



## An Integrated Approach to the Efficient Management of Scarce Water Resources in West Africa

- Case Studies for Selected River Catchments in Different Climatic Zones -

P. Speth<sup>1</sup>, B. Diekkrüger<sup>2</sup> and M. Christoph<sup>3</sup>

<sup>1</sup> Coordinator, <sup>3</sup> Project Manager, Institut für Geophysik u. Meteorologie, Universität zu Köln

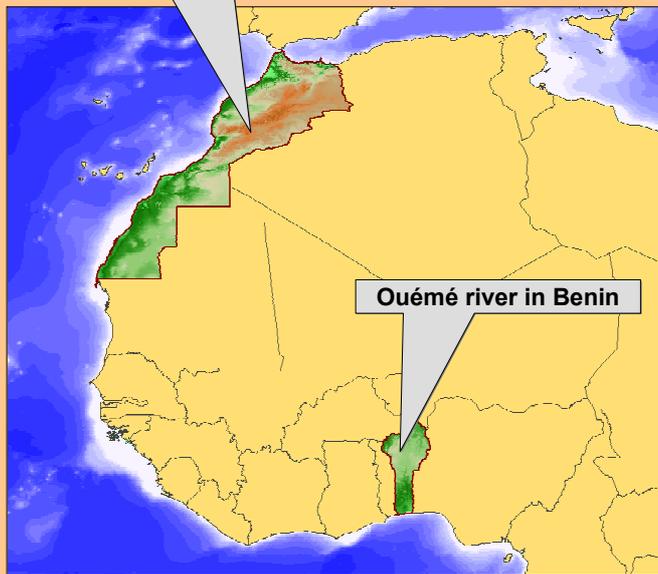
<sup>2</sup> Vice Coordinator, Geographisches Institut, Universität Bonn

[www.impetus.uni-koeln.de](http://www.impetus.uni-koeln.de)

### Abstract

The availability of fresh water is governed by the hydrological cycle. Within IMPETUS, the different components and their interactions are investigated with an interdisciplinary approach in two river catchments in West Africa: the Ouémé River in Benin and the Wadi Drâa in the southeast of Morocco. Considered are the atmospheric variability, the continental hydrosphere, and the important processes regarding land use and land cover. Moreover, the influence of the socio-economical development and of the cultural and medical conditions on the availability of drinking water is examined.

Wadi Drâa in Morocco



Ouémé river in Benin

In the first project phase (2000-2003), a series of numerical and conceptual models of the individual components of the hydrological cycle were adapted. In order to solve the relevant problems concerning complex issues such as water availability, climate change, land use, food security or demographic development, the models are being coupled by means of data exchange and integrated in plausible scenarios during the current second phase (2003-2006). The objective consists in describing possible ways of future development, as well as their causes and their interactions. It will build up the foundation allowing to develop strategies for the local decision makers in the course of the third phase.

### Introduction

Fresh water has already become critically scarce in many regions of the world. It is anticipated that until 2025 about 25% of the world population will suffer from severe water scarcity. For Africa some estimates suggest that already now the amount of fresh water available per capita is only about a quarter of that in 1950, and that fresh water supply could become problematic especially in West Africa, where about 35 years of drought have been observed. Although the climates of West Africa are still relatively poorly known and understood, it is recognised that Northwest and tropical West Africa have experienced the most pronounced inter-decadal variability of climate in the world during the 20<sup>th</sup> century. The possibility of human-induced climate changes – by increase of greenhouse-gas concentrations and/or by degradation of the vegetation cover – adds additional serious aspects to the challenging water-related problems already encountered in many parts of the world.

### Motivation

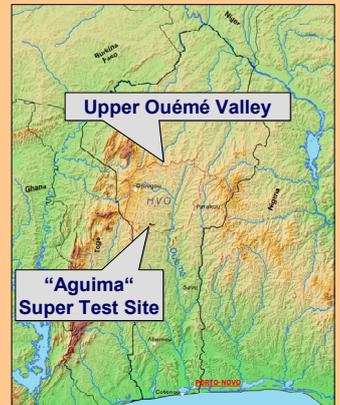
The available fresh water is controlled by the hydrological cycle. Climate, in particular the spatial and temporal distribution of precipitation and evaporation, plays a significant role in the hydrological cycle, and climate data are therefore of the utmost importance in the analysis of ground and surface water supply for domestic and industrial users, irrigation, hydropower generation and ecosystems. Hence, in order to solve possible future problems with regard to fresh water supply, a clearly interdisciplinary approach is necessary. This is done in the present initiative for West Africa and it is the purpose of this project to offer concrete ways of translating into action scientific results through scientifically-based strategies. This approach will provide a reliable basis for political measures and international agreements. In the first three-year phase the focus was set on the identification and analysis of influencing factors regarding different aspects of the water budget. A number of numerical and conceptual models were adapted for this purpose. In these data sparse regions of the world a permanent measurement network of different – mainly ground-based – instruments was installed. In the still on-going second three-year phase methods are developed to assess the range of changes to be expected during the next two decades and the resulting consequences for all relevant water-related problems such as availability and access of fresh water, climate and land-use changes, food security, and demographic development. During the final project phase management options will be developed and operational tools for the decision-making process (so-called "Decision Support Systems") installed.

### Choice of Catchments

West Africa was chosen because

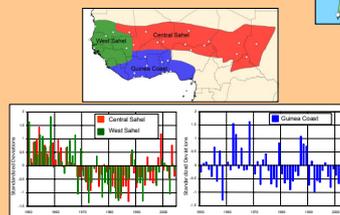
- it has experienced the most pronounced inter-decadal variability of climate in the world during the 20<sup>th</sup> century,
- relations to the climates of Europe might exist via complex atmosphere-ocean interactions, and
- the regions north and south of the Sahara might be linked via atmospheric teleconnection processes with regard to precipitation anomalies;

Results obtained during the first project phase give strong hints for the existence of such a link by the episodic occurrence of atmospheric moisture outbursts out of the West Sahel zone across the Sahara towards the Atlas mountains.

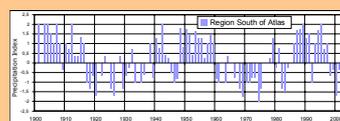


Since the 1970s both subtropical Northwest Africa and tropical West Africa have experienced decadal-scale drought conditions that have probably been related. For this reason it is of advantage to consider both areas north and south of the Sahara desert in a combined approach, realised by means of a transect between the Atlas mountains and the Gulf of Guinea. This transect contains two reasonably sized river catchments (< 100.000 km<sup>2</sup>) which are representative in the following sense: the Drâa catchment in the south east of Morocco is typical of a gradient from humid/sub-humid subtropical mountains to their arid foothills; the Ouémé basin in Benin is typical of an alternating sub-humid climate ("Guineo-Soudanian") of the outer tropics embedded within a transect from the Sahelian to the Guinean Coast climate.

The feasibility of the presented initiative has been guaranteed by the availability of useful data sets gathered by pre-existing projects of both the natural and the human sciences and by politically stable conditions in Morocco and Benin.



Precipitation variability in West Africa for the period June - September 1950-2004.



Precipitation variability throughout the 20<sup>th</sup> century in the Region South of the Atlas (Morocco) for the period September - August.

