



Climate Information for Integrated  
Renewable Electricity Generation

## Reservoir operation under climate variability & Hydropower for grid balancing in hybrid electricity systems

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Niamey, 02. October 2018



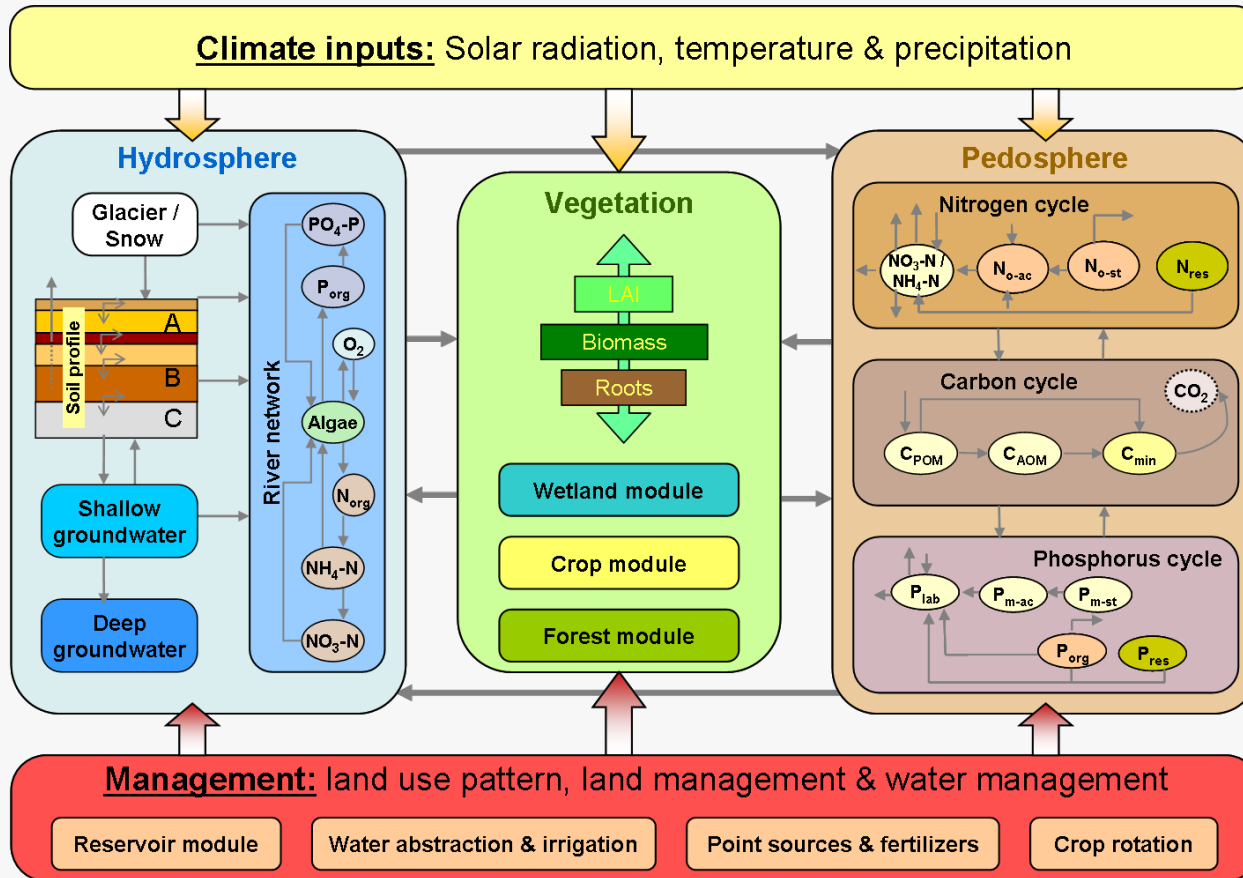


# Overview

- I. Process-based eco-hydrological model SWIM**
- II. Hydropower generation - Example from the Upper Niger Basin**
- III. Hydropower for grid balancing in hybrid electricity systems**

