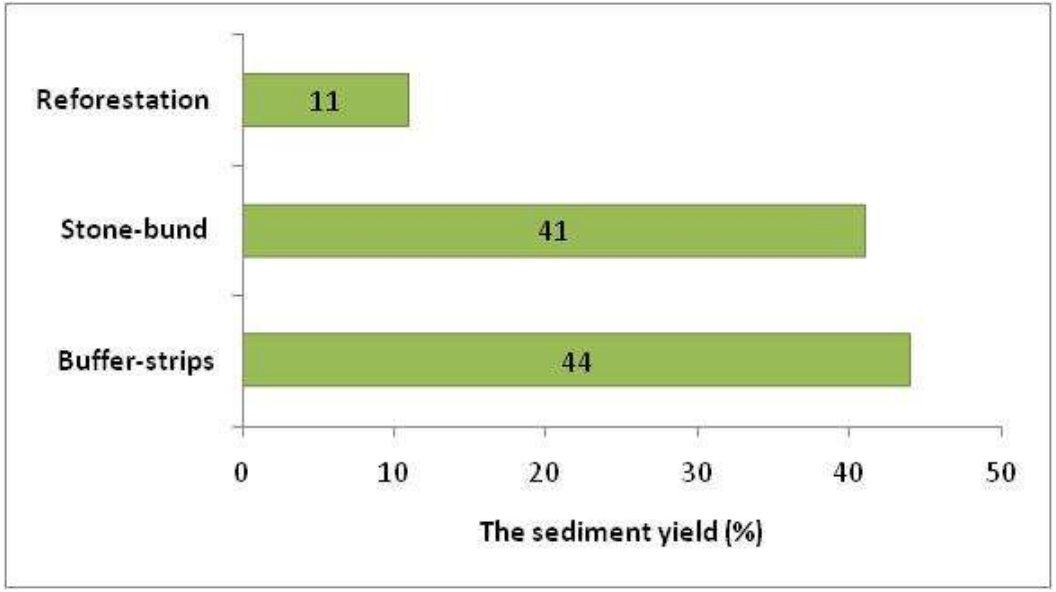


- Blue Nile provides about 60% of the annual flow of the main Nile measured at High Aswan

Blue Nile: Upper Blue Nile

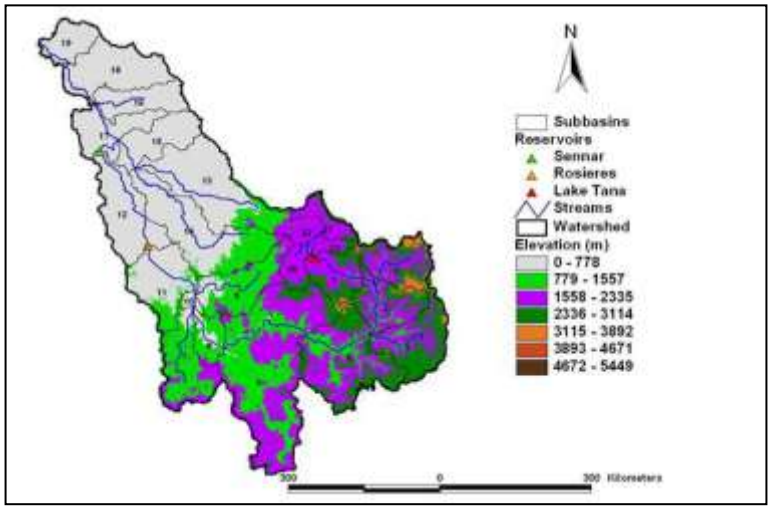
- Betrie et al. (2011), studied daily sediment yield simulations in the Upper Blue Nile under different maintaining existing conditions,
- The model was run daily for 14 yr;
- Calibration (1990–96), and validated 1998–2003 for daily flow and sediment simulation.





