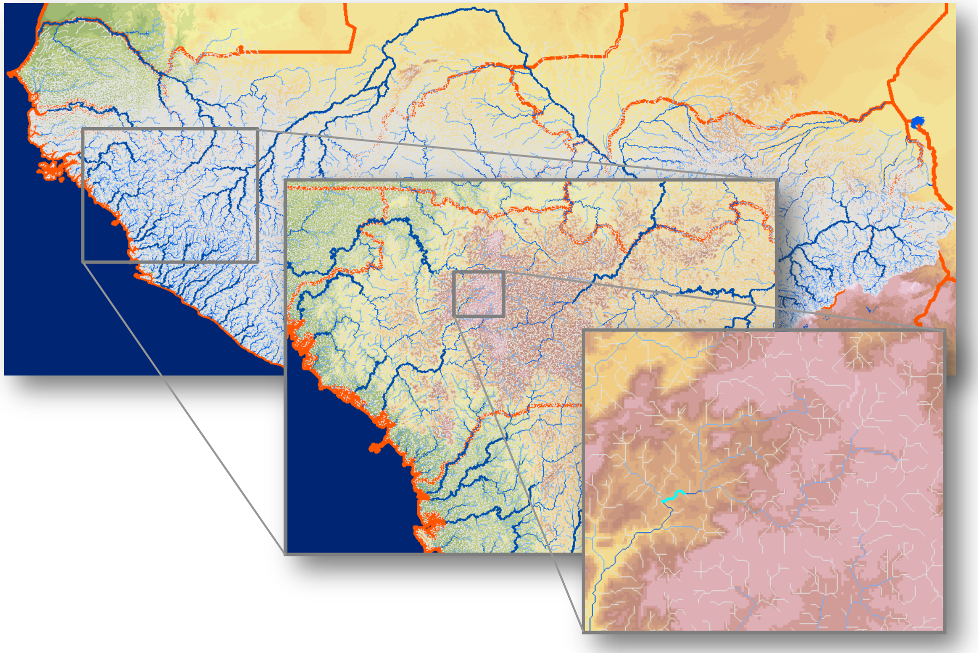
GIS Hydropower Resources Mapping for ECOWAS Region

Session 8: Climate change analysis



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AUSTRIAN DEVELOPMENT COOPERATION

