



Food and Agriculture  
Organization of the  
United Nations



# Strengthening agricultural water efficiency and productivity on the African and global level

WATER ACCOUNTING







# The project

Africa is a rural continent, with agricultural production accounting for 17 percent of the GDP, and it relies on agriculture as a driving force for its social and economic development. The agricultural sector employs about 60 percent of the total labour force and most smallholders depend on rain-fed production for their livelihoods.

At the same time, irregular and unreliable rainfall is a main contributing factor to low agricultural productivity. Improved Agriculture Water Management (AWM) is thus crucial to increasing production levels and improving food security.

The **GCP/INT/231/SWI project, “Strengthening Agricultural Water Efficiency and Productivity on the African and Global Level”**, strives for reducing hunger and poverty by focusing on improved AWM practices on the African and global level and mainstreaming AWM in national frameworks and processes.

In particular, **Output (2)** of the project aims at “**Enhanced capacity for increased water use efficiency (WUE) in small scale irrigation in Burkina Faso, Morocco and Uganda**”, through:

- Preparing/updating national land and water resources database, supported by adequately performing water data processing and GIS software and hardware.
- Conducting training programmes for relevant personnel on the operation and maintenance of the land and water resources database and on the operation of the water accounting tool.
- Examining meteorological records/river discharges/ground water levels and evaluating trends.
- Preparing GIS supported water use assessment for each country, including all water use sectors, with a special focus on agricultural water use assessment.
- Developing a spatially distributed decision support - water accounting tool, linked to the upgraded database, applied for water resources scenarios including a users' manual.
- Conducting an institutional and policy assessment – moving from accounting to auditing.
- Outreach and awareness campaign to disseminate the results of the Water Audit to stakeholders involved in water management on all levels.

The overall approach of the project was a combination of **bottom up and top down activities** in the field of AWM and at different levels, from micro, working with extension agents and farmers’ representatives;



© Yapi Sina

Irrigation scheme of a pilot site in Burkina Faso

to meso, with research institutes and regional governance structures; up to macro levels, liaising with national governments. The commitment showed by national governments and the support of a relevant network of stakeholders ensure the **project's sustainability** and the most effective **dissemination of results**.

Furthermore, to achieve a **long term impact** of the project's outcomes, the in-country findings and processes of common nature are synthesized in order to, on one side, **scale them up at national level** and, on the other, **scale them out to other countries**, in a regional (South-South) cooperation process.



# The definition and the objectives

Demographic growth, economic development and rapidly growing urbanization represent the most challenging trends to raise pressure on renewable but finite water resources. **Water scarcity, that is the excess of water demand over available water supply is thus, by far, the most important phenomenon affecting water resources nowadays.**

Appropriate resources governance and adoption of coping strategies can alleviate water stress levels and reduce overall scarcity. However, it is imperative to consume less resources, especially in the agricultural sector, the highest water-consuming domain.

In this respect, it is essential to enhance the use of water-related information and match them with coping strategies according to different biophysical and societal context.

According to FAO (2012), **water accounting (WA) can be defined as the systematic acquisition, analysis and communication of information relating to stocks, flows and fluxes of water in natural, disturbed or heavily engineered environments.** It considers and assesses both the supply and demand sides of water systems and it centres on the analysis of trends in water supply, demand, accessibility and use in time and space within specific domains.



© FAO, 2016

## Effective uses of water accounting:

- Consolidate, assess and interpret information and evidence from a wide range of different sources.
- Develop an information base for relevant domains, to be shared and agreed upon with stakeholders.
- Support cycles of learning, stakeholder dialogue and evidence-informed decision making.