Blue Nile: Upper Blue Nile

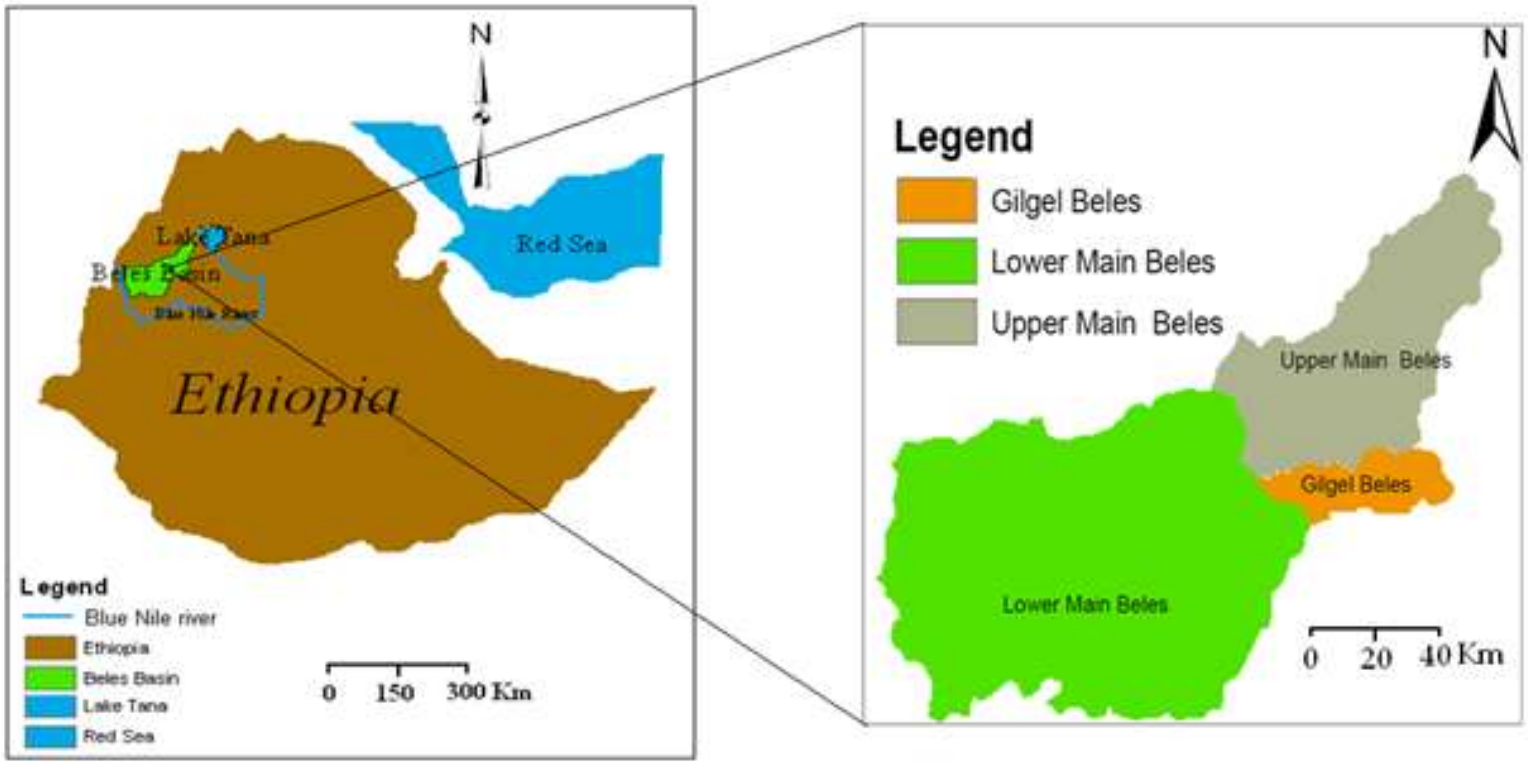
- Sead, 2010. aims to evaluate the impacts of land use change and climate change on both hydrologic regimes and water resources of the Blue Nile River Basin



Land-use Scenarios	Change in savana forest (%)	Δ annual water Yield (%)
Baseline 92-93	0	0
Senario (1)	10	-15
Senario (2)	-8	12

- The seasonal flow analysis shows major increase and decrease of flow has occurred in this wet season compared to the dry seasons (Oct-Jun).

