Implication of cimate change on sustainable development and DRR

BY: Mihretab Gebretsadik Tedla, PhD

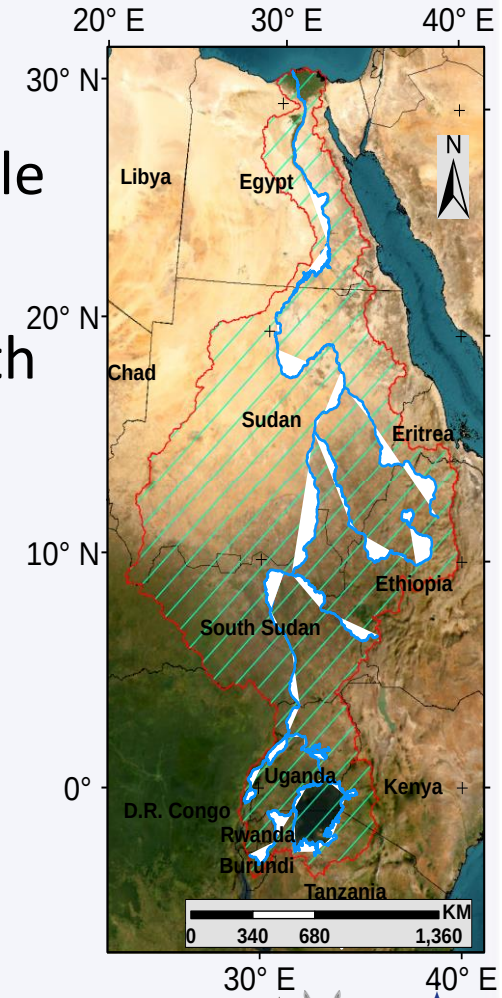
unesco
Centre
Under the auspices
of UNESCO

ICHARM
International Centre for Water
Hazard and Risk Management
under the auspices of UNESCO

PWRI
Public Works Research Institute,
National Research and Development Agency,
Japan

Climate change and the Nile basin

- The African region is one of the most vulnerable continents to climate variability.
- Growing evidence of climate change over North Africa and in East Africa (Niang et al., 2014).
- The Nile basin is characterized by heterogeneous hydro climate and topography.
- Water resources management becomes challenging in transboundary basins.

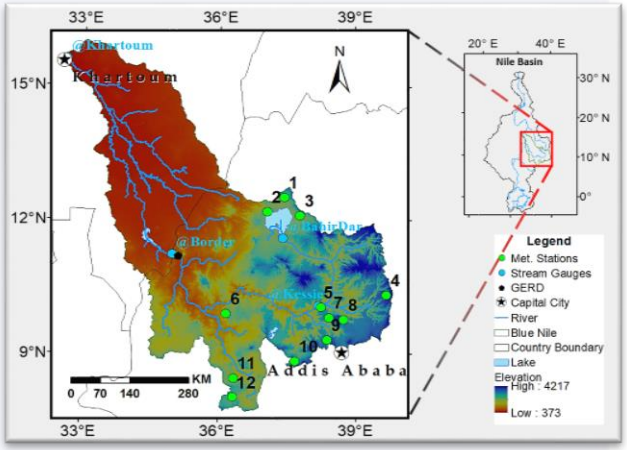


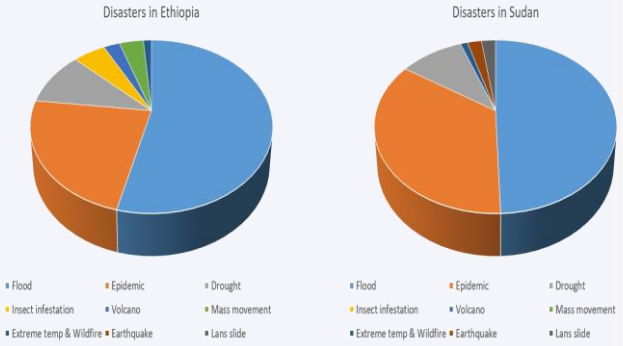
Status quo in Eastern Nile basin

- Egypt and Sudan account for the largest water withdrawals at 57 and 31% (FAO Aquastat 2005)
- Egypt depends on the Nile for 97 % of its water supply (Wheeler et al., 2018)
- GERD nears completion, downstream countries are concerned about the management (Wheeler et al., 2020).
- Watershed management activities such as large scale afforestation for enhancing the water towers (Singh et al., 2023)