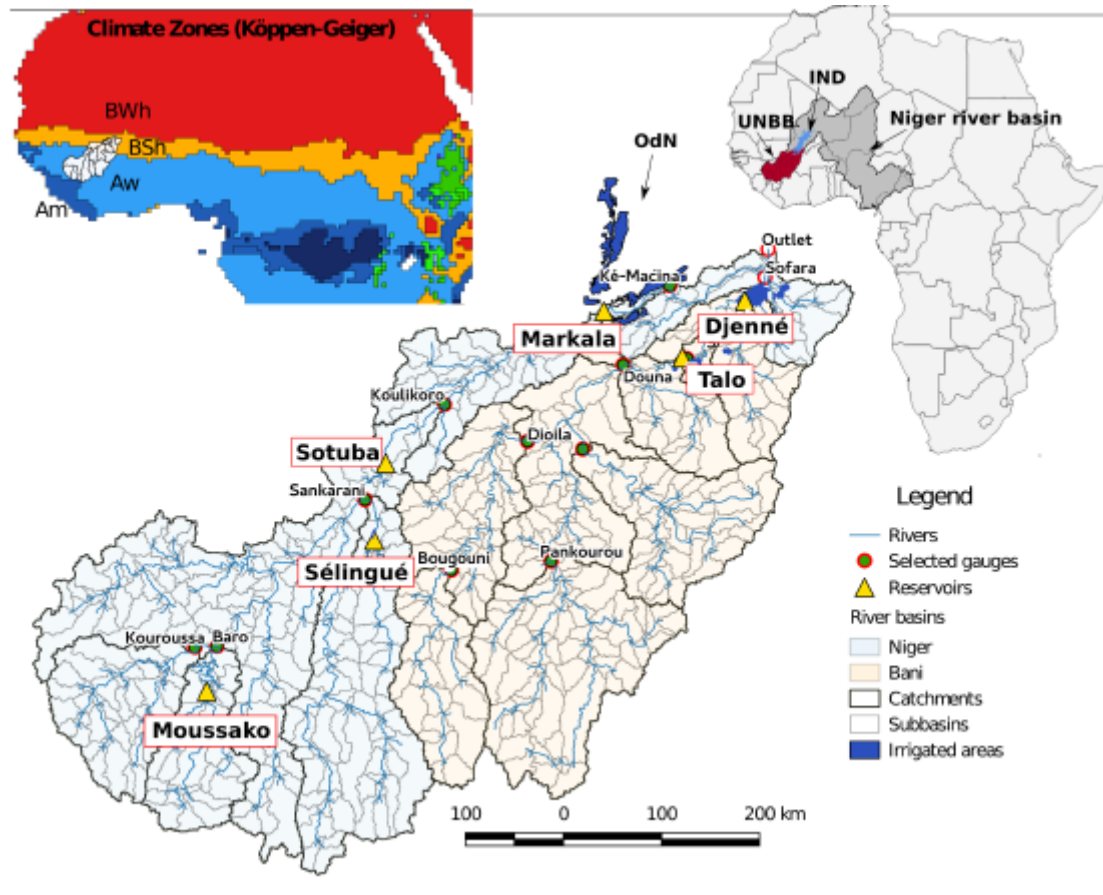


# Process-based eco-hydrological model SWIM (Soil and Water Integrated Model)





# Example from the Upper Niger Basin



Map of the Upper Niger and Bani River basins with SWIM-catchments and sub-basins, discharge gauges, reservoirs, irrigated areas, and climate zones.

Liersch et al., 2018



# Example - Moussako reservoir

- **Moussako reservoir with three dimensions:**
  - 1. Large: Dam height **402 m a.s.l.**, storage volume of **4.9 BCM**
  - 2. Medium: Dam height **396 m a.s.l.**, storage volume of **2.8 BCM**
  - 3. Small: Dam height 388.5 m a.s.l., storage volume of 1.17 BCM



