La piattaforma EU H2020 FREEWAT per la gestione della risorsa idrica

JRC sample case studies on Water-Energy-Food nexus assessment in Developing Countries

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SCOPE

Current presentation focuses on WEFE nexus. Recognizing that the four sectors — water, energy, food and ecosystems — are inextricably linked, each action in one sector potentially impacting on others, ongoing JRC case studies from developing countries are introduced.

Key themes include, among others:

- water availability and challenges of climate variability/change, extreme events risks (drought and flooding);
- hydropower energy production, reservoir multipurpose optimization and release management;
- rain-fed vs. irrigated agriculture, impact of land use and agricultural practices (including livestock and fisheries), water quality;
- groundwater;
- role of ecosystems (parks, flatlands, wetlands)
- water governance and water information systems

FOREWORD - JRC's MISSION, FACTS AND FIGURES

As the science and knowledge service of the Commission, JRC mission is to support EU policies with independent evidence throughout the whole policy cycle.

6 geographic locations

- Around 3000 staff, including PhDs and visiting scientists
- 42 large scale research facilities, more than 110 online databases
- More than 100 economical, bio-physical and nuclear models

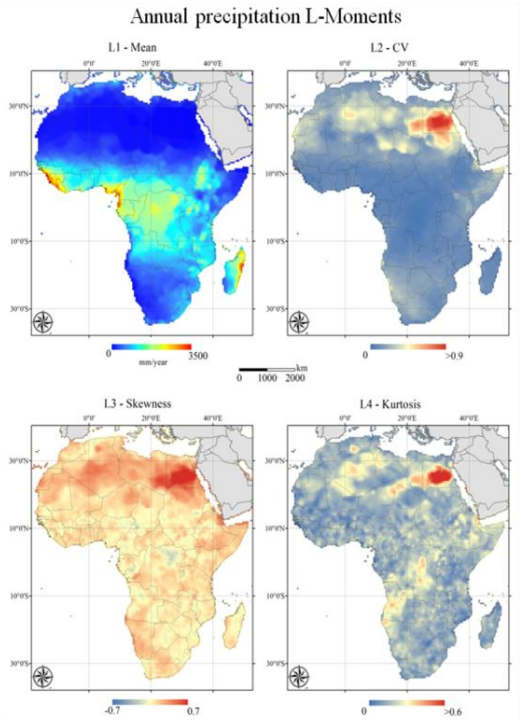
JRC geographical scope extends beyond Europe, with specific focus on Latin America and Africa.

CLIMATE VARIABILITY ANALYSIS

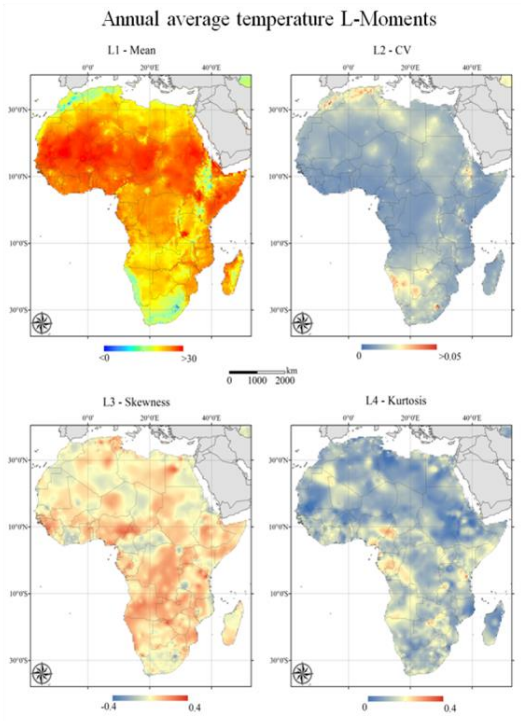
THEORY OF REGIONAL FREQUENCY ANALYSIS

- Theoretical background: **i.** identification of homogeneous regions, where rescaled variables have approximately the same probability distributions; **ii.** grouping of sites/gages based on the similarity of physical and/or meteorological characteristics; **iii.** heterogeneity statistical testing of the proposed homogeneous regions (Hosking and Wallis, 1997); **iv.** estimate variability and skewness of regional data using L-moment statistics, testing for heterogeneity as a basis for accepting or rejecting the proposed regions.
- Main objective is to process time series of data from ground meteorological stations (precipitation data), in order to generate spatially-explicit products (return period maps) based on the L-moments statistics (less susceptible to outliers, good performance with smaller sample sizes, relevant for heterogeneous time series length);
- Products at local and regional scale can be used in the planning process and, concretely, to prepare investment in multi-purpose (irrigation, flood and drought prevention, environment protection) hydraulic infrastructures.