Spanish Cooperation

Training, Dakar, Senegal, July 2016

Trainer: Harald Kling

Pöyry, Hydro Consulting, Hydropower, Austria

Climate change analysis

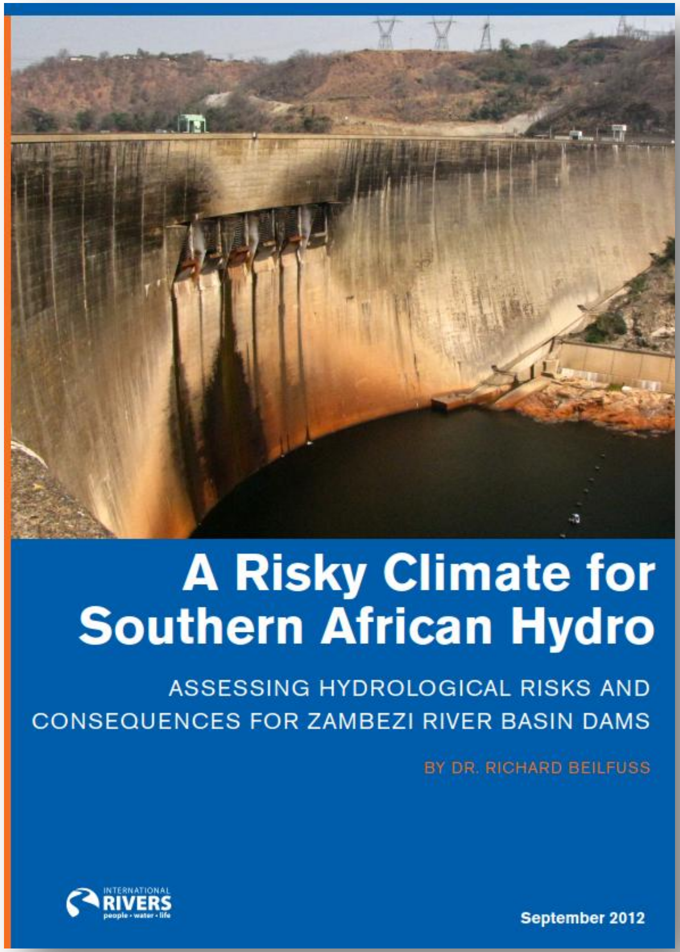
Overview

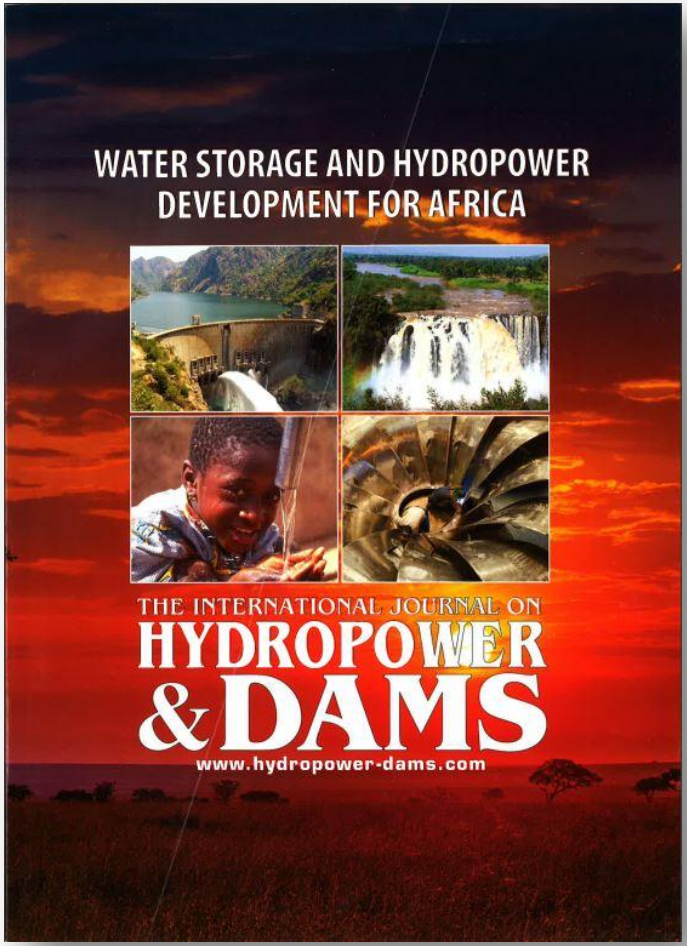
- Climate change projections for Africa
  - Example: Zambezi basin

- Group work
  - Climate change projections for rivers in West Africa
  - Results for Zambezi used for comparison