Study Area – Abbay/ Blue Nile basin

- Blue Nile catchment area 310,000 km^2 (10% of the Nile basin)
- The Blue Nile catchment area in Ethiopia 197,000 km^2 (~65 %) and Sudan 107 km^2 (35 %)
- The Blue Nile is highly seasonal ~70% flow occur between July and September
- Annual Runoff from Blue Nile is approximately 52BCM (60% of the Nile)





- Water related disasters takes the highest share

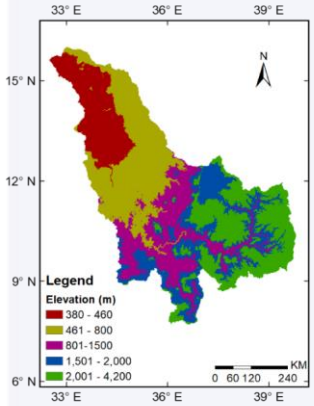
Problem description

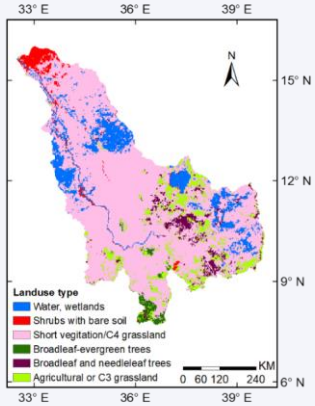
- Developing regions existing vulnerability to flood and drought
- Scarcity for food, water supply and energy to satisfy the demand.
- In transboundary basins differences in countries policy
- Inadequacy of observation system for evidence based decision making
- Insufficient institutional and policy tools for cooperative framework

Objective

- To assess climate change impact for informed decision-making in the Blue Nile basin.
- To study Integrated Water Resources Management (IWRM) practice under climate change and provide policy suggestion for sustainable transboundary basin development in the Blue Nile basin.

Data



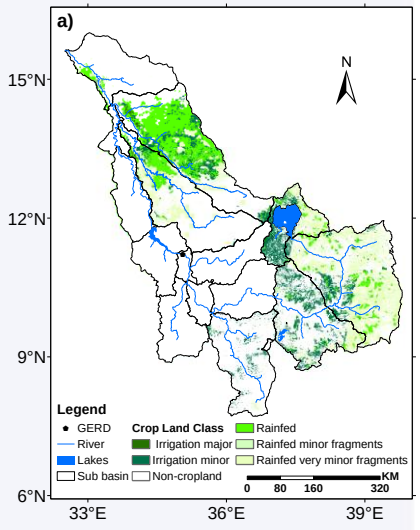


- Land Surface Data
  - (a) DEM ((HydroSHEDS)
  - (b) Soil type distribution (FAO)
  - (c) Land use data (USGS)
  - (b) Modis (LAI and FPAR)

- Gauged data
  - (a) Daily precipitation & Temperature
  - (b) Daily discharge data

DIAS
Data Integration & Analysis System

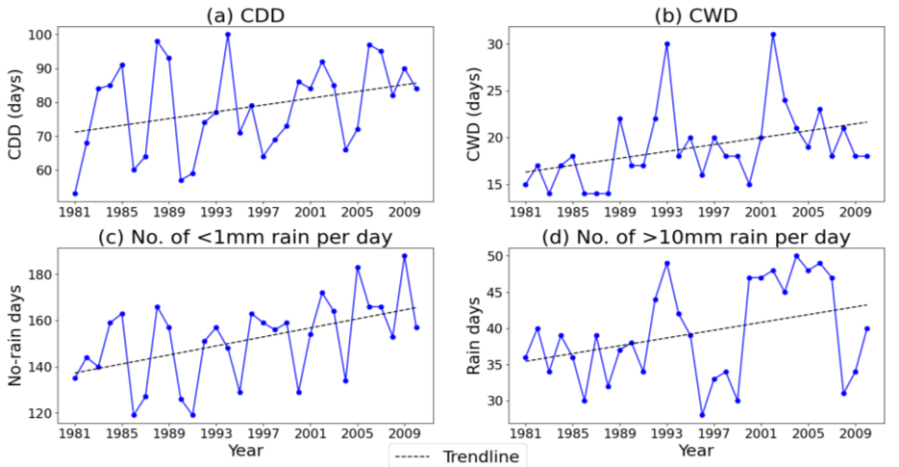
- CMIP5-DIAS
  - (a) GCM selection and data download
  - (b) Statistical bias correction
- Meteorological forcing data (JRA-55)