CLIMATE VARIABILITY: REFRAN CV PRODUCTS (i)



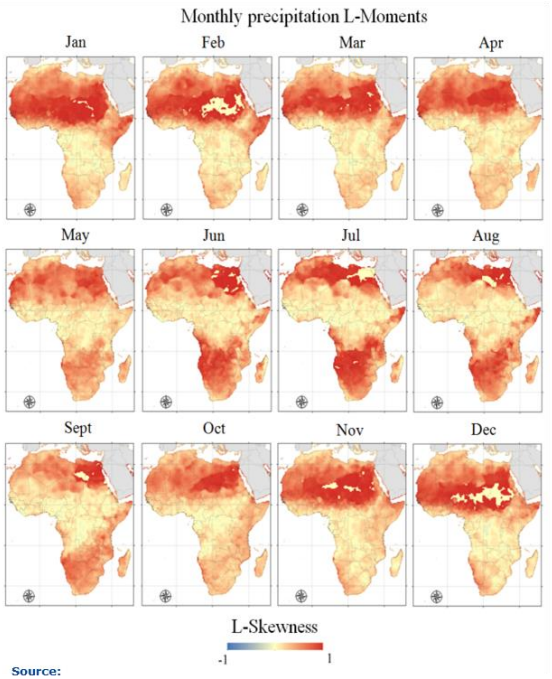
Yearly frequency analysis

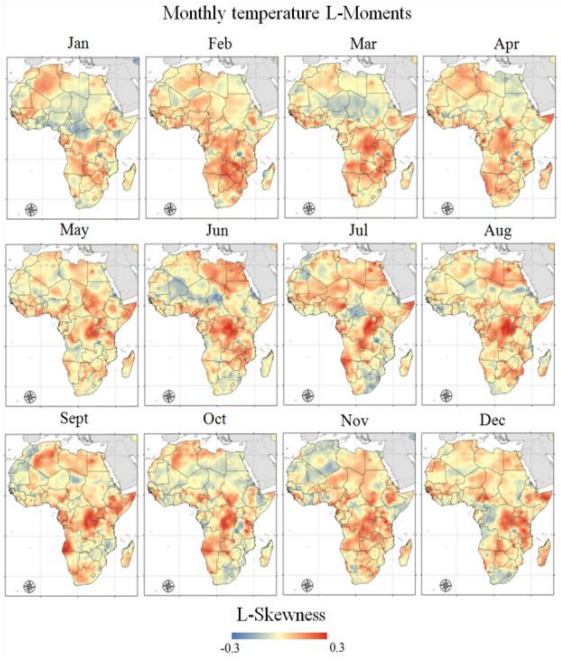


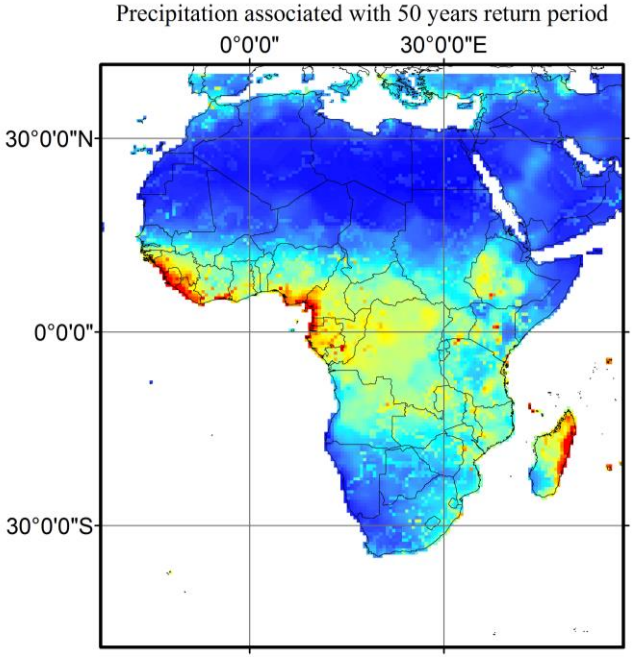
L-moment ratio (L-cv) measures a variable's dispersion, L-skewness the asymmetry of the samples distribution, L-kurtosis whether the samples are peaked or flat relative to a normal distribution

- Maeda, E.E., Arévalo, J., Carmona-Moreno, C. (2012). Characterization of global precipitation frequency through the L-moments approach. *Area-Royal Geographical Society*. doi: 10.1111/j.1475-4762.2012.01127.x JRC66941 http://onlinelibrary.wiley.com/doi/10.1111/j.1475-4762.2012.01127.x/abstract
- Hosking, J. R. M., and Wallis, J. R. (1997). Regional frequency analysis: an approach based on L-moments. Cambridge University Press, Cambridge, U.K.

CLIMATE VARIABILITY: REFRAN CV PRODUCTS (ii)







Source:
Maeda, E.E. et al "Characterization of global precipitation frequency through the L-moments approach". AREA- Royal Geographical Society

- Monthly spatial distribution based on L-moments analysis;
- Generation of return period maps for both excess and deficit (flooding and drought risks) conditions and analysis of climate scenarios performed over 20-30 years time horizon.

