Climate Change and Hydropower in Africa

Impacts , Mitigation and Adaptation

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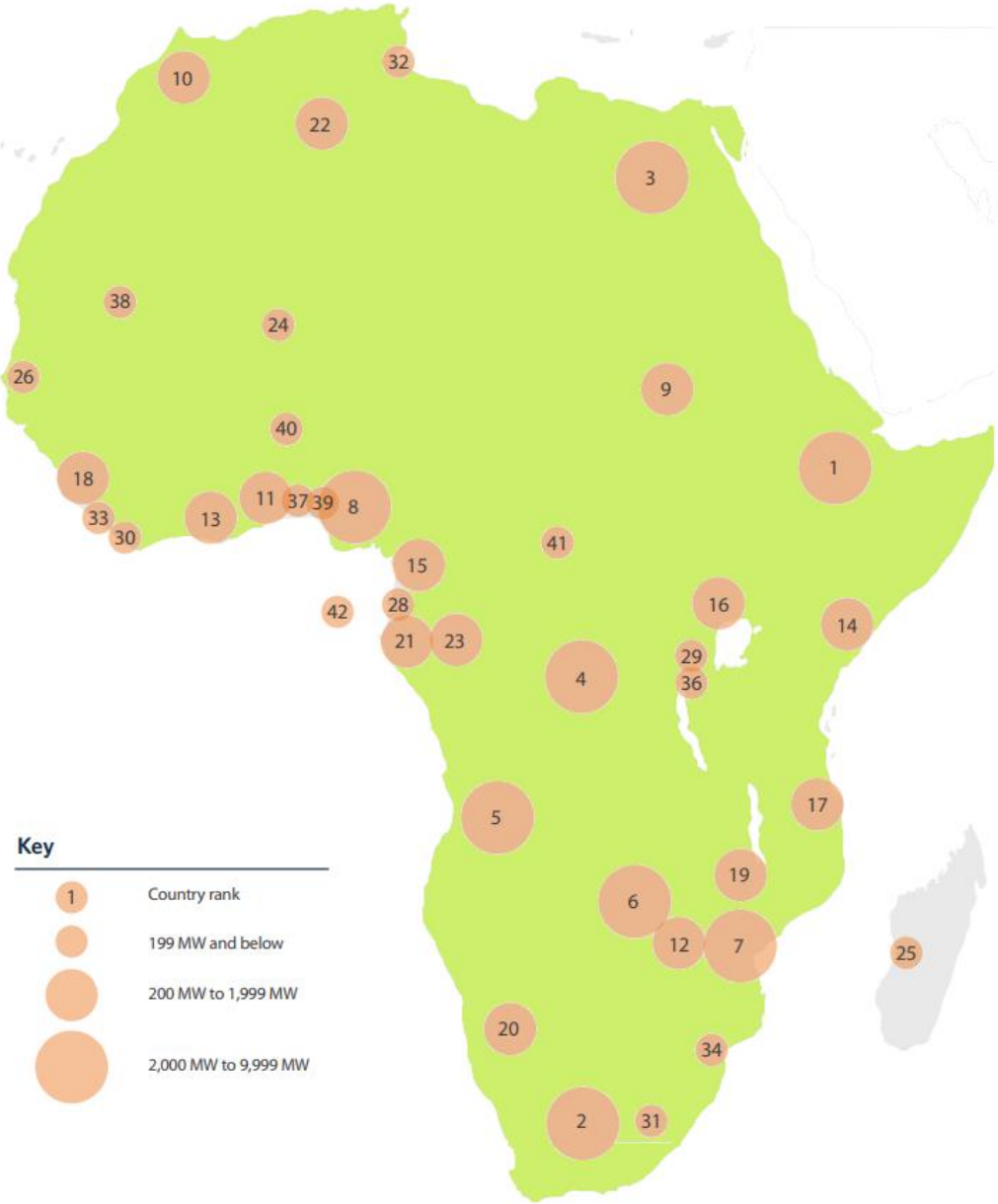
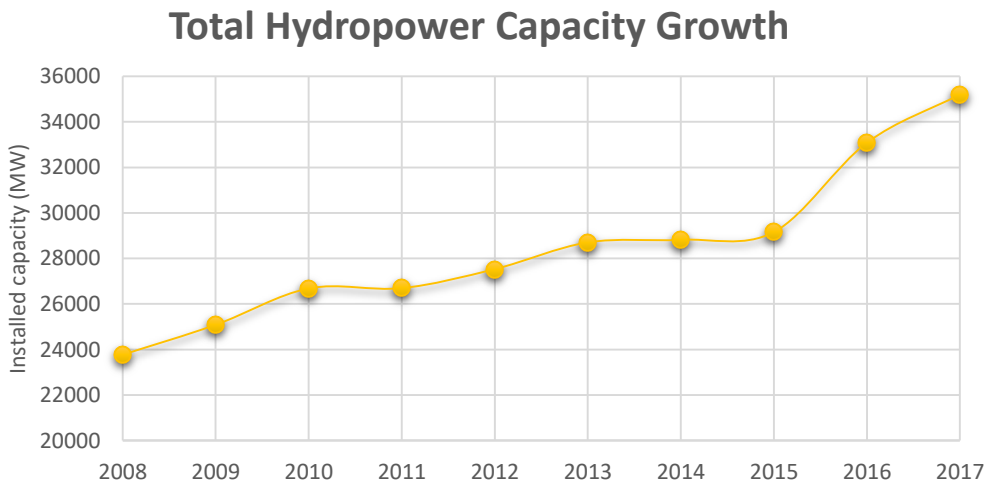
Hydropower resource in Africa



Source: International Hydropower Association | Hydropower Status Report 2018

- Operating 35,000 MW
- Under construction 17,000 MW
- Planned 77,375 MW
- Technical Potential 1,800 TWh/year



Hydropower and Climate Change

- Impacts on precipitation & temperature

  -> Change in hydrology

  -> Change in Hydropower Generation

- Expected to play an increasing role in climate change adaptation
  - Hydropower :A renewable energy source
  - Climate adaptation services: Offer flood management and drought protection
  - Clean Battery: Energy storage and dynamic capacity to balance grids