# Example - Moussako reservoir

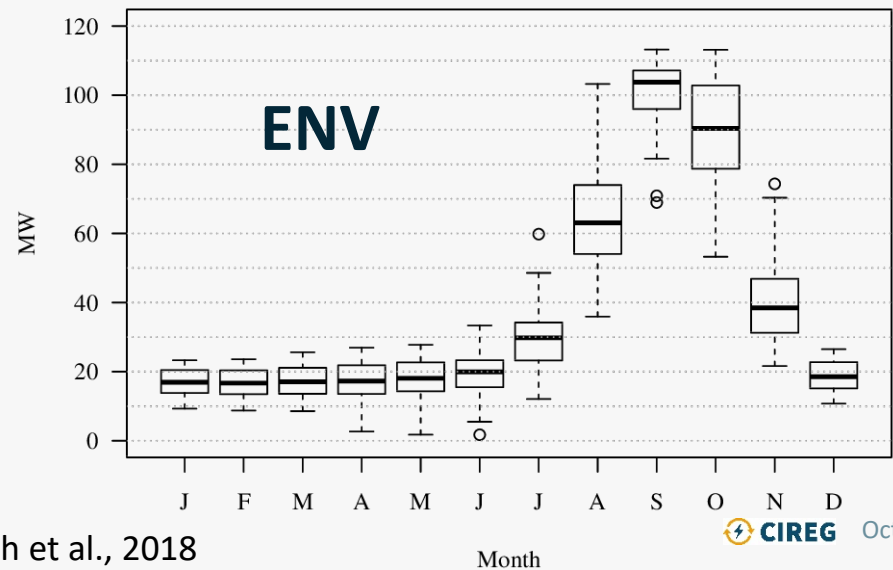
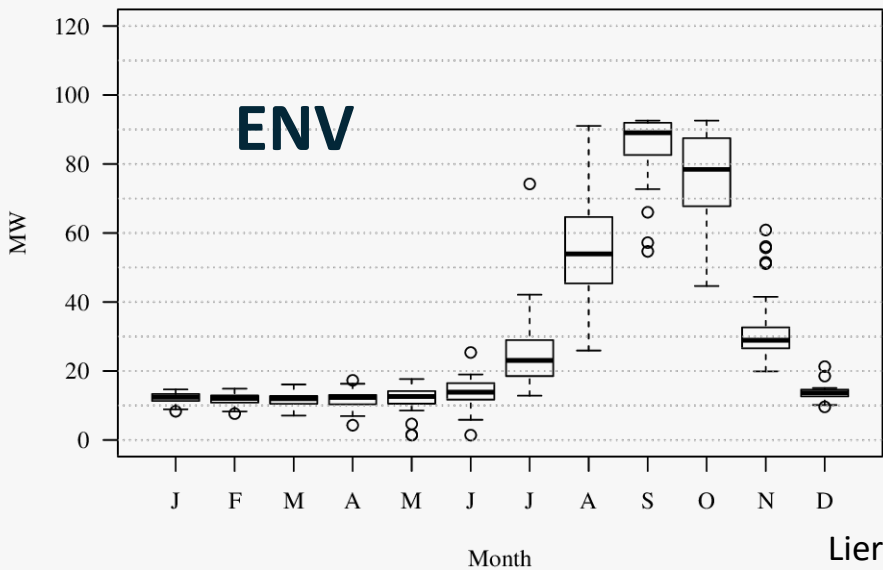
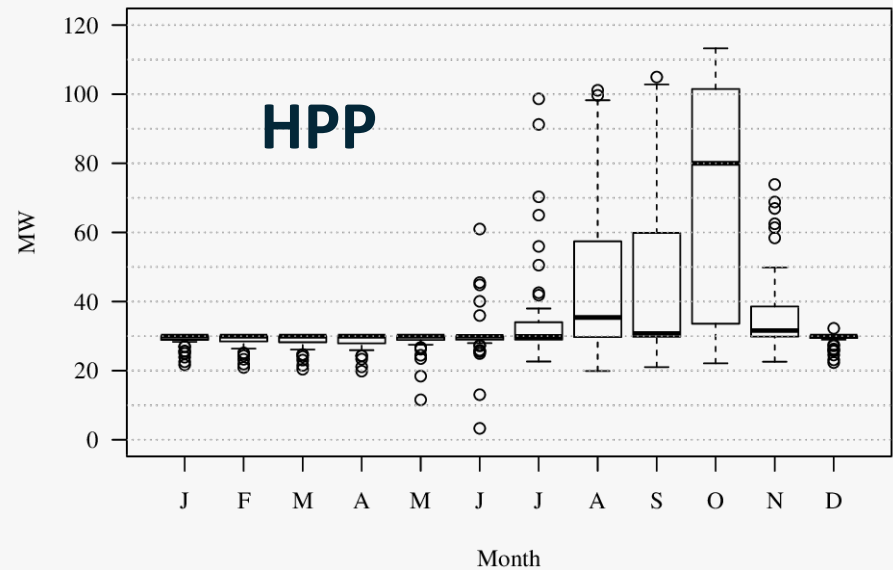
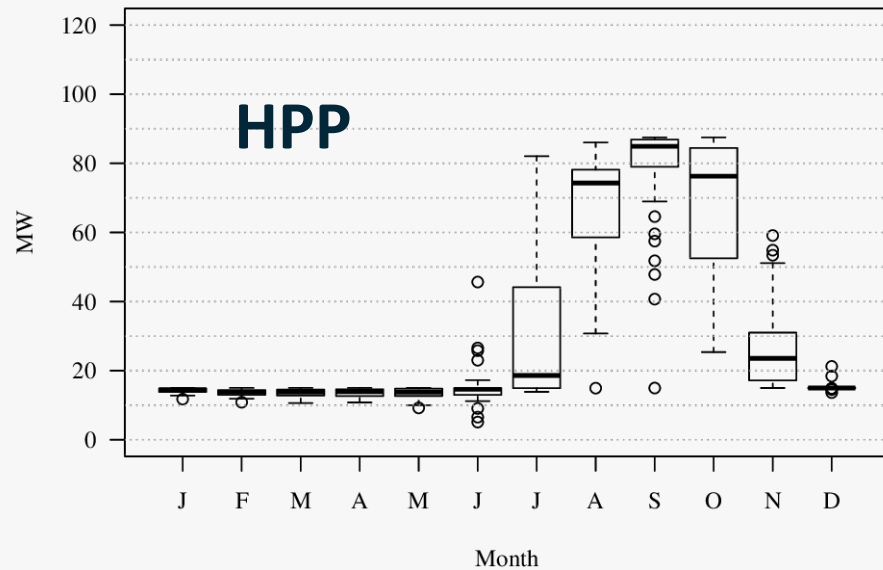
- **Two different operation rules:**
  - priority on hydropower production (**HPP**),
  - preserve the natural flow regime (**ENV**) downstream (meet the  $Q_{90}$  discharges of the natural flows during the rainy season (July to November in the period 1961–2000) and to generate 13MW in the dry season.