GIS-EPIC: INFRASTRUCTURE CONCEPTUAL OVERVIEW

A loose coupled modelling framework, combining the agro-hydrologic model EPIC in an ESRI ArcGIS framework (geodatabase & GIS interface)

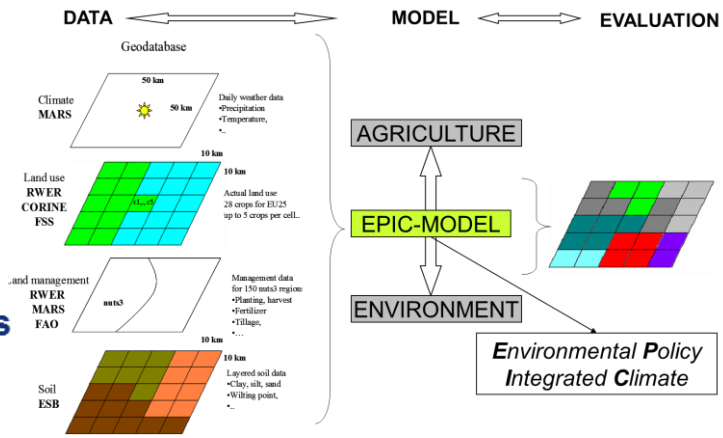
It is composed of three components:

EPIC model: a continuous simulation model that can be used to determine the effect of management strategies on agricultural production and soil and water resources

The Geodabase: it holds all the necessary data (soil, meteorological, crop management, etc.) to perform EPIC simulations to formulate and evaluate various management scenarios

GIS Interface. This is an ESRI ArcMap customization that allows the use of EPIC using data stored in the previously described geodatabase through an intuitive GIS interface.

A dll component. It controls input-output transfer to the GIS



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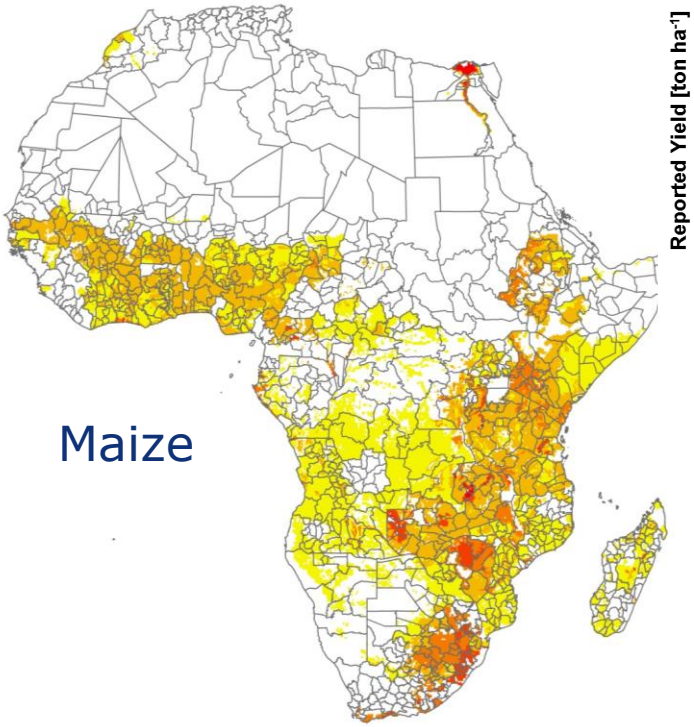
GIS-EPIC: YIELD PREDICTION & IRRIGATION DEMAND



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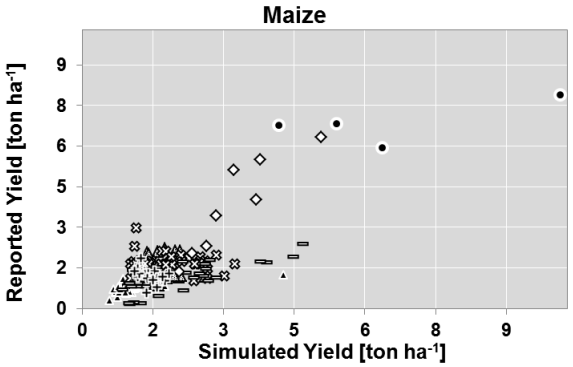
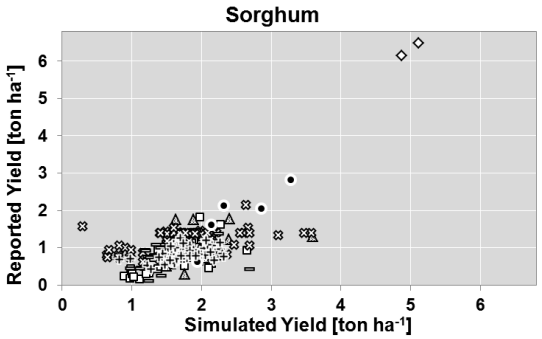
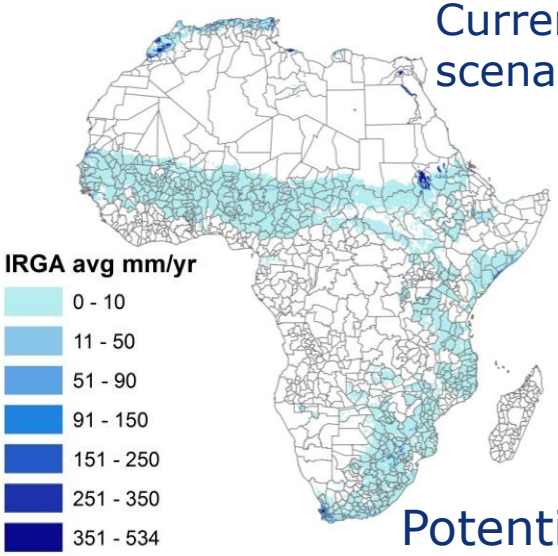
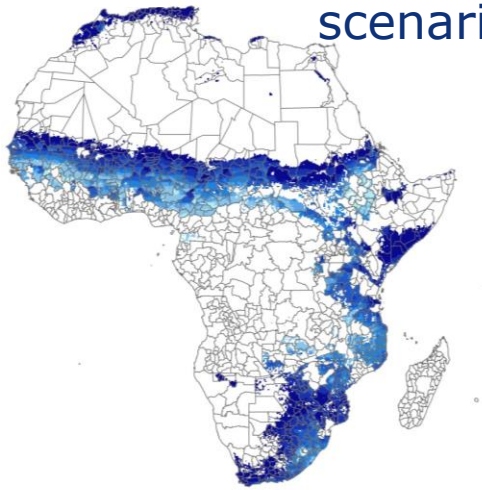