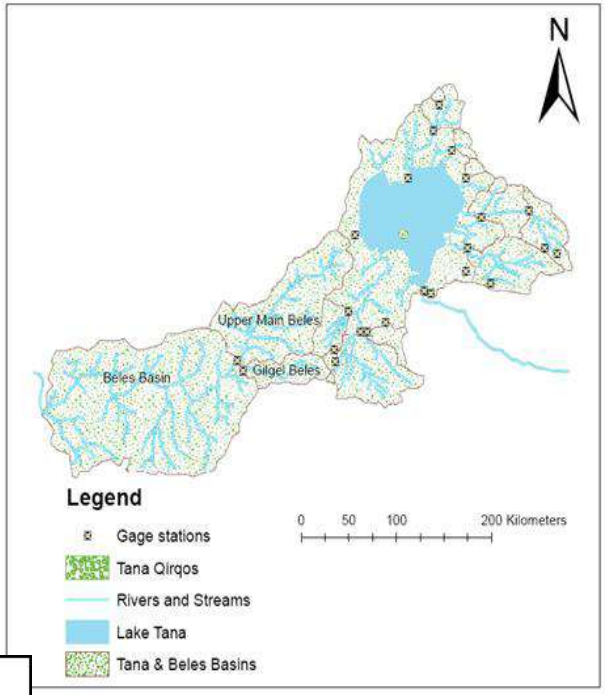
Blue Nile: Beles River

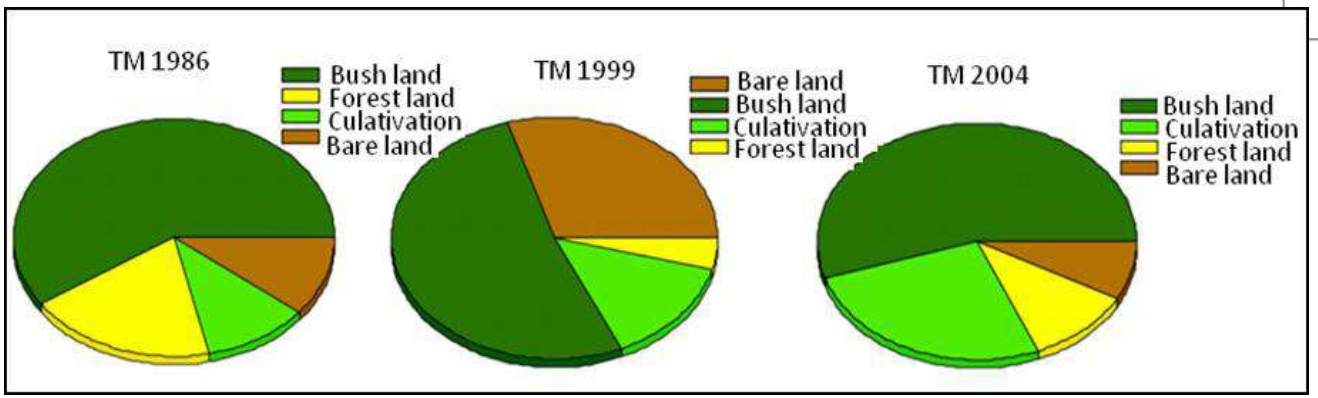


- Beles is located northeast part of Ethiopia and it is the major tributary of upper Blue Nile

Blue Nile: Beles River

- Surur (2010), studied the streamflow due the change of land-use
- Overall, the forest land decreased 13 % whereas the cultivation land increased 21.4 %.
- The model results revealed that the decrease in forest cover caused the increase in the stream flow