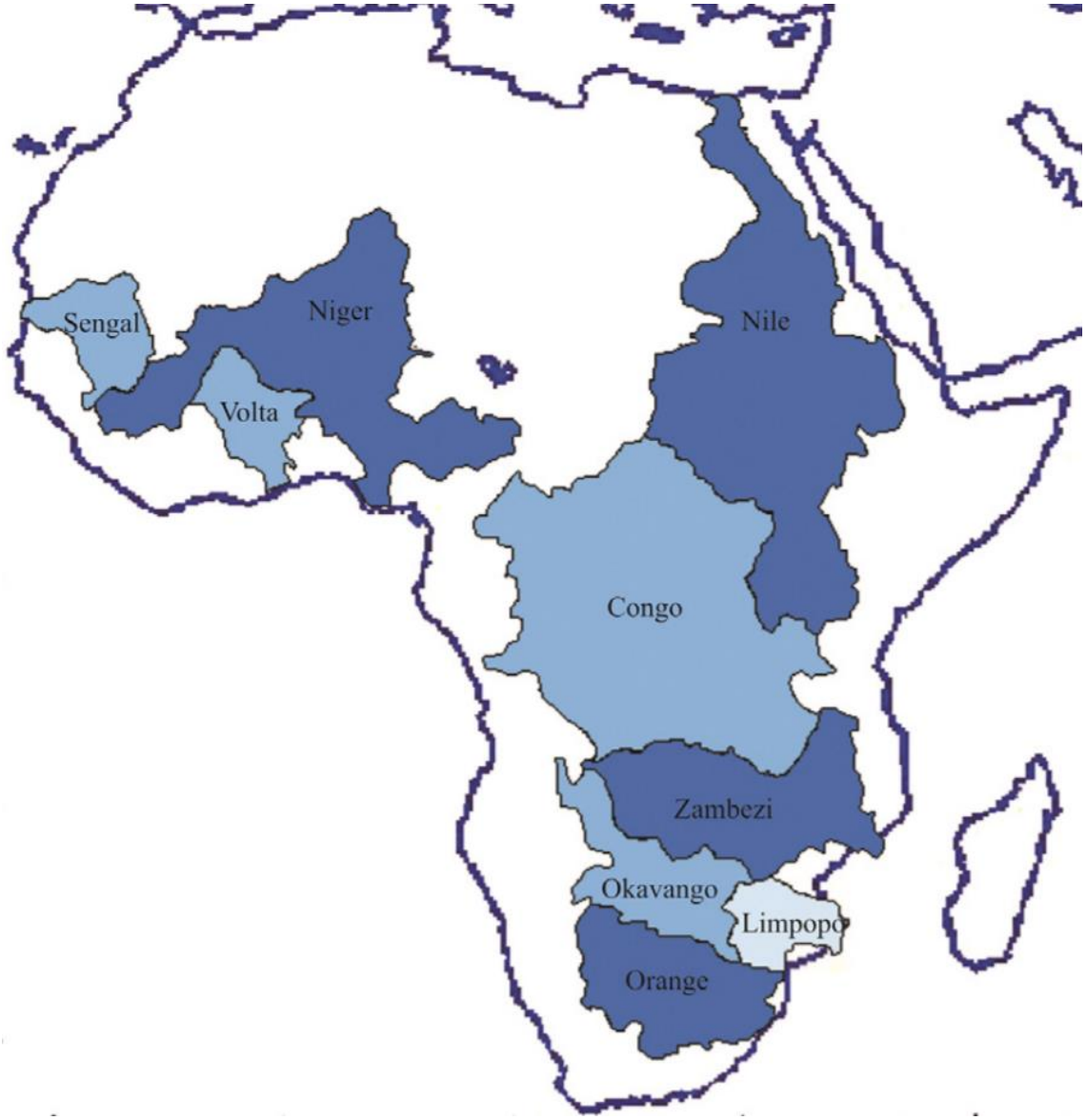
Impact assessment

Water Models

- Hydrologic model
- Crop Model
- Water resources systems model

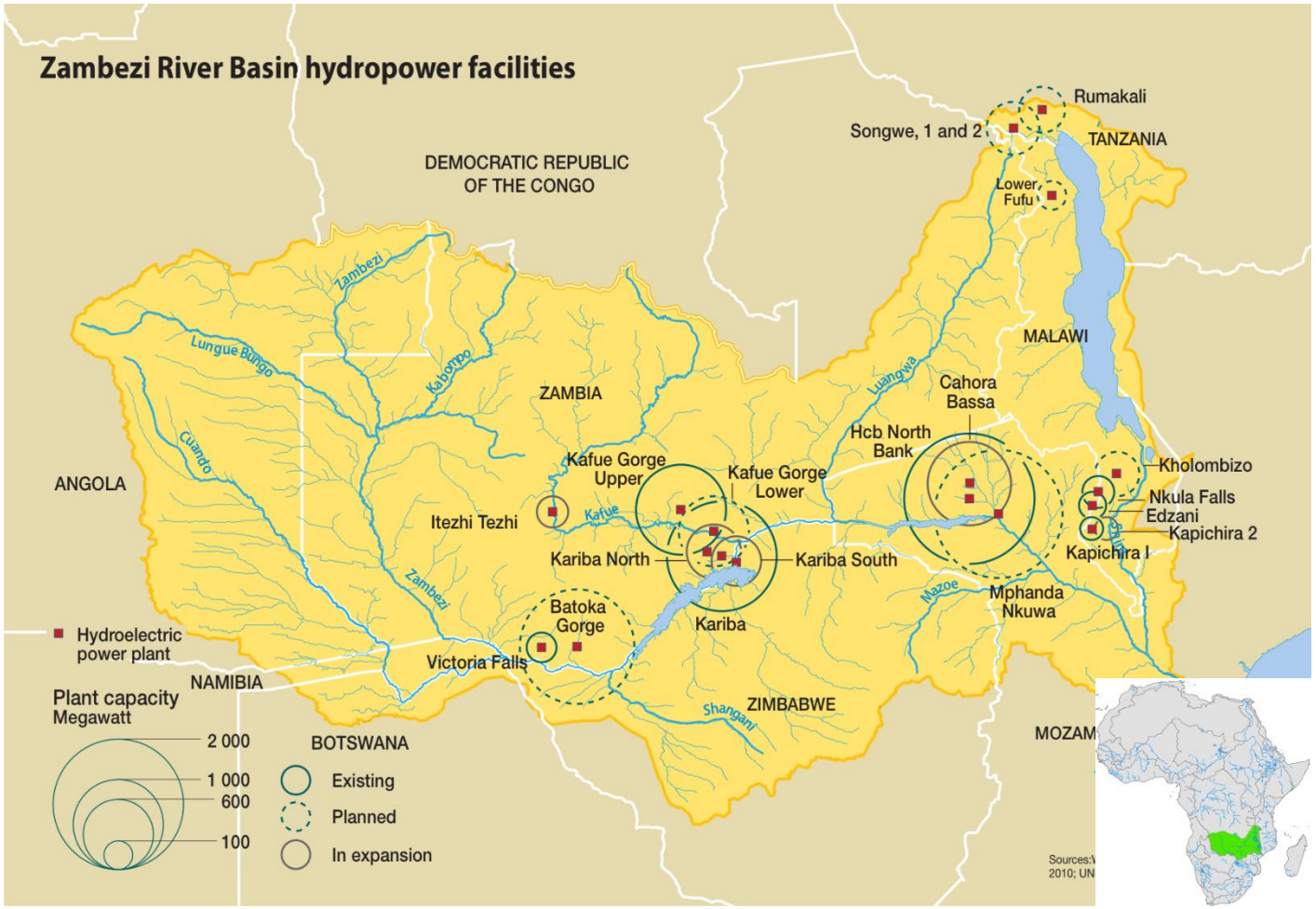
Hybrid Frequency distribution (HFDs)
(Schlosser et al. 2011)

- Two emission scenarios
  - Unconstrained emission (UCE)
  - Level 1 Stabilization (L1S)

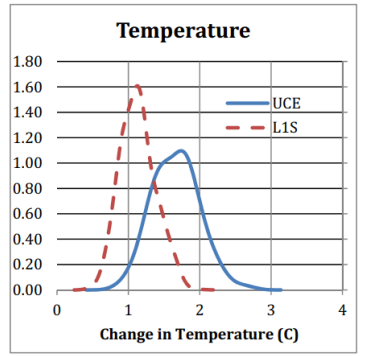


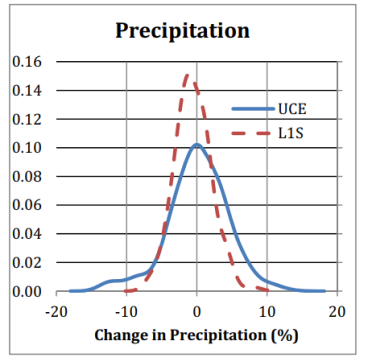
Climate Change impacts on Hydropower : Zambezi