Current scenario



Potential scenario



○ Northern Western ● Northern Eastern ◬ Eastern Central ⊠ Eastern Northern ▭ Eastern Southern

□ Central + Western Central ▲ Central Equatorial ◇ Southern

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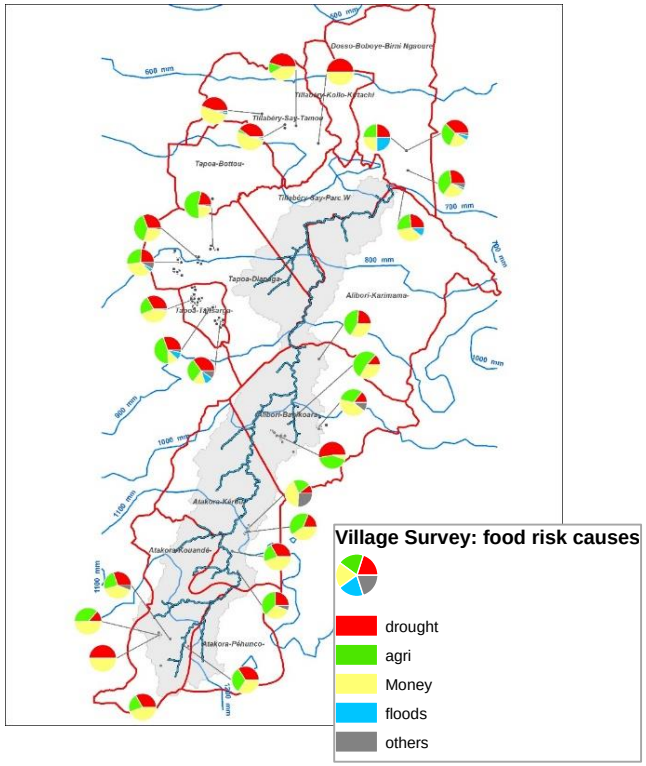
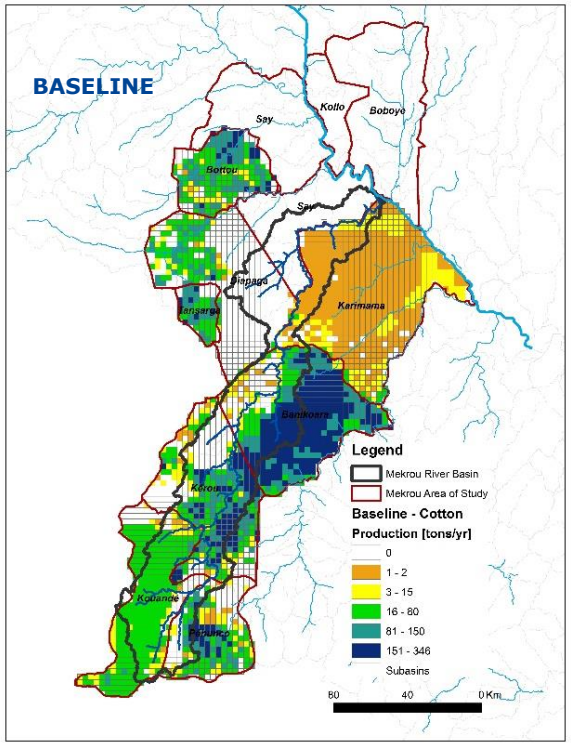
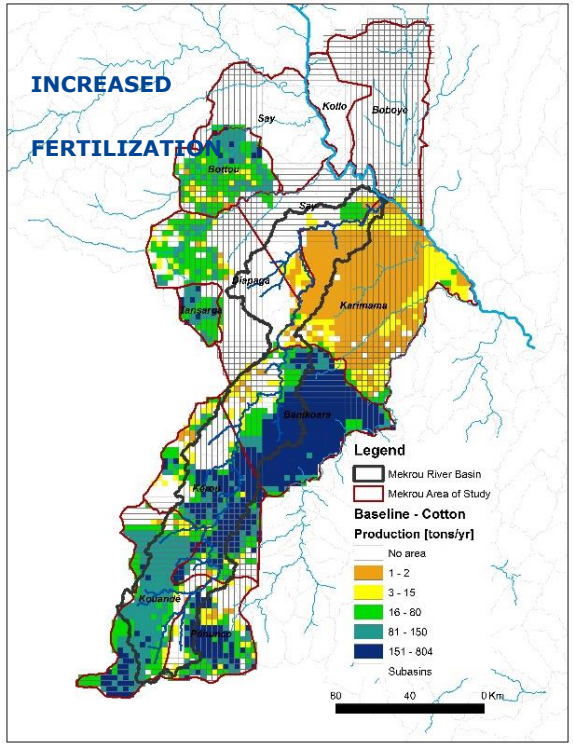
GIS-EPIC: LOCAL SCALE SCENARIOS ANALYSIS