- Socio-economy data
  - (a) Global Human Settlement Layer (GHSL)
  - (b) Global Food Security Support Analysis Data (GFSAD) Crop Mask

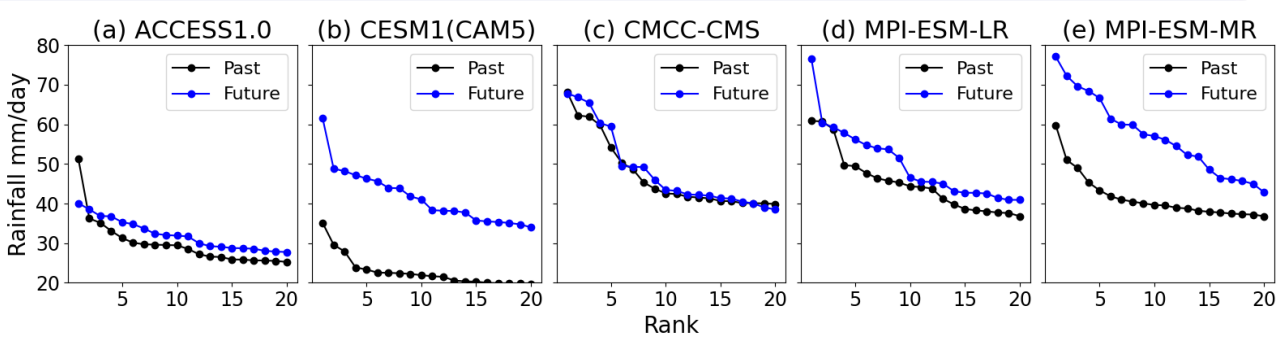
Results

- Extreme rainfall trends



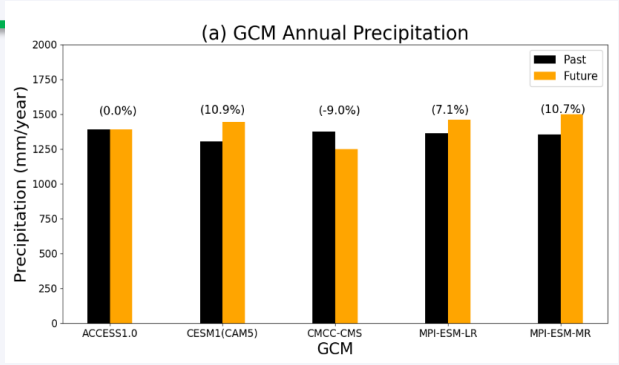
- Both consecutive wet and dry days indicates an increasing trend.
- Days of extremely high rainfall and no-rain days indicated an increasing trend

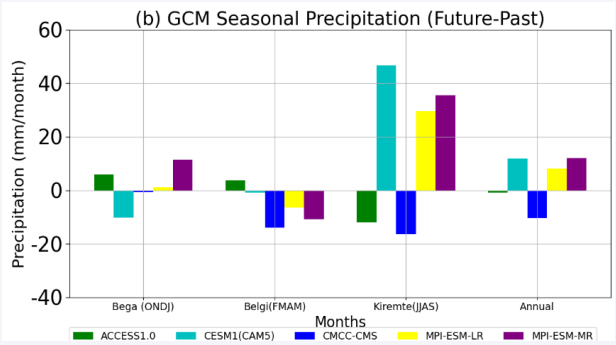
- Extreme rainfall events increased in 4 GCMs.