Botswana
Malawi
Namibia
Mozambique
Tanzania
Zambia
Zimbabwe



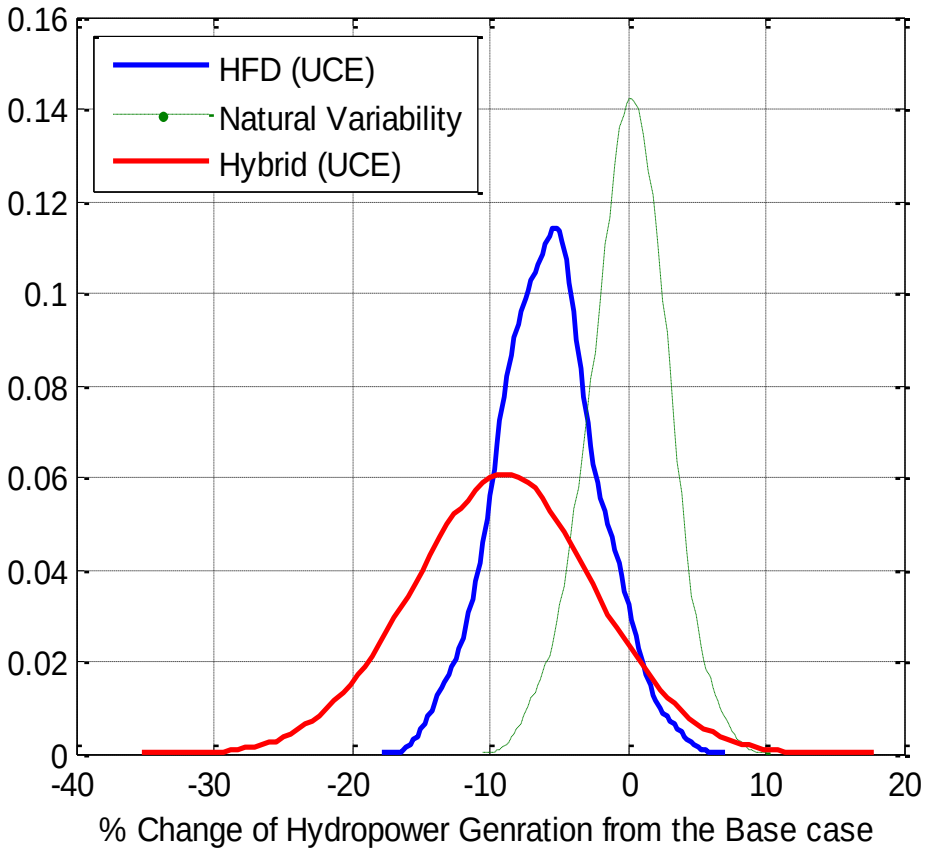
[10th] 50th [90th]	Temperature (C)			Precipitation		
	Base	UCE	L1S	Base (mm)	UCE (%)	L1S (%)
Malawi	21.9	[1.26] **1.64** [2.05]	[0.90] **1.16** [1.52]	1180	[-2.8] **2.5** [8.7]	[-2.8] **1.1** [5.1]
Mozambique	23.8	[1.21] **1.58** [1.99]	[0.86] **1.13** [1.49]	1030	[-6.0] **-1.5** [3.8]	[-4.2] **-1.4** [2.5]
Zambia	21.4	[1.33] **1.74** [2.16]	[0.84] **1.11** [1.45]	1020	[-3.0] **2.0** [8.3]	[-2.9] **0.5** [4.0]
Zimbabwe	21.0	[1.25] **1.68** [2.12]	[0.80] **1.09** [1.43]	692	[-11.6] **-2.6** [5.4]	[-7.1] **-3.0** [2.2]



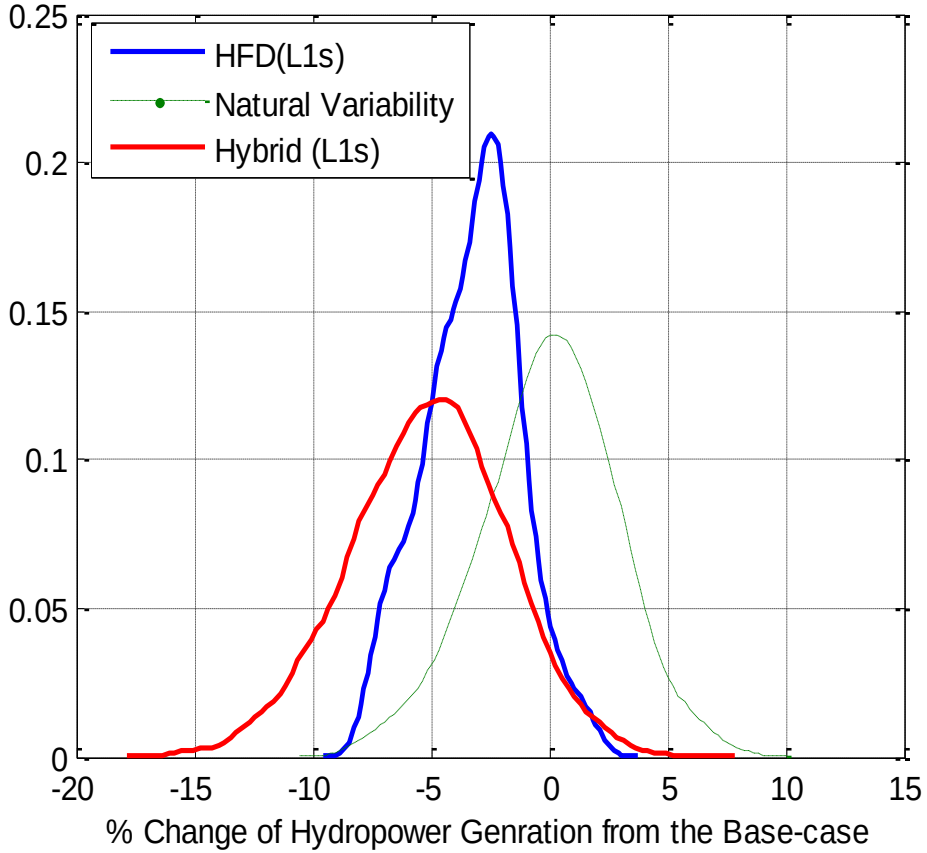


Climate Change impacts on Hydropower : Zambezi

Comparison of Energy generation average for the period of 2045-2050s



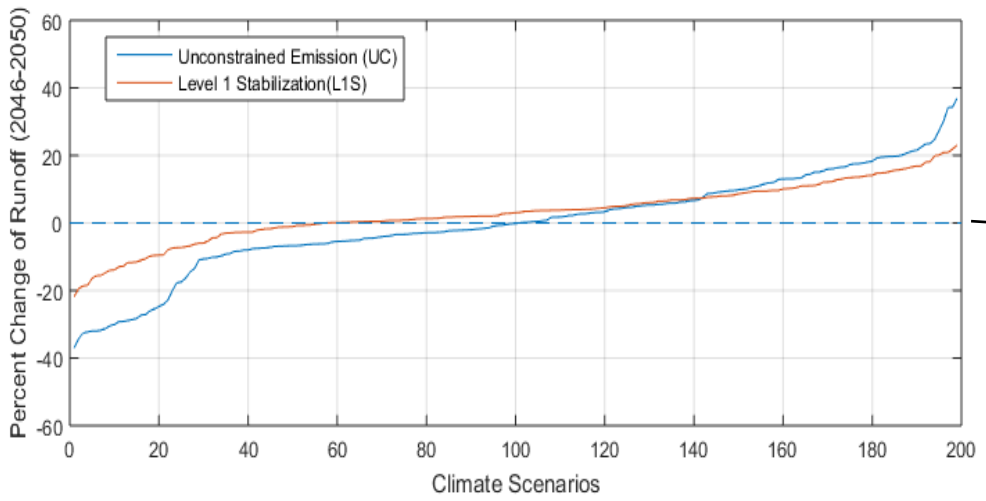
Unconstrained Emission scenarios
no policy action is taken to limit greenhouse