Objectives of WA are multiple and vary according to the domain. With regards to the agricultural sector, the following appear to be the most relevant:

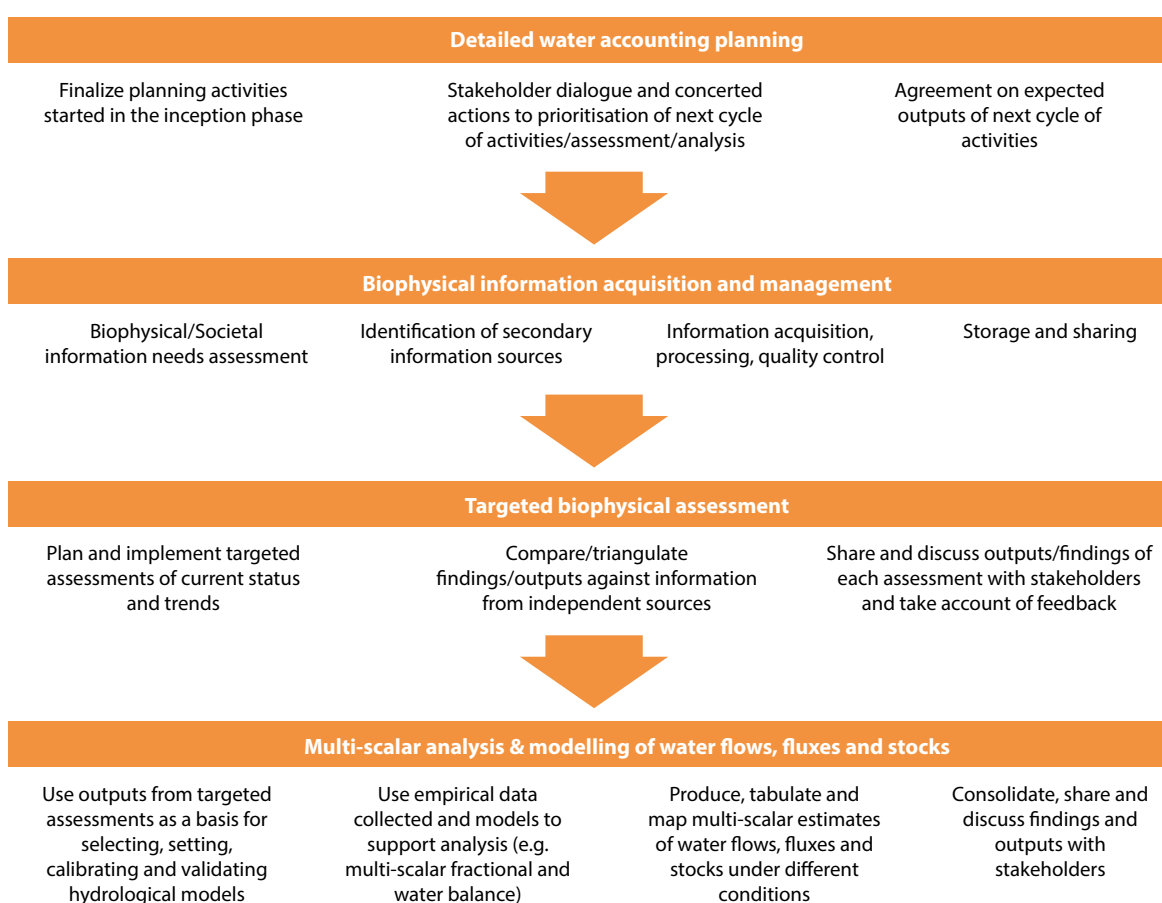
- Highly rigorous **quantitative and qualitative description of current status and trends** in water supply, demand, accessibility and use.
- Sound **understanding of biophysical mechanism, processes and pathways** that determine flow, fluxes and stocks of water and **identification of imbalances** caused by biophysical conditions.
- Shared information base containing uncontested information, **following consultation with stakeholders and/or specialists.**
- **Multi-scalar analysis of consumptive/non consumptive water uses** at different scales and potential employment of return flows.
- Identification of **potential allocation conflicts** (scale, magnitude, nature, location).
- **Assessment of water policies and practices and scenario building to evaluate effectiveness.**