# Example - Hydropower generation

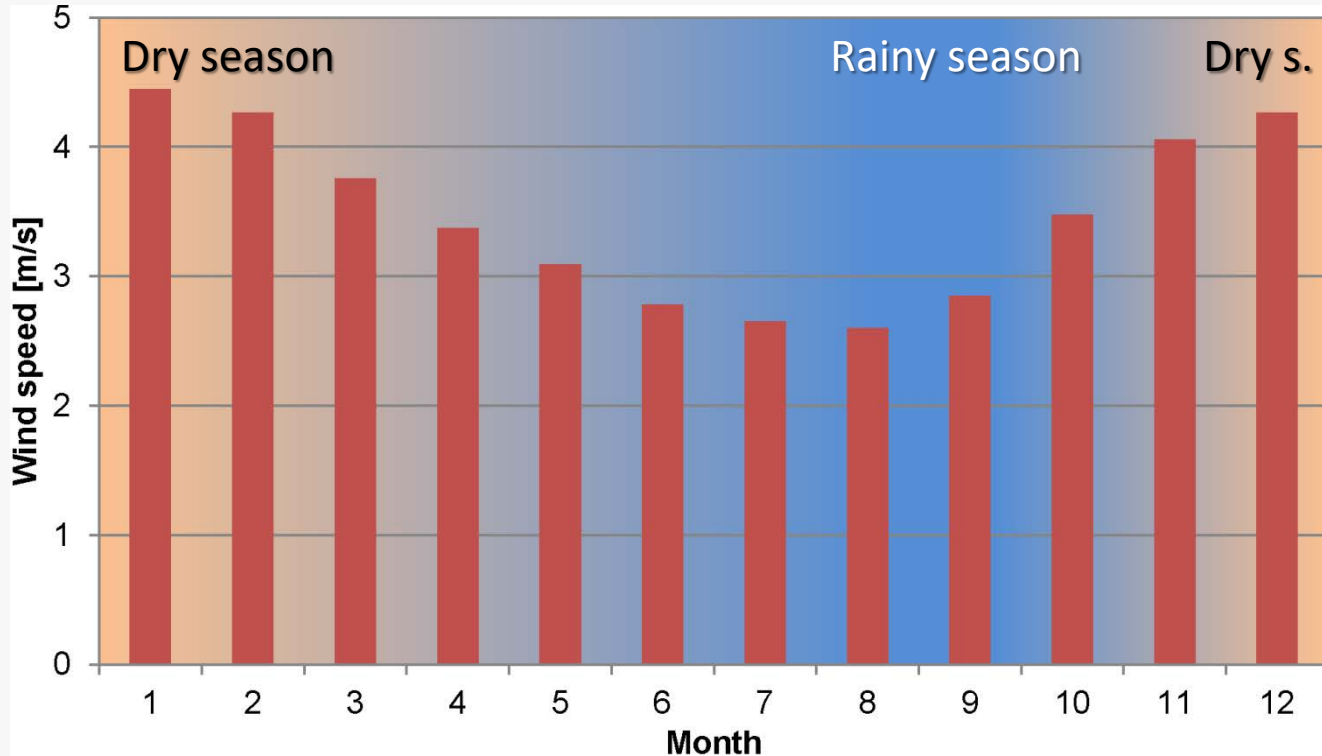
## 396 m a.s.l. & 2.8 BCM

## 402 m a.s.l. & 4.9 BCM





# Hydropower for grid balancing in hybrid electricity systems (monthly)

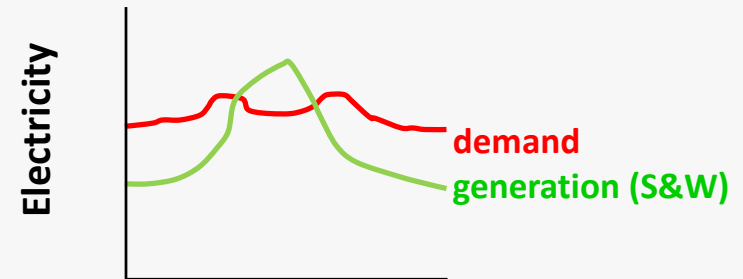
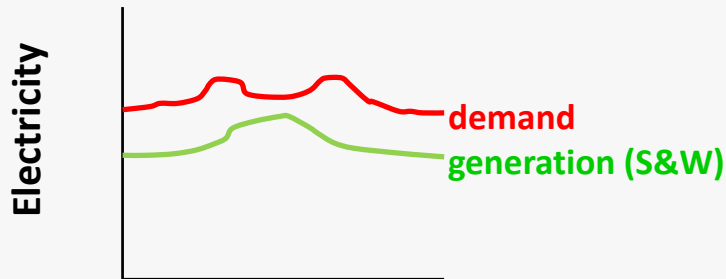
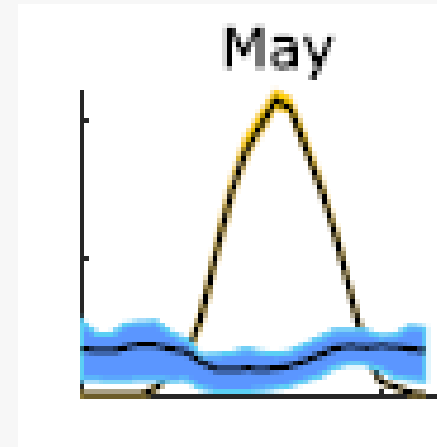
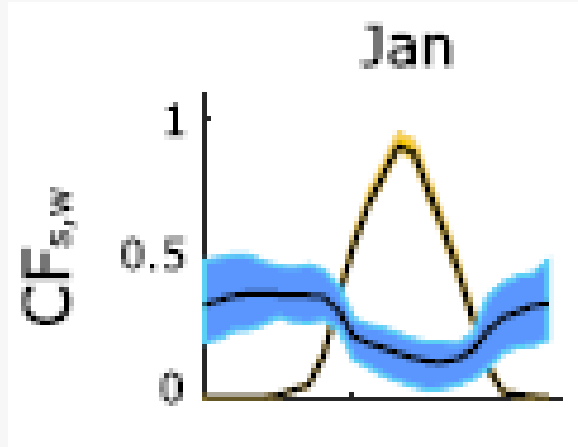