Level 1 Stabilization scenario
Concentration at 560 ppm CO2

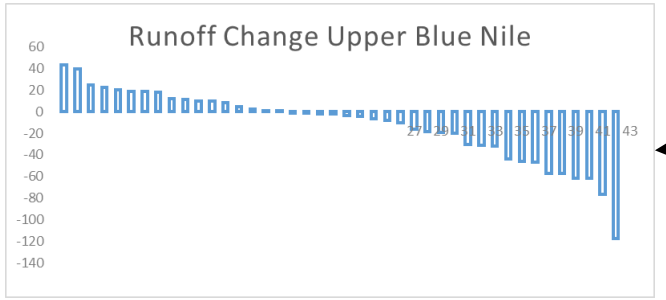
Climate Change impacts on Hydropower : Nile

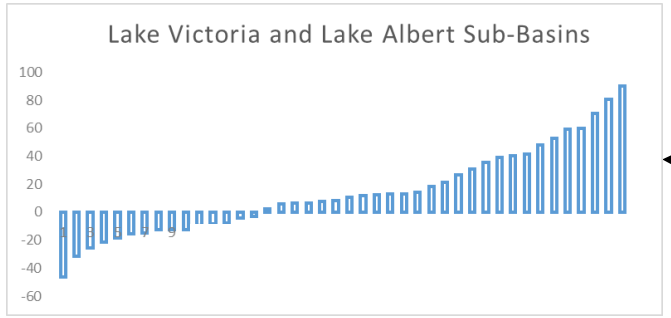
Change in Runoff across Climate scenarios for main Nile flow at Aswan

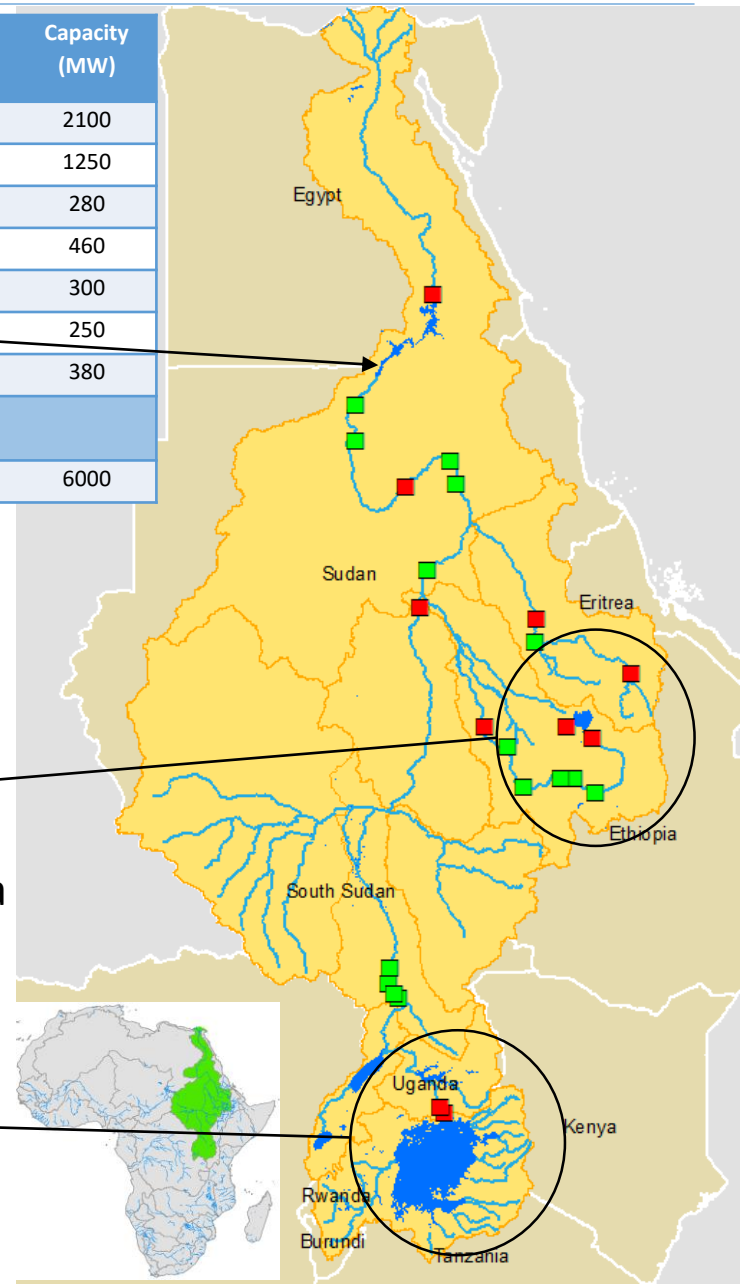


Major existing HP	Capacity (MW)
Aswan Dam	2100
Merowe	1250
Roseires	280
Tana Beles	460
Tekeze	300
Bujagali	250
Nalubaale	380
Under Construction	
GERD	6000