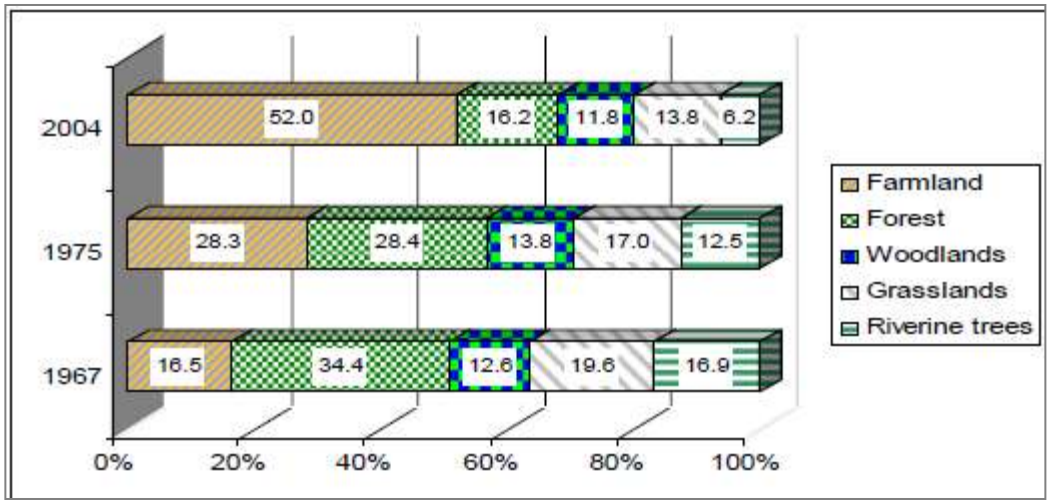


Blue Nile: Hare River Basin

- Hare River locates in Southern Rift Valley Lakes Basin in Ethiopia

Blue Nile: Hare River Basin

- Tadele et al. (2007) investigated the dynamics of land-use change and its consequent impacts on streamflow



- During the 1992-2004, the mean monthly discharge for wet months had increased by 12.5% while in the dry season decreased by up to 30.5%.

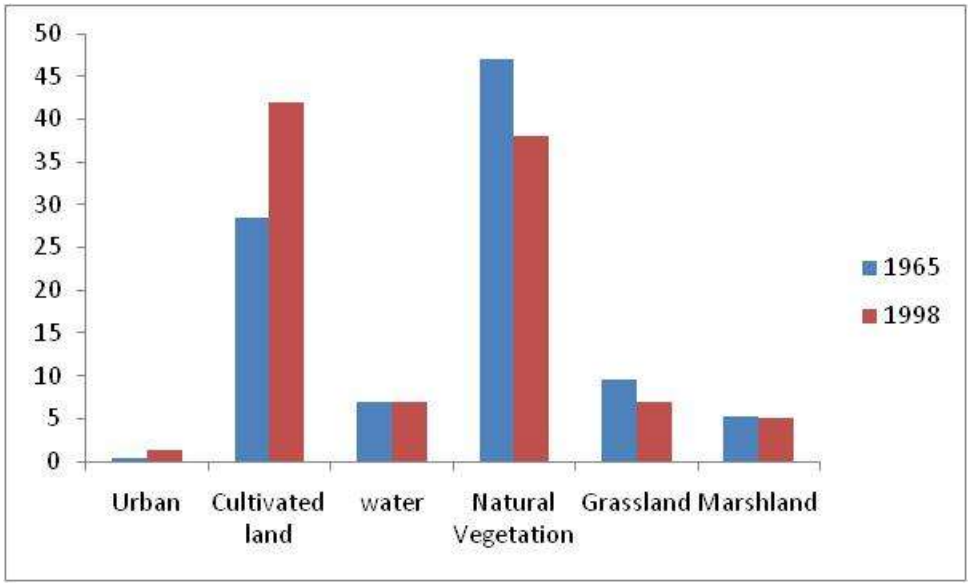
Blue Nile: Awassa Lake

➢The Lake Awassa catchment is located in the central part of the higher Ethiopian Rift region.

Blue Nile: Awassa Lake

- Shewangizaw et al. (2010), assessed the hydrological response of the catchment in relation to the land cover data of 1965 and 1998

- A Scenario for land cover change in 2017 was adapted based on a Master plan study for Rift Valley Lakes basin, and compared with the scenario of 1998.



- The result showed that the average inflow to the lake will increase in 2017 by 0.35 m^3/s, and there will be slightly increasing in the average discharge from 3.15m^3/s in 1998 to 3.5m^3/s in 2017.

- In consequence, there is an expectation of raising the lake level.

Conclusions

- SWAT model has been applied in various catchments of Nile River basin under different topographic, hydrologic, and climatic conditions. The application covered small to large watersheds.