Hydropower:	low	high	low
Wind power:	high	low	high
Solar power:	high	low	high



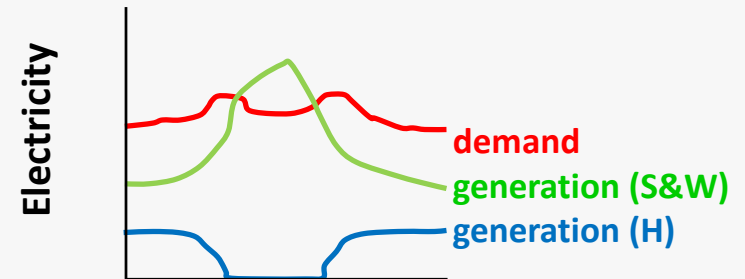
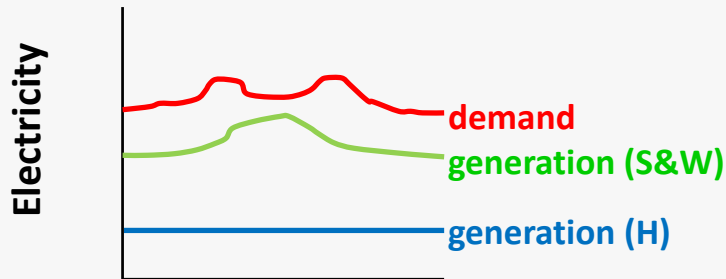
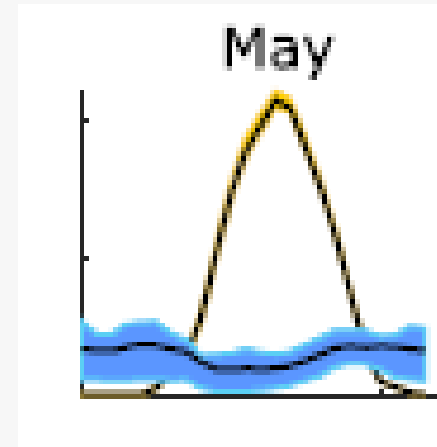
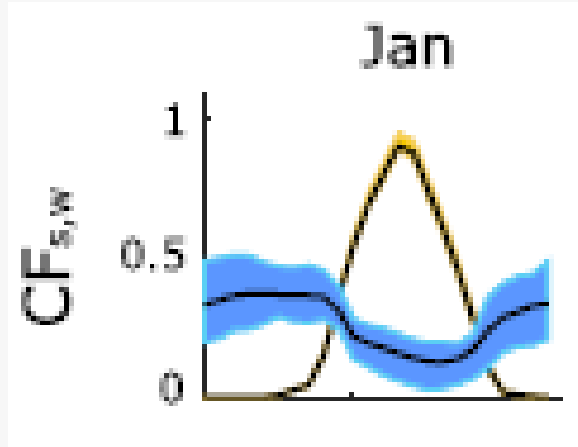