Climate change impacts on hydropower

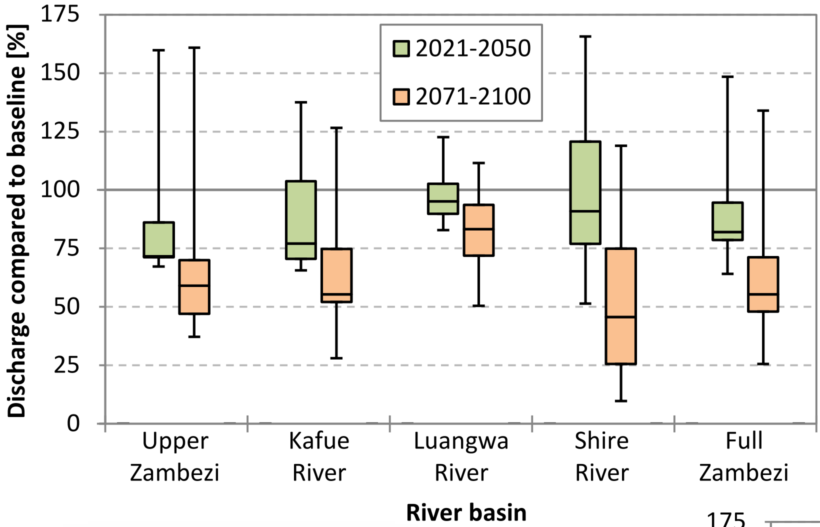
Previous studies for Africa





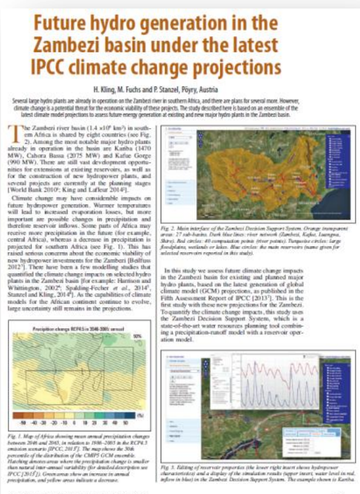
Future decrease projected for Southern Africa

Future discharge



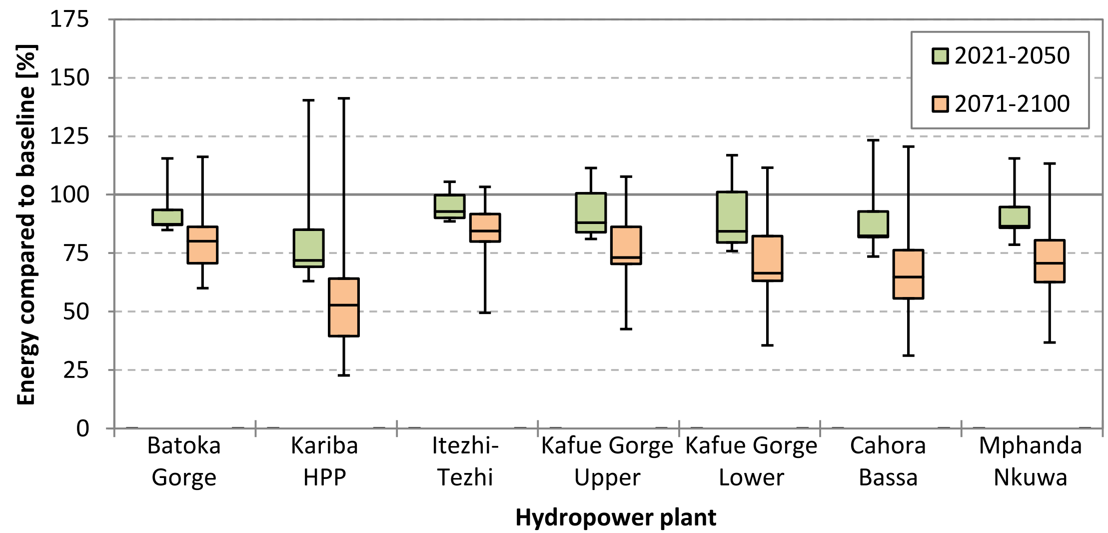
Such climate change projections raise concerns for hydropower investors.

➡ **Future discharge in West Africa?**


Future hydro generation in the Zambezi basin under the latest IPCC climate change projections