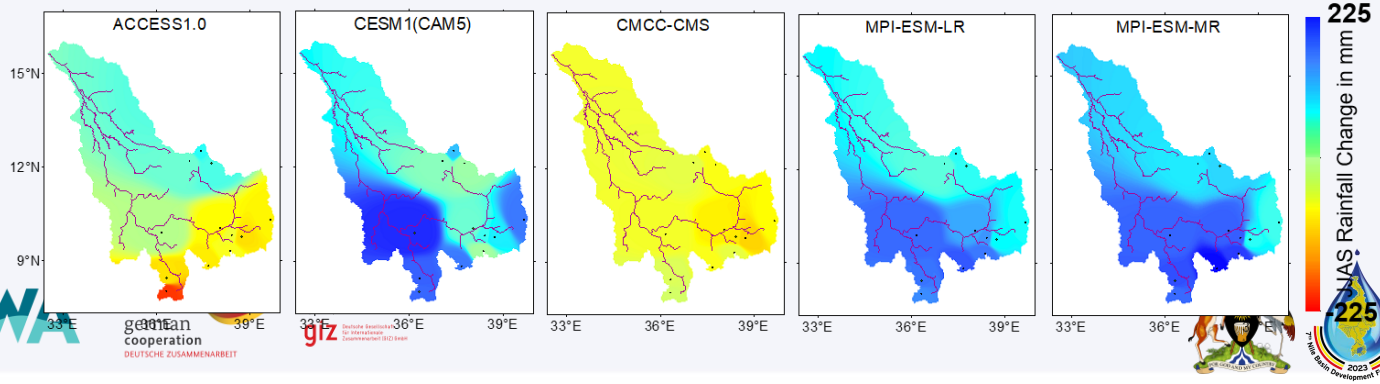


Annual and seasonal trend

- Observation data indicates a significant increasing trend in Kiremt season and decreasing trend in dry season.
- Precipitation change in GCMs indicates increase in 3 models, 1 model no change and 1 model decrease
- High spatial and inter-annual variability in precipitation change.