# Hydropower for grid balancing in hybrid electricity systems (hourly)





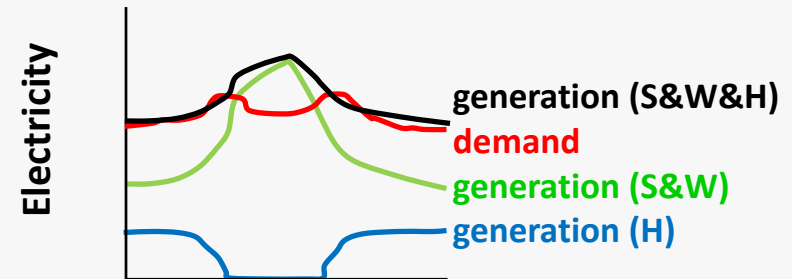
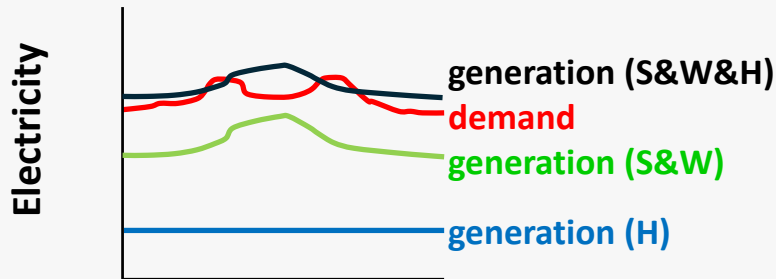
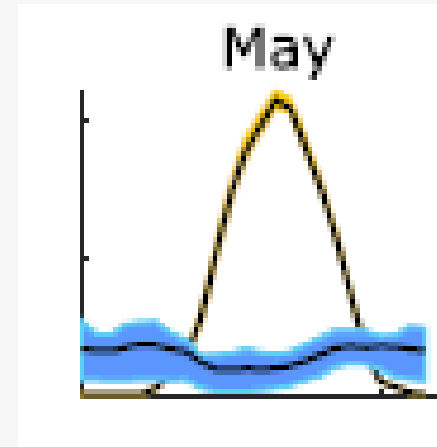
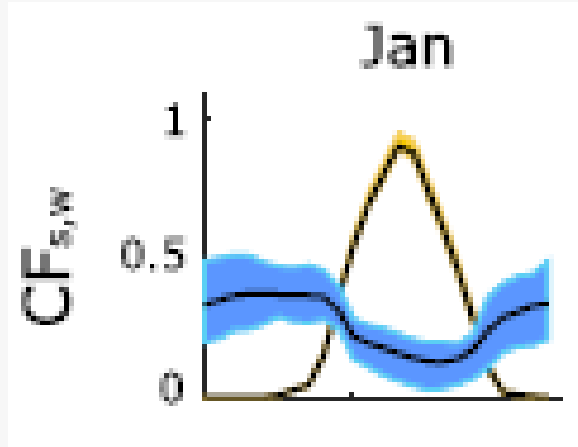
# Hydropower for grid balancing in hybrid electricity systems (hourly)



Hydropower: run-off-river or reservoir ↔ reservoir (pumped storage?)