IDENTIFICATION OF AREAS WITH LOW PRODUCTION AND CAUSES CONTRIBUTING TO FOOD INSECURITY

CROP PRODUCTION AS AFFECTED BY DIFFERENT MANAGEMENT STRATEGIES (current baseline conditions, increased mineral-organic fertilization, increased irrigation)







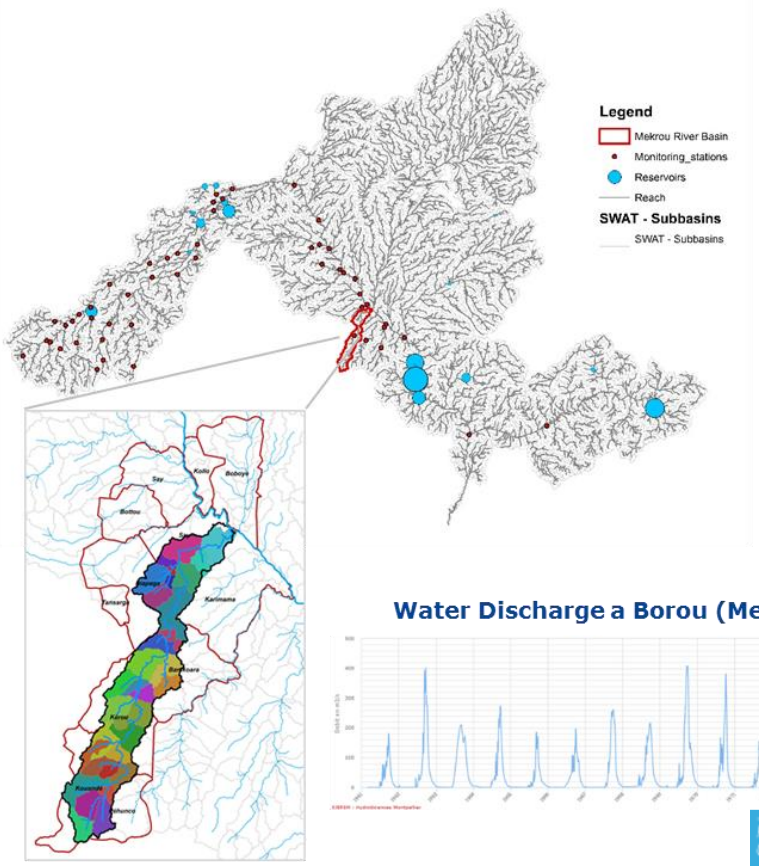
Case study: Mekrou transboundary basin (Benin, Burkina Faso, Niger)

SWAT APPLICATIONS (NIGER AND MEKROU)

SWAT HYDROLOGICAL MODEL

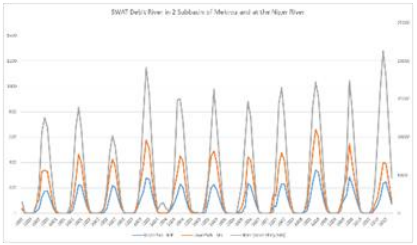
SWAT SETUP FOR NIGER RIVER BASIN

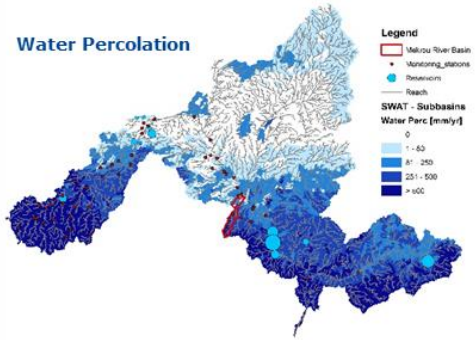
WITH A DOWNSCALE FOR THE MERKOU RIVER BASIN



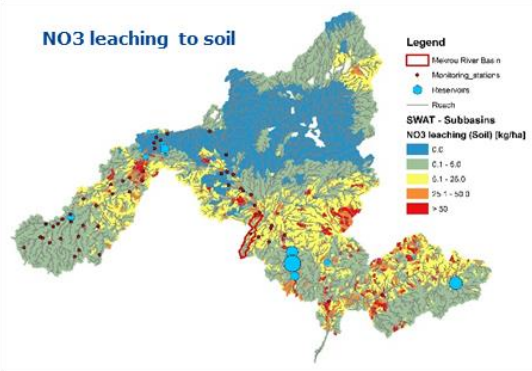
Water Discharge a Borou (Mekrou)