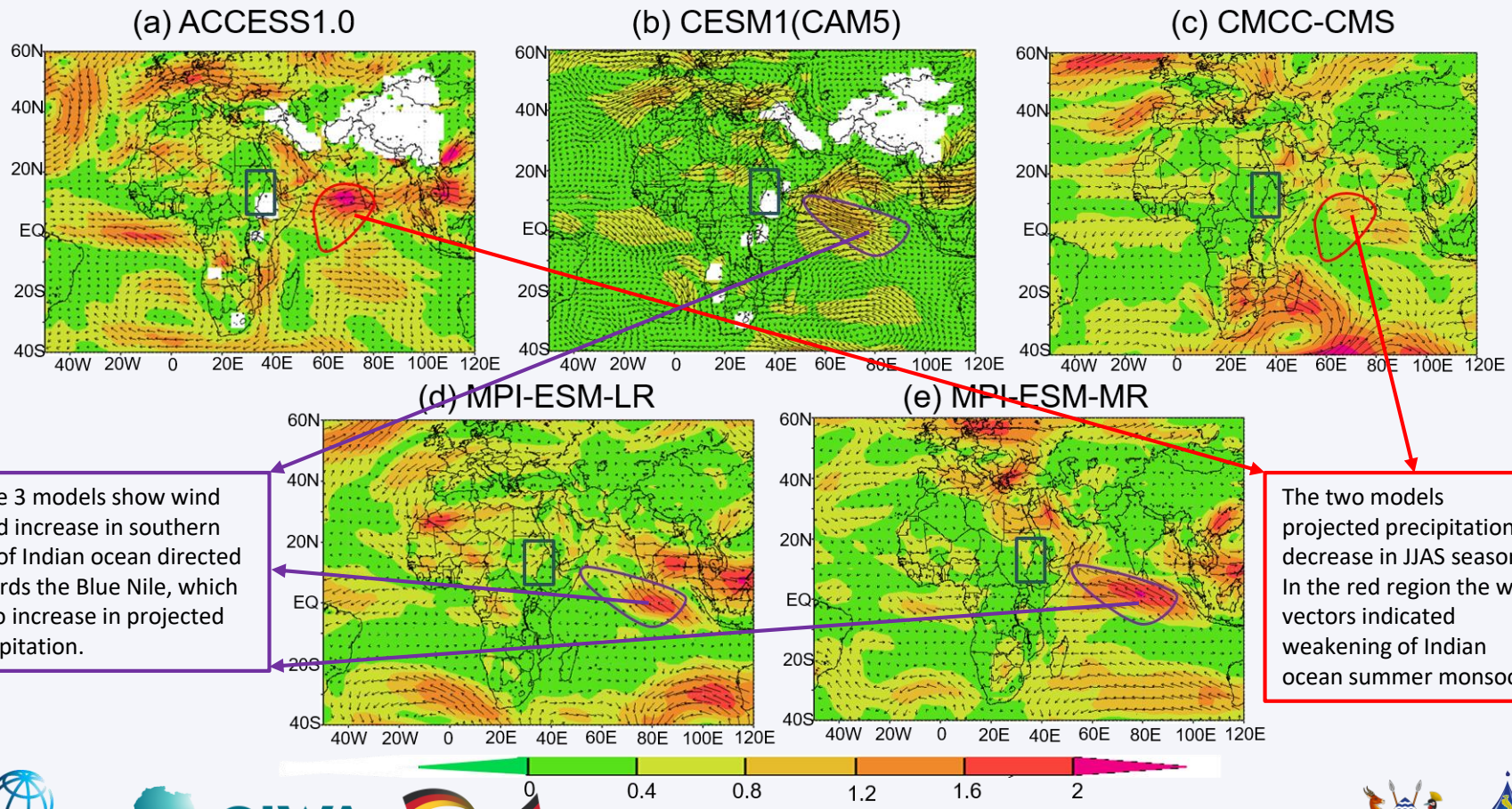






Uncertainty analysis in GCMs

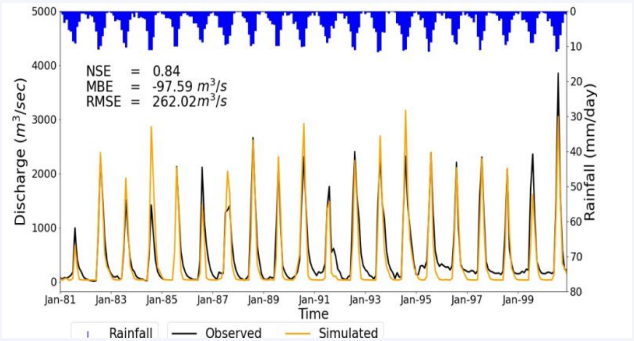
- Wind speed and vector:- JJAS @850hPa



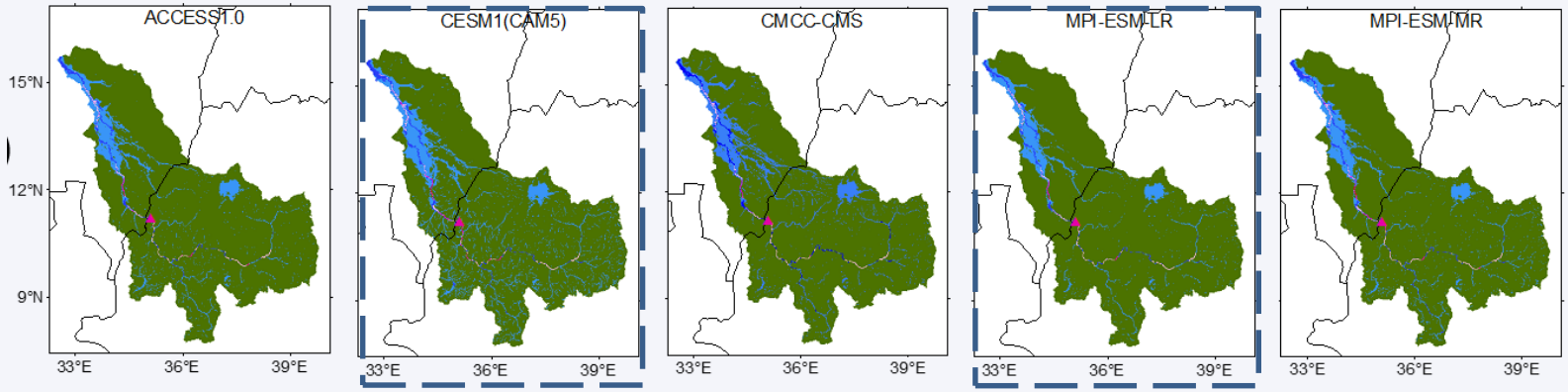
These 3 models show wind speed increase in southern part of Indian ocean directed towards the Blue Nile, which led to increase in projected precipitation.

The two models projected precipitation decrease in JJAS season. In the red region the wind vectors indicated weakening of Indian ocean summer monsoon.