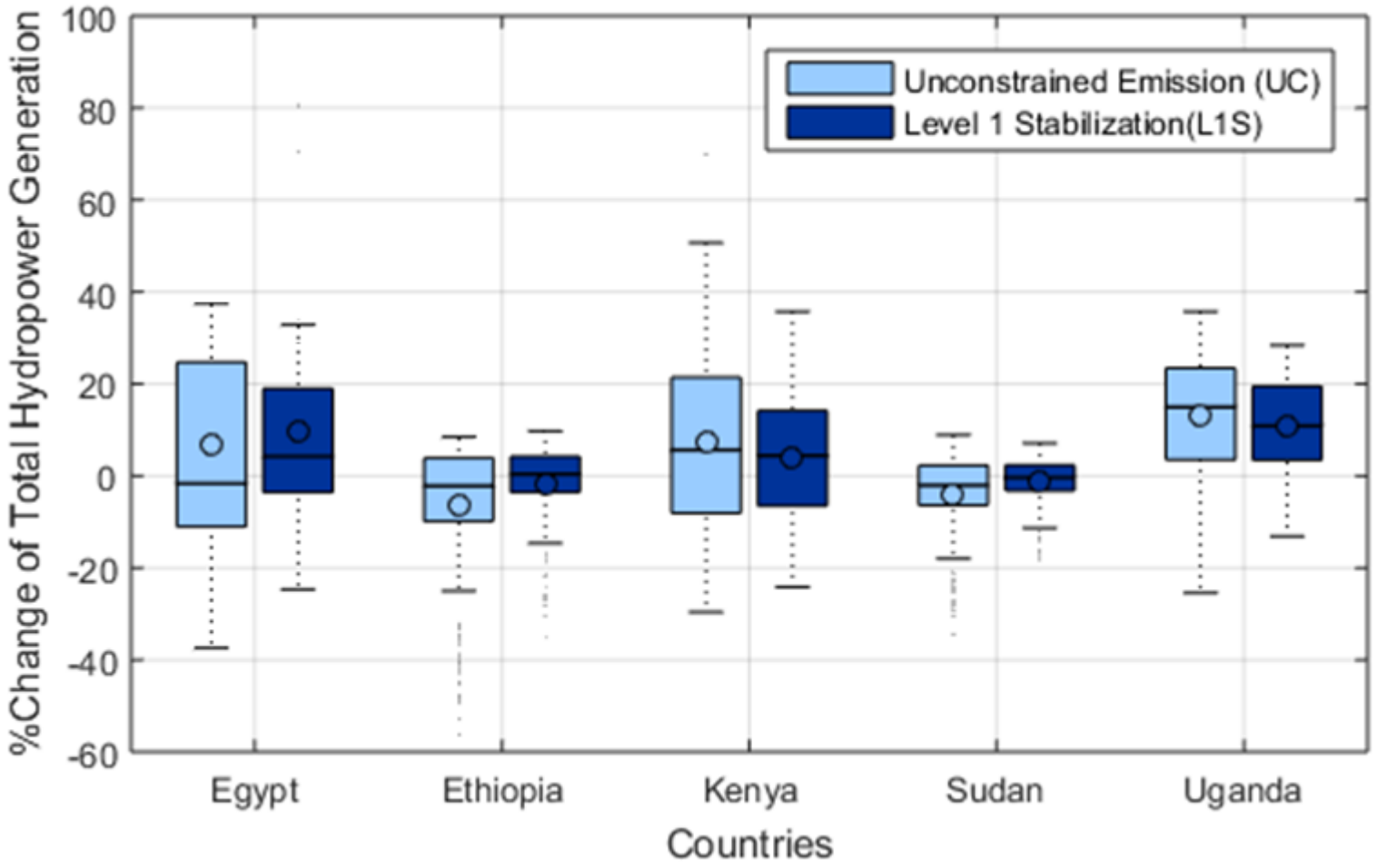
Burundi
Egypt
Eritrea
Ethiopia
Kenya
Rwanda
Tanzania
Sudan
Uganda



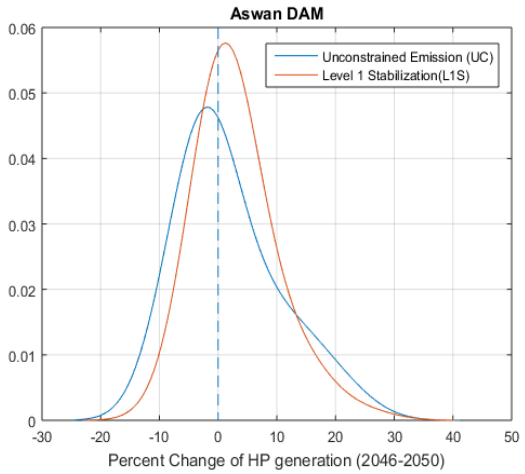


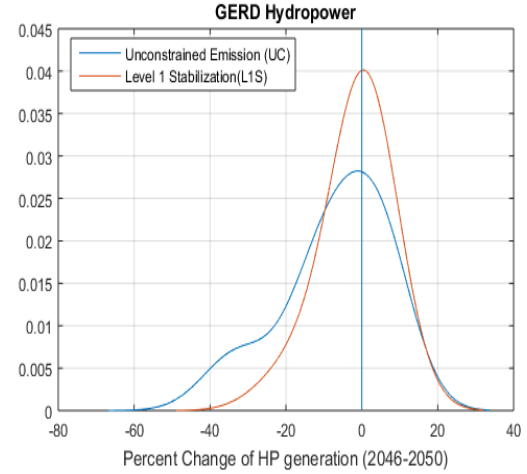


Climate Change impacts on Hydropower : Nile

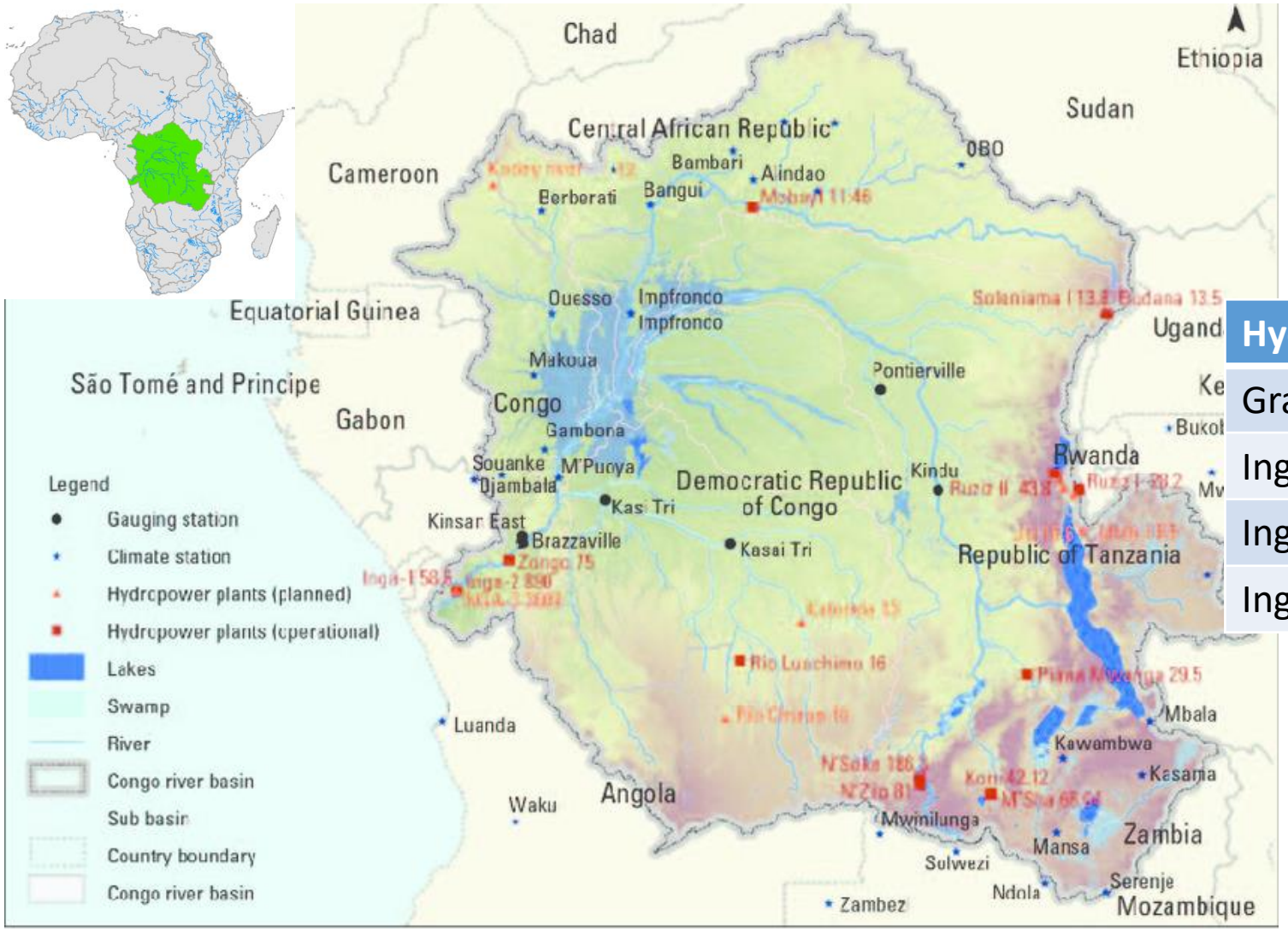


Percent change of Hydropower generation from reference case average over the years 2045-2050 for unconstrained emission (UC) and level 1 stabilization (L1S) climate change scenarios.