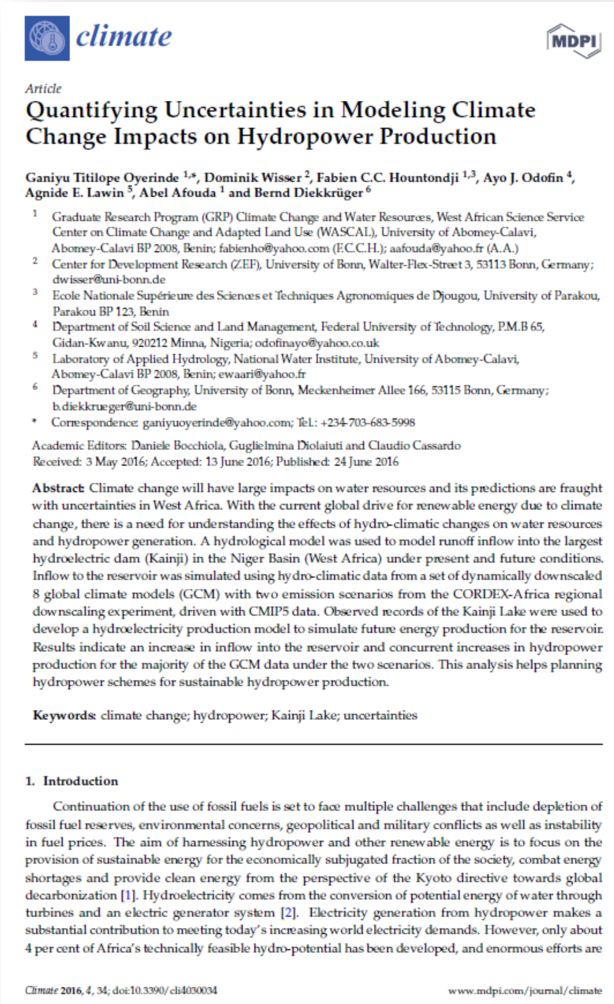
H. Kling, M. Fuchs and P. Stanzel, Pöyry, Austria

Future energy generation



Climate change projection for Kainji HPP at Niger River

New scientific publication using CORDEX data



climate MDPI

Article

Quantifying Uncertainties in Modeling Climate Change Impacts on Hydropower Production

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Abstract: Climate change will have large impacts on water resources and its predictions are fraught with uncertainties in West Africa. With the current global drive for renewable energy due to climate change, there is a need for understanding the effects of hydro-climatic changes on water resources and hydropower generation. A hydrological model was used to model runoff inflow into the largest hydroelectric dam (Kainji) in the Niger Basin (West Africa) under present and future conditions. Inflow to the reservoir was simulated using hydro-climatic data from a set of dynamically downscaled 8 global climate models (GCM) with two emission scenarios from the CORDEX-Africa regional downscaling experiment, driven with CMIP5 data. Observed records of the Kainji Lake were used to develop a hydroelectricity production model to simulate future energy production for the reservoir. Results indicate an increase in inflow into the reservoir and concurrent increases in hydropower production for the majority of the GCM data under the two scenarios. This analysis helps planning hydropower schemes for sustainable hydropower production.

Keywords: climate change; hydropower; Kainji Lake; uncertainties

1. Introduction

Continuation of the use of fossil fuels is set to face multiple challenges that include depletion of fossil fuel reserves, environmental concerns, geopolitical and military conflicts as well as instability in fuel prices. The aim of harnessing hydropower and other renewable energy is to focus on the provision of sustainable energy for the economically subjugated fraction of the society, combat energy shortages and provide clean energy from the perspective of the Kyoto directive towards global decarbonization [1]. Hydroelectricity comes from the conversion of potential energy of water through turbines and an electric generator system [2]. Electricity generation from hydropower makes a substantial contribution to meeting today's increasing world electricity demands. However, only about 4 per cent of Africa's technically feasible hydro-potential has been developed, and enormous efforts are