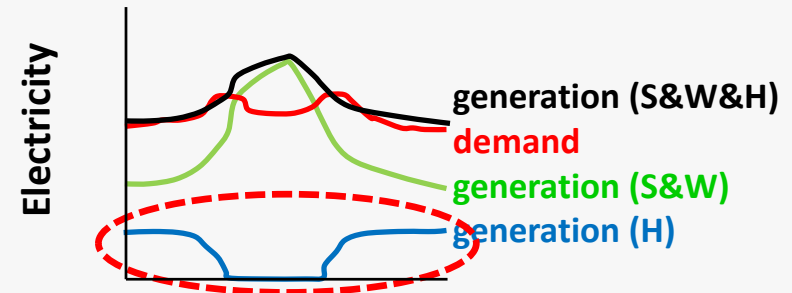
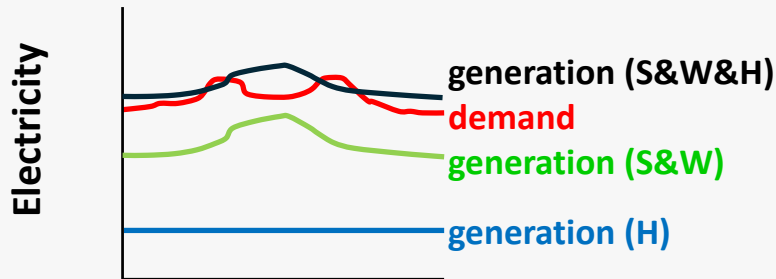
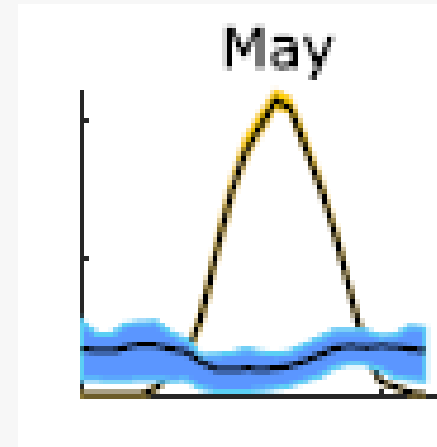
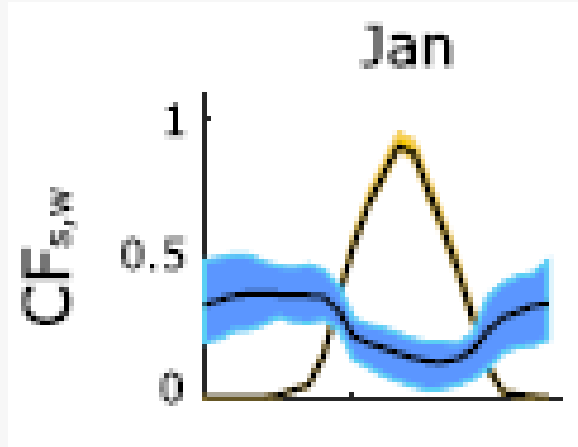
# Hydropower for grid balancing in hybrid electricity systems (hourly)



Hydropower: run-off-river or reservoir ↔ reservoir (pumped storage?)



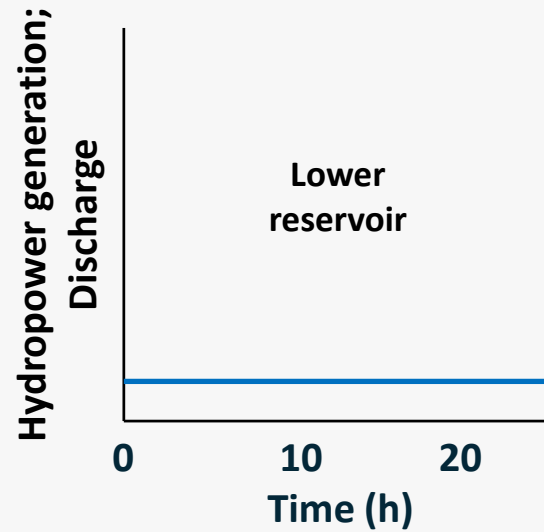
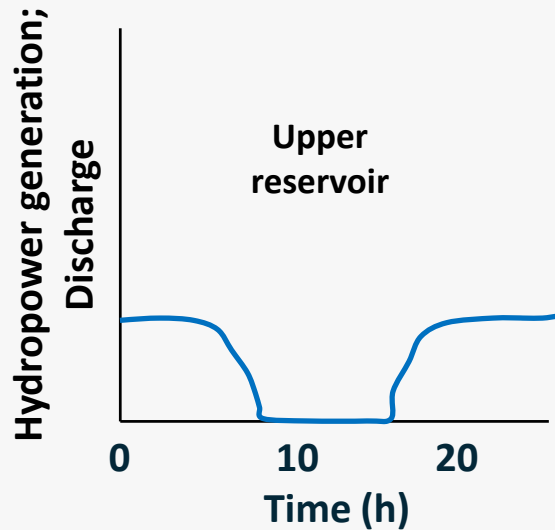
# Hydropower for grid balancing in hybrid electricity systems (hourly)



Hydropower: run-off-river or reservoir ↔ reservoir (pumped storage?)



# Hydropower for grid balancing in hybrid electricity systems (hourly)



Upper reservoir

Lower reservoir

## Consortium partners



POTSDAM INSTITUTE FOR  
CLIMATE IMPACT RESEARCH



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University of Bonn



West African  
Science Service Centre on  
Climate Change  
and Adapted Land Use



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