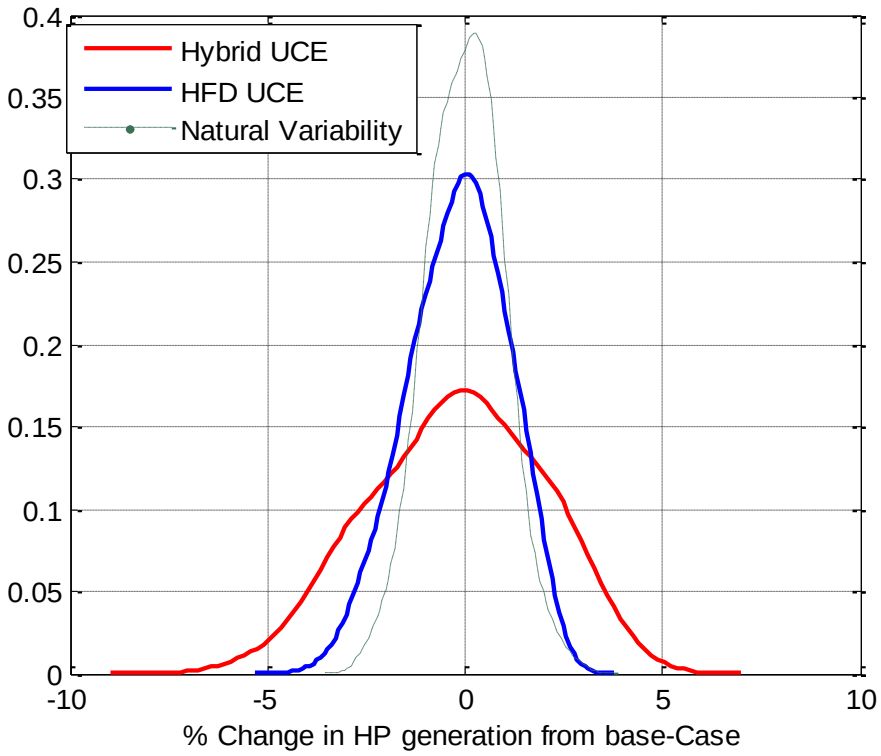
Climate Change impacts on Hydropower : Congo

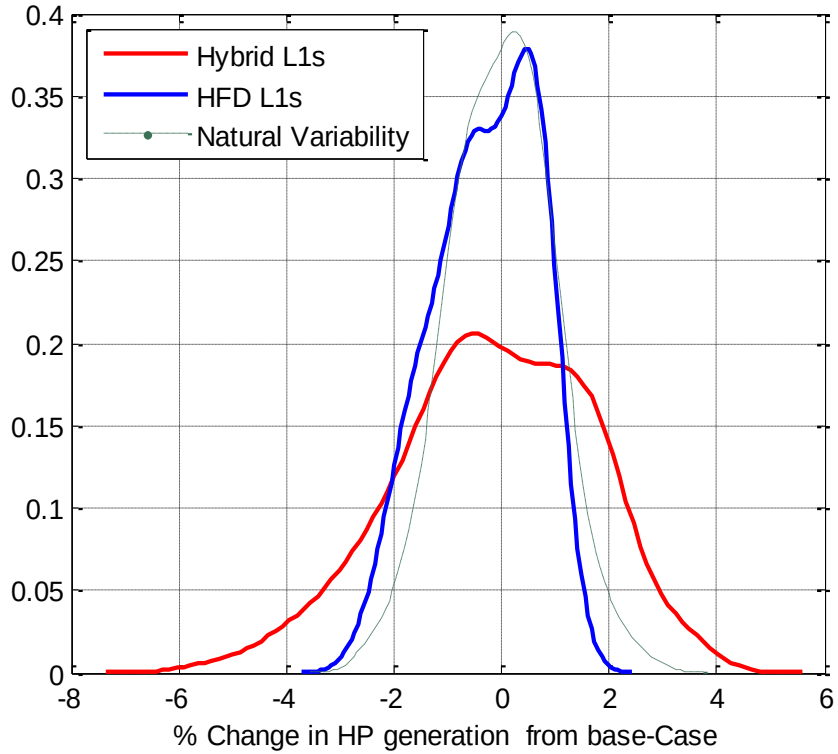


Hydropower Name	Capacity
Grand Inga	40,000 MW
Inga 3	4800 MW
Inga 2	1424 MW
Inga 1	351 MW