Model setup and simulation



Location	GCM Annual Flow % change (Future-Past/Past*100)				
	ACCESS1.0	CESM1(CAM5)	CMCC-CMS	MPI-ESM-LR	MPI-ESM-MR
Bahir Dar	**-5.3**	**0.5**	**-24.0**	**3.6**	**20.4**
Kessie	-10.3	5.6	-26.7	7.5	15.8
Border	-15.1	11.5	-33.3	8.9	18.3
Khartoum	-6.1	9.7	-25.7	5.2	16.3

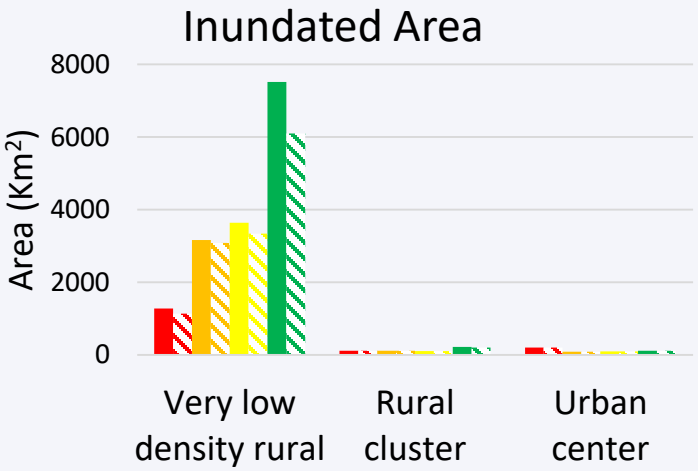


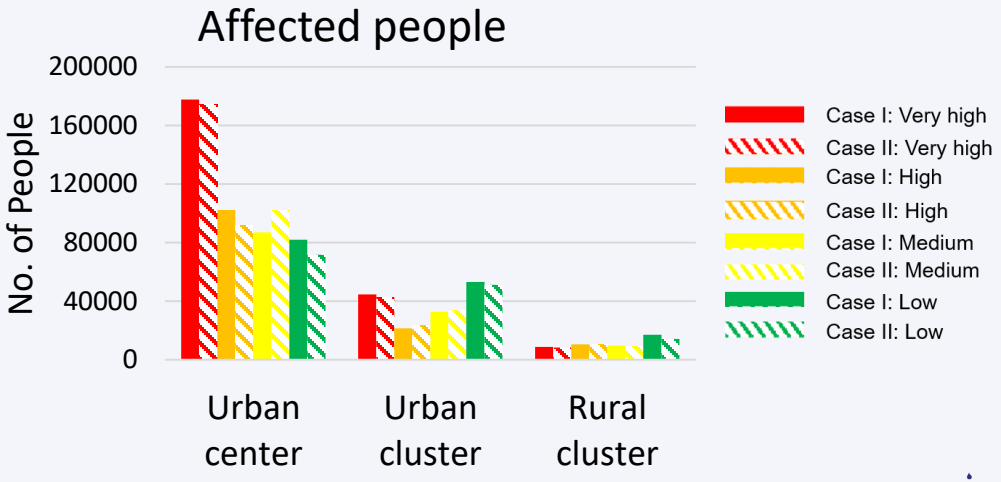
Flood inundation increased at downstream and lake Tana areas

Socio-economic risk assessment

- Flood inundation indicate high level of risk to physical and socio-economic indicators particularly at downstream area

Risk category	Low	Medium	High	Very high
Flood Depth (m)	< 0.5	0.5 – 1.0	1.0 – 1.5	> 1.5





Summary and Conclusion

- Projected climate changes are classified qualitatively, and it is very likely that extreme rainfall and discharge will increase.
- Uncertainty analysis led to an understanding of synoptic scale climate variables impact on the precipitation projections.
- Flood inundation area will increase due to climate change, with direct and indirect impacts on the socio-economic indicators.
- The results highlight the need for adaptation strategies, including the beneficial use of reservoirs to smooth the projected temporal variability and extreme flows in the Blue Nile river.

Recommendation

- Understanding of climate change risks and the anticipated socio-economic impact of extreme flows for evidence-based decision-making in the Eastern Nile basin.
- Promoting transparency in negotiations, including the risks posed by climate change and the utilization of water storage structures such as GERD for equitable development.
- Utilizing existing all-inclusive partnerships and agreements to deepen water use and development, and enhance multilateral development.

THANK YOU!

mihretab1@gmail.com