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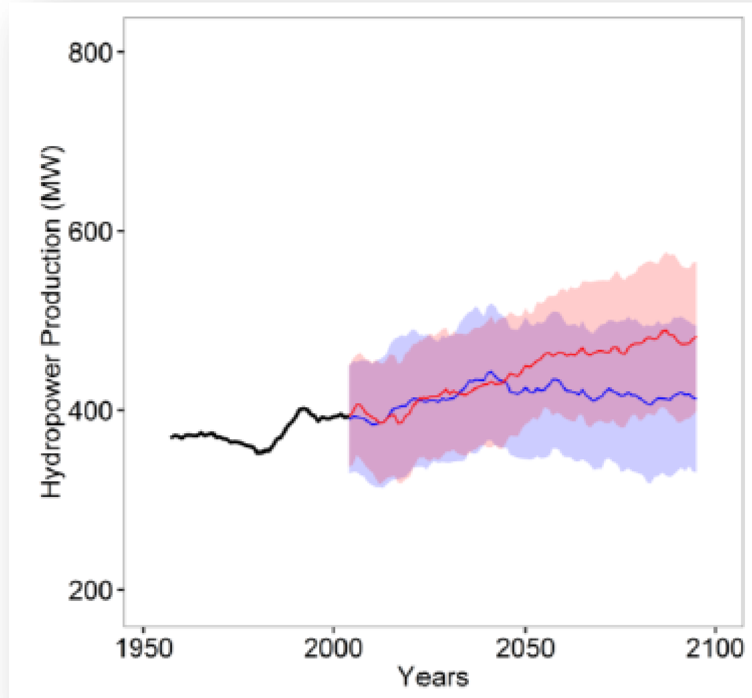
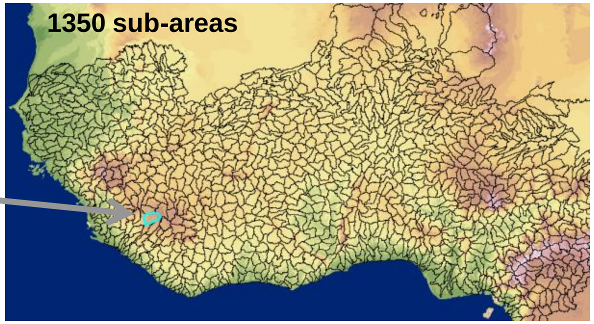
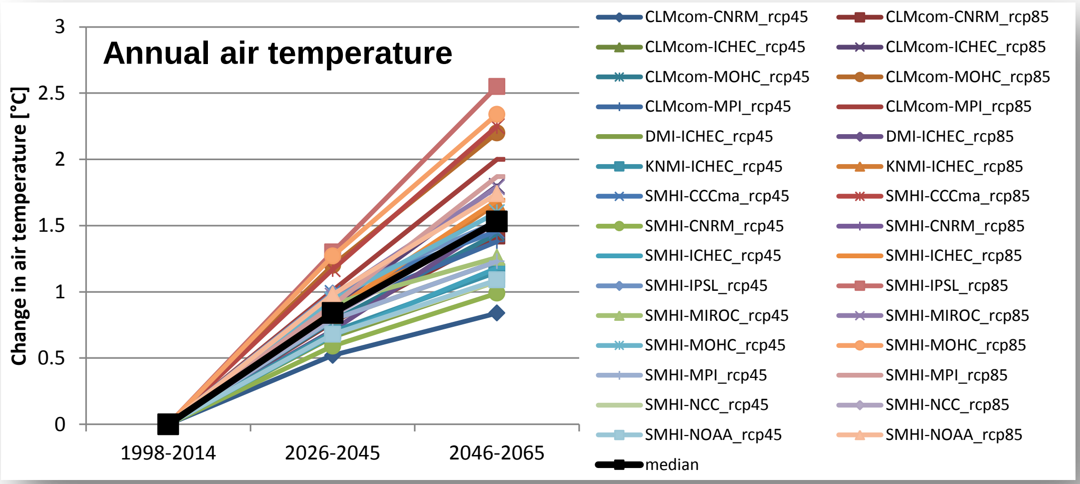