Climate Change impacts on Hydropower : Congo

Comparison of energy generation average for the period of 2045-2050s





Unconstrained Emission scenarios
no policy action is taken to limit greenhouse

Level 1 Stabilization scenario
Concentration at 560 ppm CO2

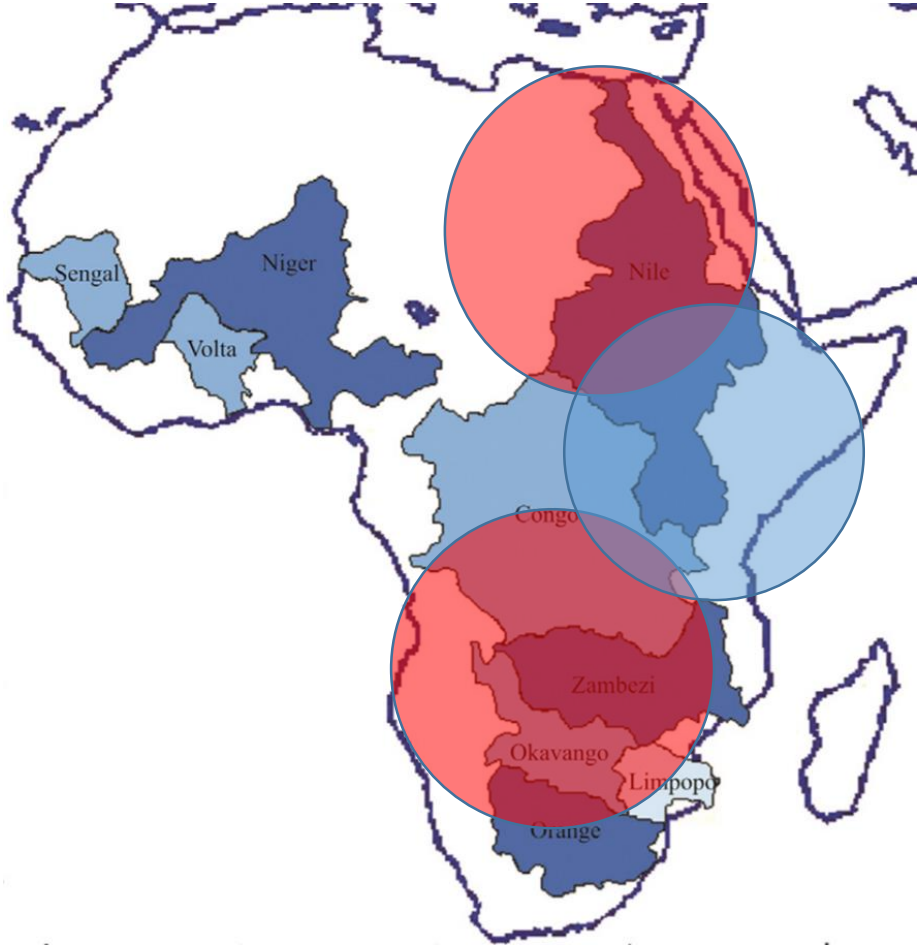
Remarks

Climate Change impact on hydropower generation vary by location

- … Change in Energy generation
- … More risk in extreme values

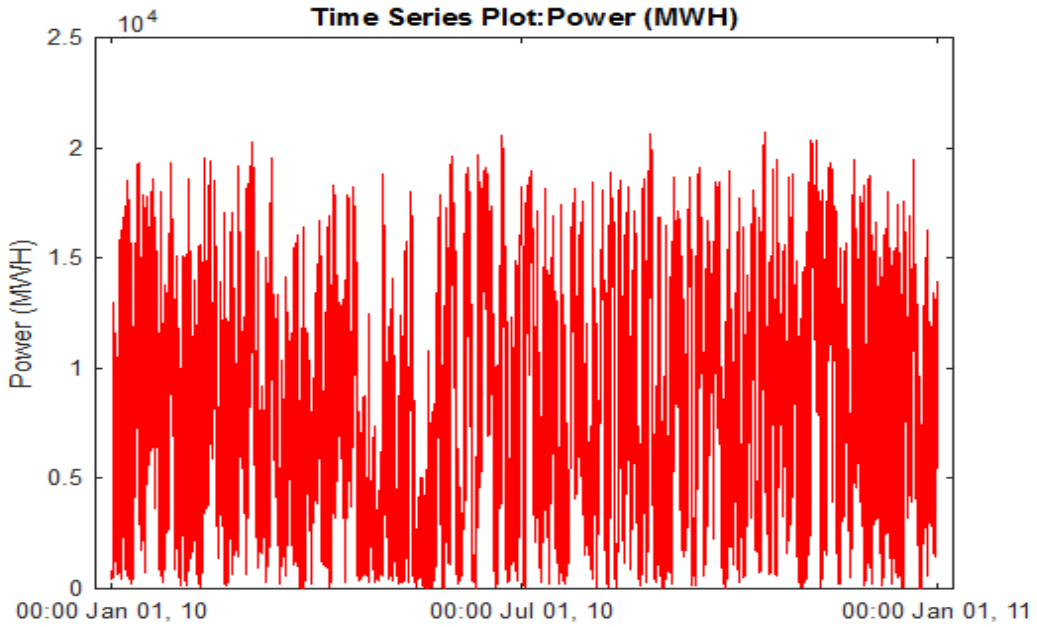
Adaption

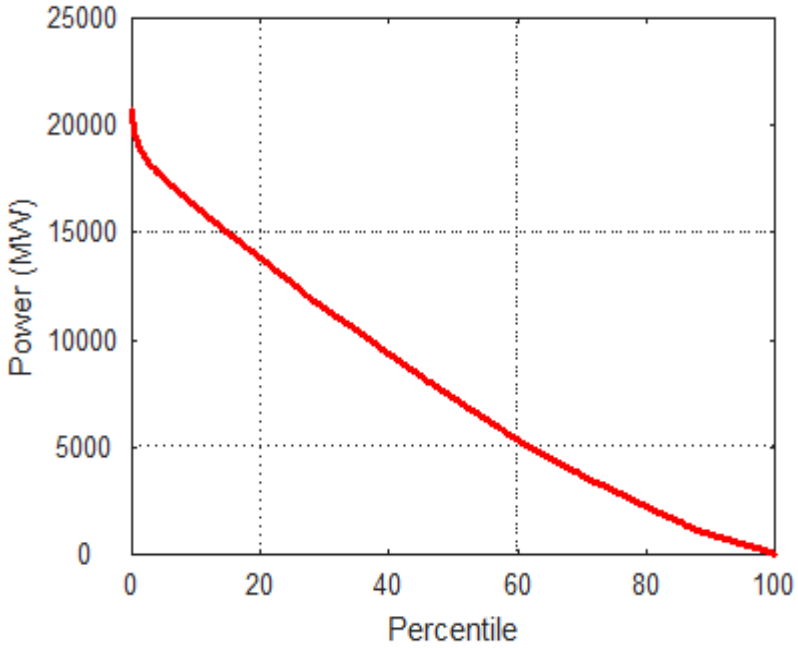
- … to mitigate energy shortage
- … to utilize opportunities



South Africa – Zambezi: More clean energy hydro-wind integration

- High Temporal and Spatial variation of Wind and solar resources
- Inherently intermittent
- Non-dispatchable source of Energy