WATER QUANTITY : RIVER DISCHARGES AS AFFECTED BY DIFFERENT SCENARIOS (Climate, Crop management, Landuse changes)



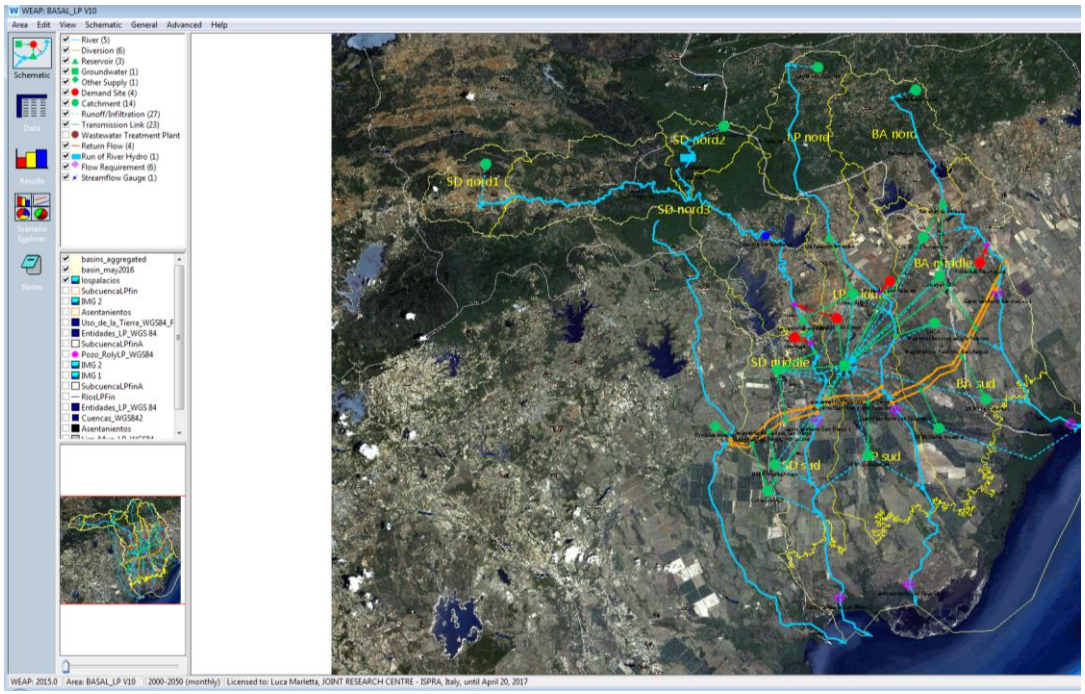


WATER QUALITY : RIVER AND SOIL QUALITY AS AFFECTED BY DIFFERENT SCENARIOS (Climate, Crop management, Landuse changes)



WATER ALLOCATION OPTIMIZATION IN CUBA

Competing uses (human consumption, agriculture, coastal ecosystem services preservation) vs. infrastructures management practices (dams, channels), addressing objectives as rice production increment for food security and self-sufficiency. Los Palacios is a low density populated area but of high production relevance



WEAP water allocation model
Case study: Los Palacios, Cuba

CUBA: GROUNDWATER ASSESSMENT

Case study focused on aquifers over-exploitation in a karstified and fractured limestone system, groundwater and soils salinization, ecological impacts on mangroves, due to increasing water supply demand from both growing population (i.e. La Habana) and agriculture.
Surface water drainage network is poorly developed due to leakage to karstic aquifers. Here below: inland location of San Antonio de Los Baños, and Ariguanabo river (just before and at point where it disappears to groundwater system along karstic conducts)