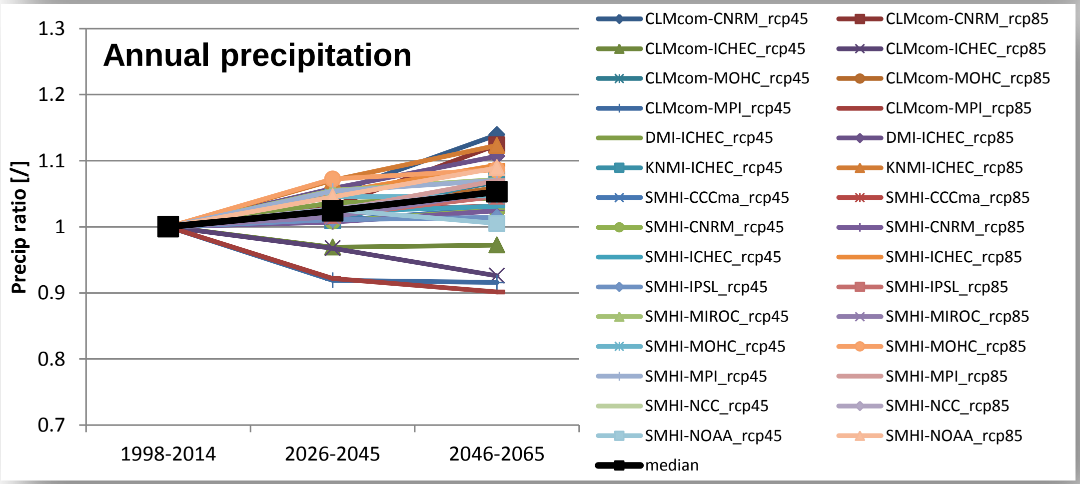
Figure 7. Ensemble median projected annual hydropower production in Kainji lake; black lines represent the historical data, red lines are RCP8.5, blue lines are RCP4.5 and standard deviations across 8 GCMs are showcased in the surrounding bounds.

Climate change

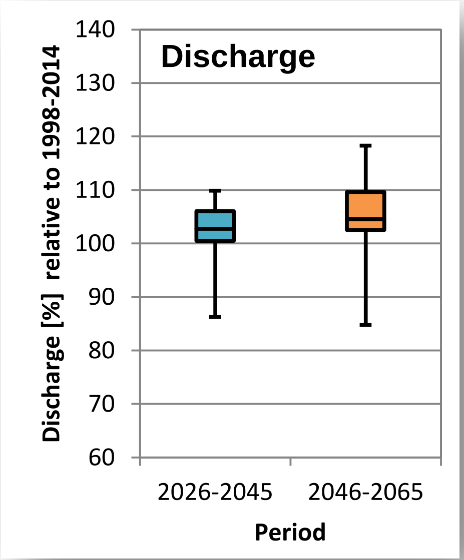
Example for upper Makona River (Guinea)







Water balance model



Climate change

Show river network
Zoom to Kainji HPP
Click on reaches and show attributes
Explain Q_2035_P50 et al.

switch to GIS presentation...

Group work

Climate change projections for selected rivers

- Groups of 3-4 people (same as before)
- Each group can select a river (or two)
- We will query the climate change projection for future discharge in GIS
- We will summarize the results in a table

Group work

Climate change projections for selected rivers

Projected change in future discharge (2026-2045 compared to 1998-2014)

River	Lower quartile	Median	Upper quartile
Zambezi	-21 %	-18 %	-6 %
your selected river...			
Mano	+ 1.3 %	+ 4.5 %	+ 7.2 %
Gambia	- 9.1 %	- 2.7 %	+ 11.1 %
Cavalla	- 1.3 %	+ 3.5 %	+ 14.4 %
Sewa	- 0.4 %	+ 2.8 %	+ 6.4 %
Senegal	- 9.2 %	- 2.6 %	+ 4.7 %
Corubal	- 7.6 %	- 1.3 %	+ 4.8 %
Volta	- 11.5 %	- 2.3 %	+ 4.5 %
Geba	- 20.2 %	- 7 %	+ 7.2 %

Overall summary of training

- Day 1: General overview about new GIS layers
  - Existing hydropower plants layer
  - Climatic zones layer
  - River network layer
  - Sub-areas layer
  - Country reports
  - Climate change (incorporated into other layers)

- Day 2: Group work and practice examples
  - Hydropower plants classification
  - Hydropower plant size & Power generation
  - Water balance analysis
  - Climate change analysis

- New GIS layers will be online in ECOWREX within the next months

- Additional training using ECOWREX system is planned

End

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