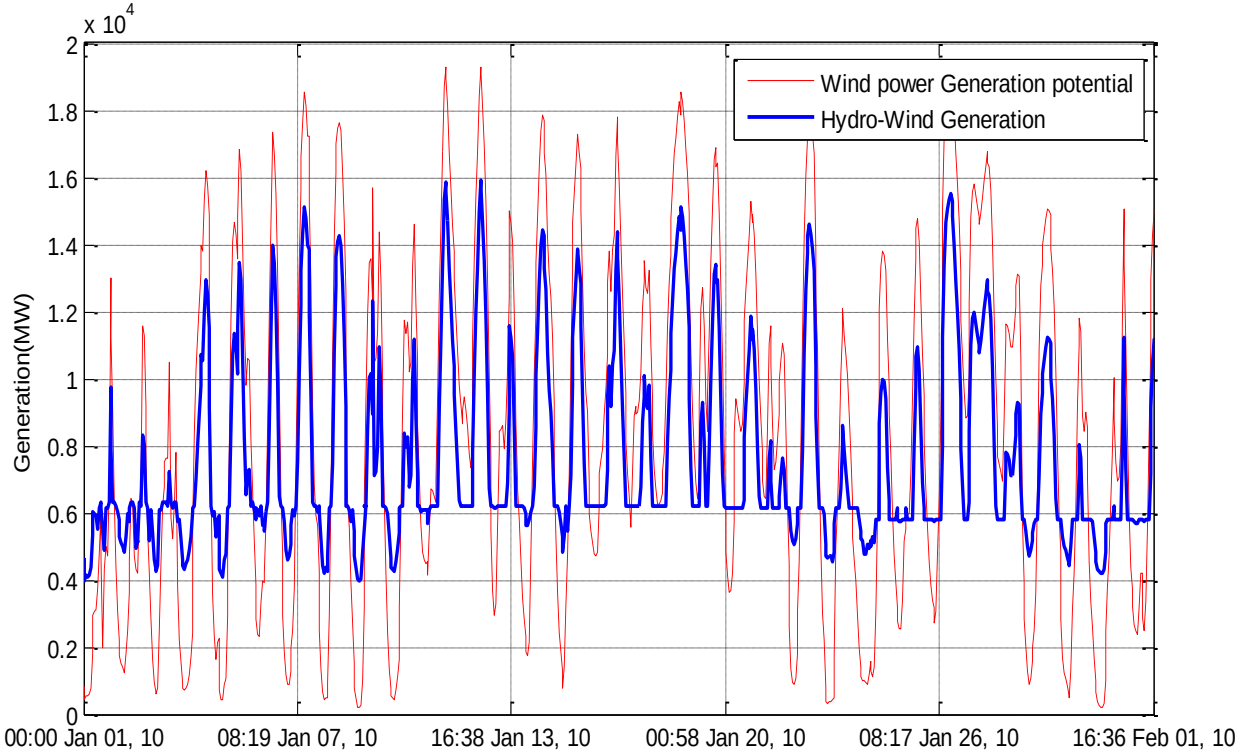


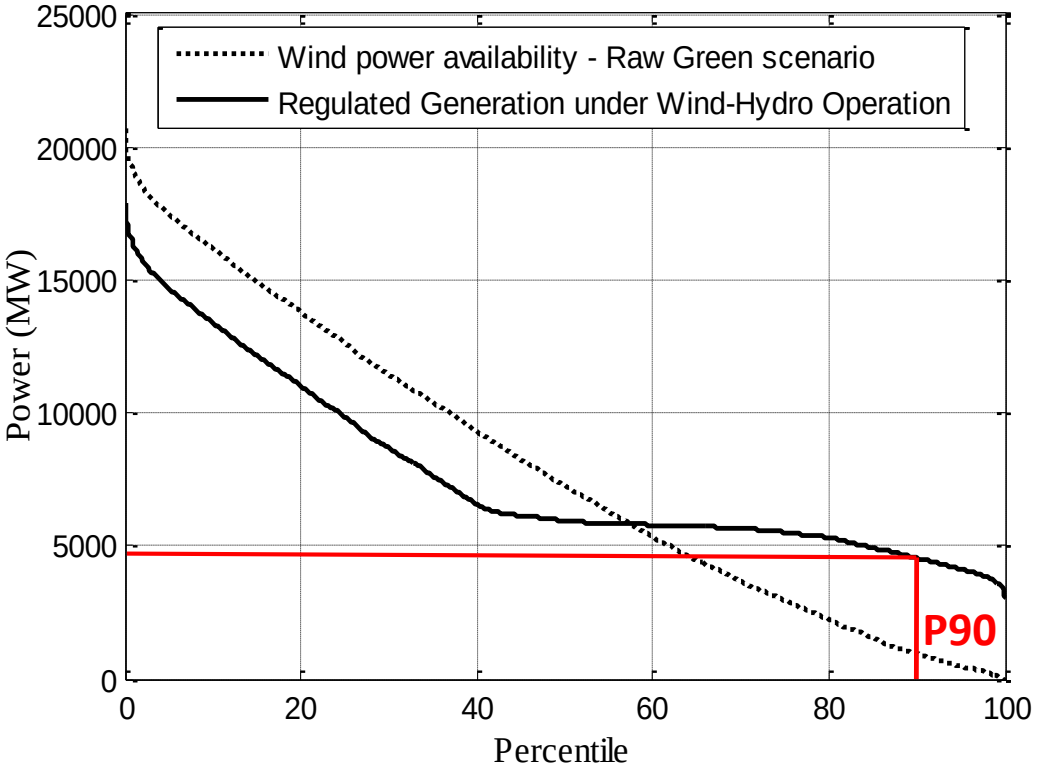


- Regional Hydropower and Storage facility -> battery
- Wind Generating Capacity 23,000 MW
- HP Capacity 9,600 MW

Firm Generation of Combined Power

➢ South Africa





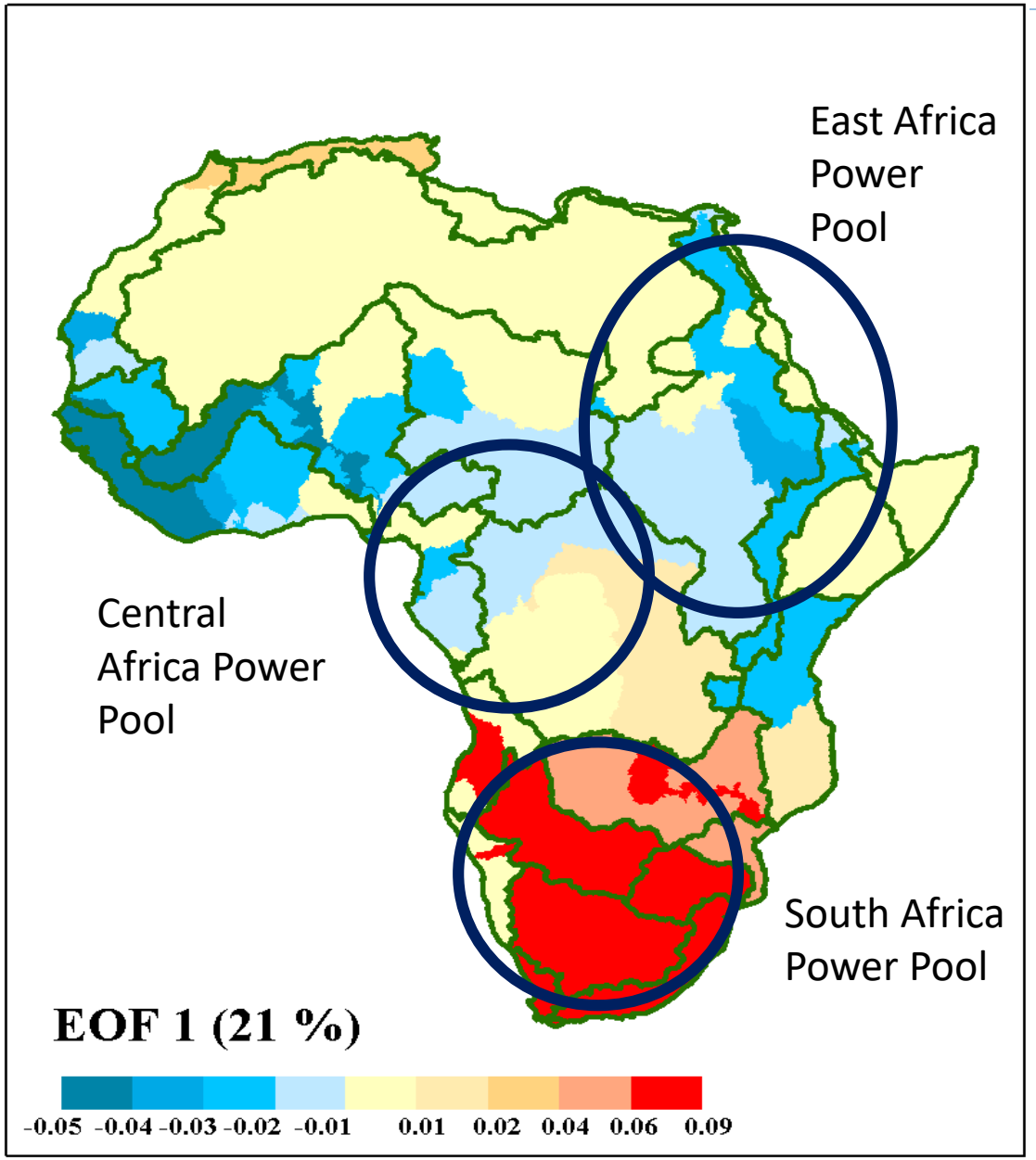
Power duration Curve for wind-hydro Operation

➢ HP facilities in Zambezi

Higher Reliability of meeting Power Target

The Case for Regional Power Pools

Regional power interconnection adaption to climate change?



Conclusion

- No Single direction of impacts for the continent Africa , varies by location
- Climate Changes combined with variability, and change in variability
- Consider adaptations in the context of risk
- Flexible design of infrastructures
- Synergy of renewable resources for adaption
- Regional interconnection for better resilience