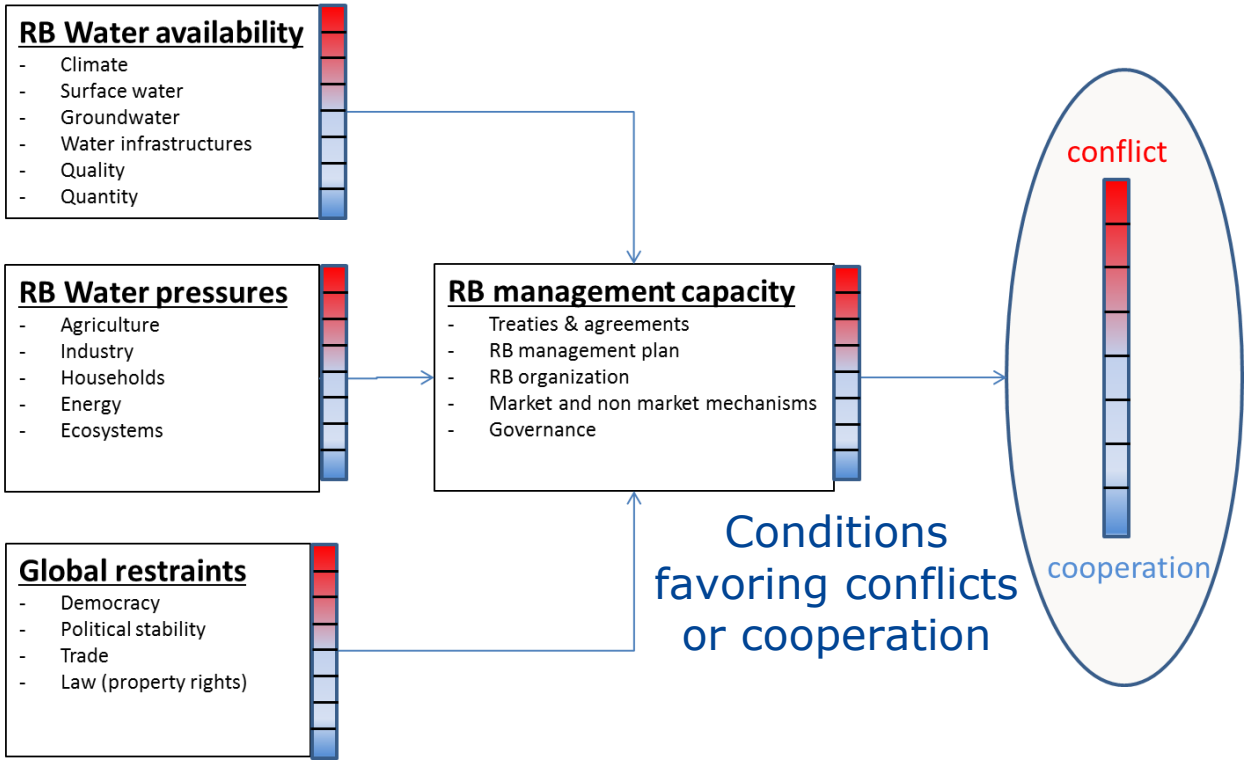
Case study: groundwater management in karstic system of Guira de Melena, Cuba

WC ATLAS: A CONCEPTUAL FRAMEWORK

Biophysical variables
SUPPLY SIDE

Water use estimates
DEMAND SIDE

Endogenous factors
(legal, socioeconomic, and cultural context)



Note: 'restraint' is used in the political sciences and economic context, identifying the factors that impact on capability to mitigate escalating conflicts or enhancing cooperation (Bohmelt et al, 2014)

ACEWATER2 PROJECT

African Centres of Excellence (CoE) in Water, second phase.

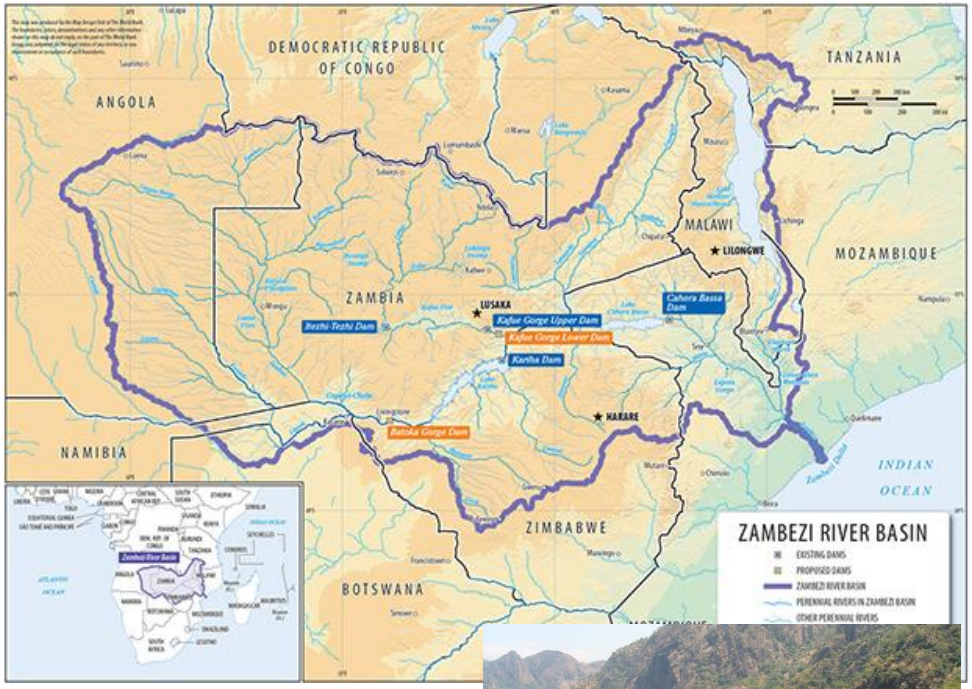
Project supported by DG DEVCO (Commission Directorate General for International Cooperation and Development) to achieve policy impact in the African water sector through:

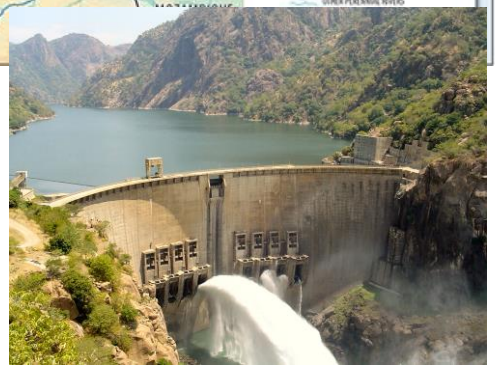
- development of a Human Capacity programme of the African Ministers' Council on Water (AMCOW);
- improvement of the Scientific Capacity, promoting data analysis, management and sharing at basin and regional scale;
- expansion of the CoE network to central and eastern Africa.

Focus of the scientific component on WEFE nexus assessment, evaluation of sustainable bridging-gap solutions, based on state-of-the-art reviews and scientific analysis, in view of an effective cooperation with other key regional stakeholders and the development of a dynamic web Atlas on Water Cooperation. supporting decision making processes through scenarios-based-analysis.

ACEWATER2 FLAG CASE STUDY IN SOUTHERN AFRICA: ZAMBEZI RIVER BASIN

- 1.390.000 km^2, 2.574 km long
- challenges related to the WEF nexus:
  1. large climatic and hydrological variability: from semi arid zones to tropical forests
  2. population distribution, mining industries, intensive farming (sugar cane along the lower valley) aquaculture, tourism
  3. large hydropower facilities (Kariba, Kafue and Cahora Bassa) with severe impact downstream (biodiversity, hydrology, morphology, etc)
  4. governance : role of the SADC water Division and ZAMCOM, the Zambezi Watercourse Commission.





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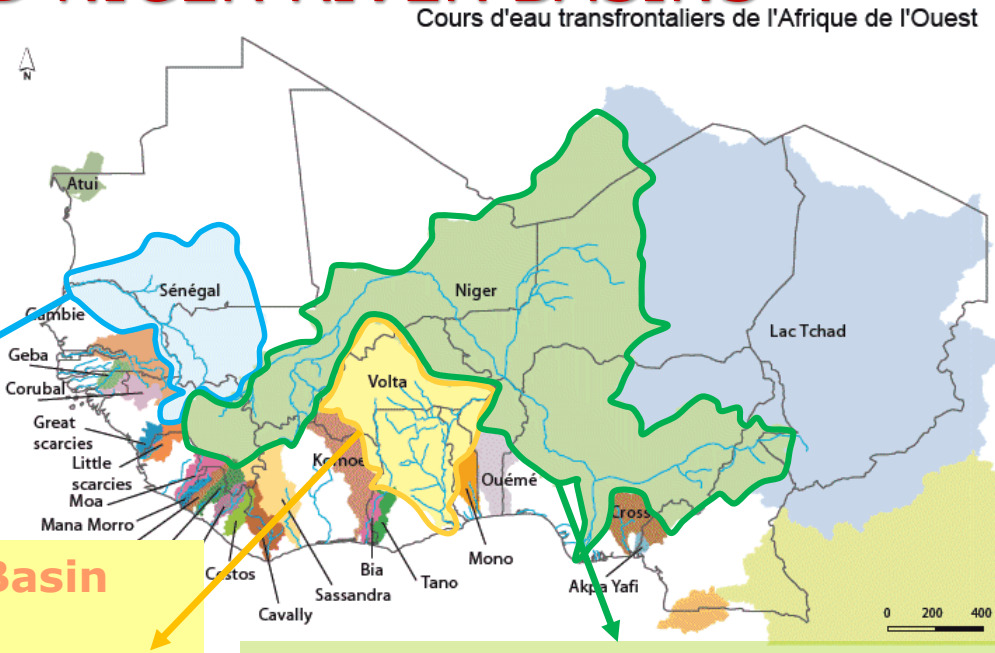
FLAG CASE STUDIES IN WESTERN AFRICA: SENEGAL, VOLTA AND NIGER RIVER BASINS

Western Network of NEPAD CoEs on Water



Senegal River Basin (SRB)
- 300.000 km²
- 4 riparian states: Guinea, Mali, Mauritania and Senegal
- OMVS River Basin Authority

Volta River Basin (VRB)
- 407.093 km²
- 6 riparian states (Ghana, Burkina Faso, Togo, Benin, Ivory Coast and Mali)
- VBA River Basin Authority

Niger River Basin (NRB)
- 2.262.000 km²
- 10 riparian states (Benin, Burkina Faso, Cameroon, Chad, Ivory Coast, Guinea, Mali, Niger, Nigeria and Algeria)
- NBA River Basin Authority

European Commission

THANKS FOR THE ATTENTION

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