IMPETUS Benin

Water availability and water demand in Benin under changing environmental and socio-economic conditions

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The current situation

Benin is currently not suffering from water scarcity as the actual annual freshwater availability of 4000m³ is far above the critical limit of 1000m³/cap/y. However, the Beninese population is affected from many water related problems:

- Water shortages during the dry season
- Low water yields in the fractured aquifer
- Insufficient water supply and sanitation infrastructure
- Poor drinking water quality
- Institutional problems of water management
- Overuse of groundwater in South Benin resulting in saltwater intrusion

Possible future development

Benin's future socio-economic and environmental changes will have an important impact on the water demand and availability in Benin. Major developments - aggravating the already difficult water situation- will be:

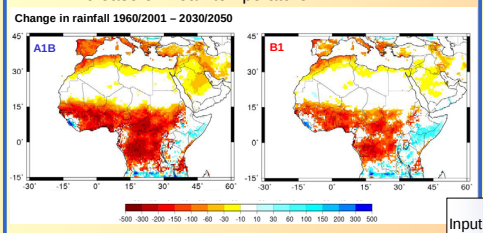
- Increased water demand for agriculture and households due to high population growth
- Impact of climate change on seasonal and total water availability in Benin
- Increased land use change which causes erosion and soil degradation
- Remaining problems with infrastructure and management
- Halving the water availability per person and year due to population growth in about 20 years

Modelling the impact of climate changes on water cycle and water availability in the Ouémé catchment

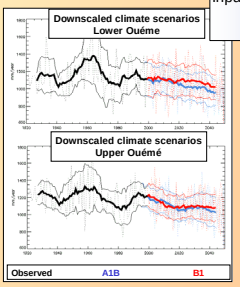
Modelling climate scenarios with a dynamical and statistical downscaling approach

The regional model REMO is nested into the GCM ECHAM. With REMO the IPCC scenarios A1B and B1 are simulated for West Africa including the degradation assumed by FAO. The results of the REMO model show similar trends for the climate in West Africa:

- Decrease of mean annual precipitation
- Increase of mean temperature



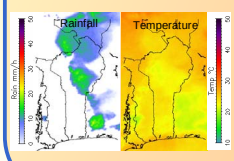
Downscaling: algorithm based on probability matching + physical term + stochastic term



In order to use the results for hydrological modelling a statistical downscaling approach was used to create virtual station data for each rainfall station in Benin.

Results are available from the Information Systems (IS):

- PrecipInfo: an interactive database composed of processed historic measurements, remote sensing data, and atmospheric models.
- PrecipMon: A satellite based monitoring tool to be operationalized at the national weather service provides real time estimates of rainfall and other meteorological data



Results of PrecipMon

PrecipMon

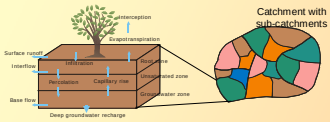
Precip Info

Input for hydrologic modelling

Modelling water availability for different climate scenarios

The conceptual hydrological model UHP-HRU was validated for several sub-catchments of the Ouémé catchment. It shows good results for different time periods in catchments with different land use. After validating the model it was used for scenario modelling.

Concept of the model UHP-HRU

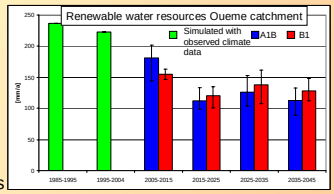


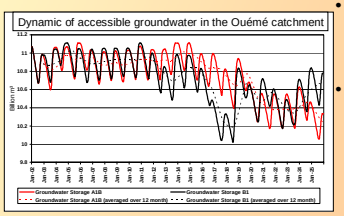
Climate impact on water availability

After evaluation the downscaled climate data were used in the hydrologic model UHP-HRU to simulate the impact of climate change on water availability in the Ouémé catchment.

The results show

- decrease of renewable annual water resources for both scenarios





- trend more distinct for the A1B scenario
- decrease of available and accessible groundwater for both scenarios

Results are available from the Spatial Decision Support Systems (SDSS): Water availability in the Ouémé: BenHydro

Input for WEAP modelling

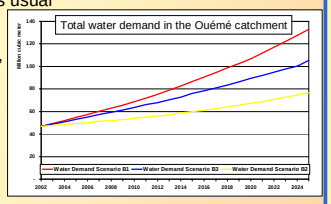
Balancing water availability and water demand in the Ouémé catchment

Application of the WEAP model

The water demand was calculated applying the three IMPETUS development scenarios:

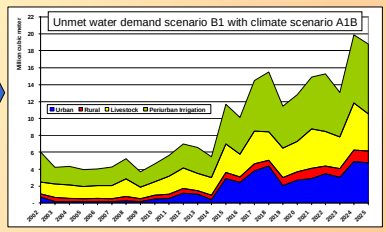
B1: Economic growth
B2: Economic stagnation
B3: Business as usual

Domestic, agricultural (irrigation, livestock) and industrial water demands were taken into account.



As shown in the figure the total water demand increases for all scenarios and is highest in B1 scenario due to higher economic growth.

The surface water and groundwater recharge results from the UHP-HRU model were used as input data for the WEAP 'Water Evaluation and Planning' system. Using this data in combination with the water demand, WEAP assesses the development of the unmet demand for the different scenarios and reveals hotspots of water scarcity. The figure below shows the unmet demand per user group. Due to a decrease of available surface water the unmet demand increases mainly for the surface water users like irrigation, livestock etc.



Results are available from the Spatial Decision Support Systems (SDSS):
Water Demand: BenEau

Conclusions

- For the assessment of environmental and socio-economic impacts on future water resources an interdisciplinary modelling approach is required.
- Downscaling of global climate scenarios for hydrological modelling was successfully carried out by a combination of dynamical and statistical downscaling.
- Future scenarios revealed a decrease of available water resources in the Ouémé catchment for surface and groundwater.
- The water balance model shows that the unmet demand will increase in future due to the decrease of water availability and increase of water demand.
- All results of the models will be available for stakeholders in Benin in user-friendly SDSS, which are integrated in the IMPETUS SDSS-framework.
- The SDSS can support the water management process in Benin by providing reliable data und future scenarios in an user-friendly way.

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