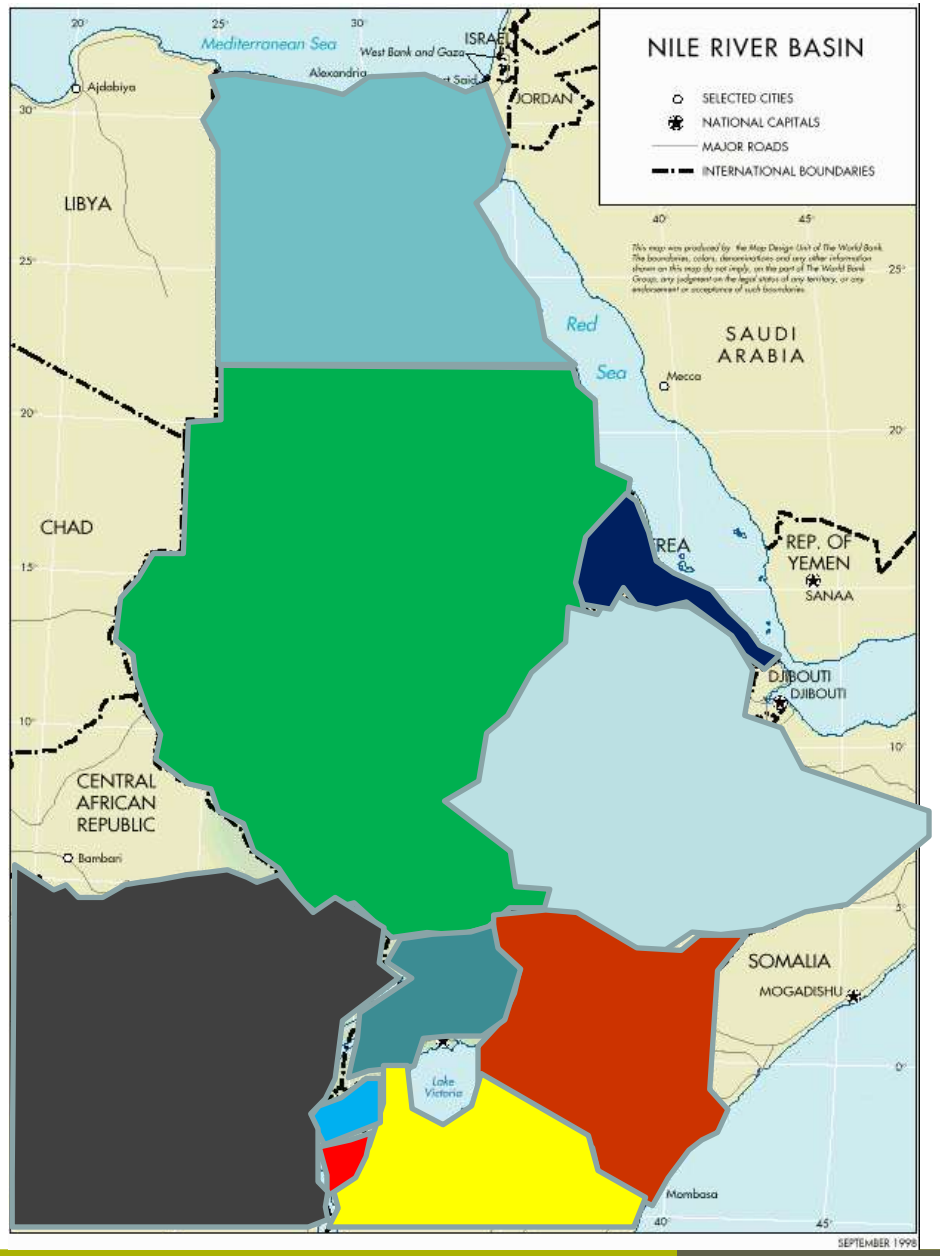
- The model gave high stream flow estimation when scenarios of decreasing forest cover were applied for all the studied watersheds, which increase the risk of frequent flooding, and more sediment loads go to the streams due to soil erosion

- Nile Basin catchments are facing serious landuse degradation

- The studied basins are characterized by scarce data, thus more collaboration in sharing data and sustainability in monitoring are needed

Recommendations

- The studied basins are characterized by scarce data, thus more collaboration in sharing data and sustainability in monitoring is required
- Further work should be identified on land-use changes with a positive effect on the hydrology of the Nile River basin
- To what level these change scenarios could happen?
- How these changes affect the hydrologic regime and socio-economic situation on the river basin scale?


NILE RIVER BASIN
SELECTED CITIES
NATIONAL CAPITALS
MAJOR ROADS
INTERNATIONAL BOUNDARIES
Mediterranean Sea
West Bank and Gaza
ISRAEL
JORDAN
Alexandria
Ajdabiya
LIBYA
Red
Sea
SAUDI
ARABIA
Mecca
CHAD
REP. OF
YEMEN
SANAA
DJIBOUTI
DJIBOUTI
CENTRAL
AFRICAN
REPUBLIC
Bambari
SOMALIA
MOGADISHU
Lake
Victoria
Mombasa
SEPTEMBER 1996


Thank you