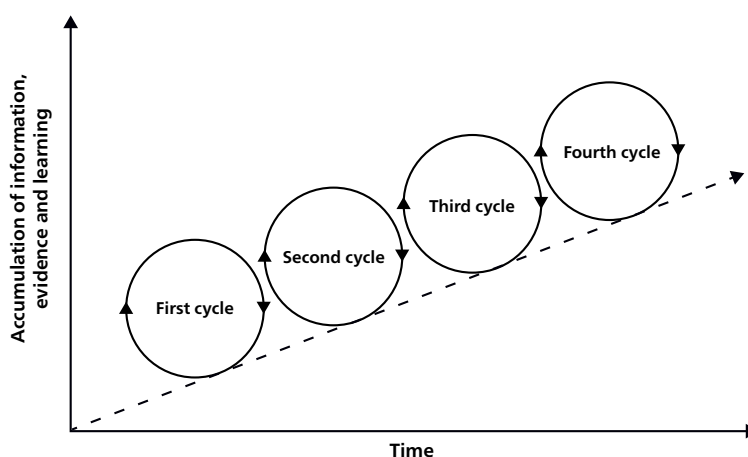
# Water Accounting - The Methodology

WA develops from three distinct perspective: (i) hydrological; (ii) engineering; (iii) monitoring and evaluation. Accordingly, information collected during WA address a range of biophysical issues and outputs result different in terms of formats, target uses and audiences.

A number of approaches exist to water accounting, from more standardized to more flexible ones. While the former are more frequently employed for comparisons among countries, the latter allow the alignment of water accounting methodology to assessed needs and priorities, to relevant issues and to specific biophysical and social contexts.



A distinction also needs to be drawn between rapid or comprehensive water accounting, along a continuum of existing approaches. Experience show that it is often best to start with an initial rapid water accounting and to carry out procedures in cycles of increasing focus and complexity.



Source: © FAO, 2016



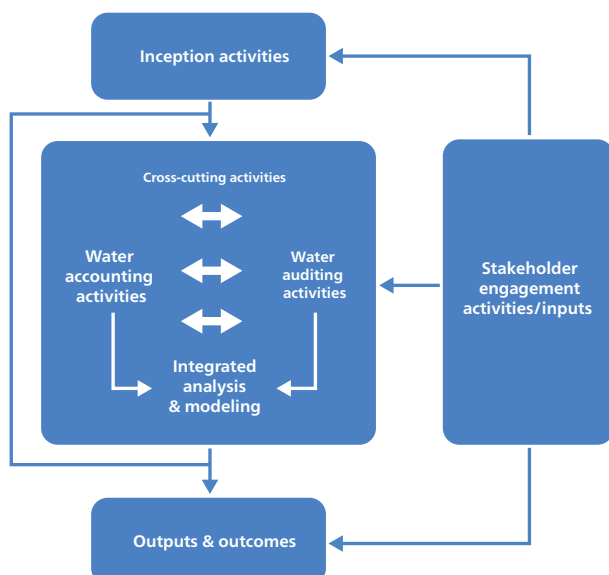
# Water Auditing - The Methodology

Water accounting frameworks prove useful in demonstrating to policy- and decision-makers the importance of water as a commodity, which thus should be quantified in terms of supply, demand and value. A growing number of policy makers, water managers and donors recognize the need to correctly account water balance to ensure a sustainable use of resources.

**Water auditing is a process best designed to complement water accounting, by placing trends in water supply, demand, accessibility and use in the broader context of governance, institutions, public and private expenditure, legislation and the wider political economy of water of specified domains.** Even in the agricultural sector, governance assessment and political economy analysis are essential processes that can shape effective policies and determine their implementation.

Furthermore, water auditing proved useful towards stakeholders by:

- **Applying and making good use of biophysical and societal evidence** whenever they give an indication on specific policies and practices being more or less effective;
- **Making evidence-informed choices**, rather than intuition-based;
- Developing **new policies and practices or adapting existing ones in order to take better account of water imbalances**;
- **Communicating information** so as it increases the probability that it will be owned, accepted, valued and adopted.



Lessons from water sector reform programmes show the role that water accounting can play in **overcoming resistance to changes** and in **fostering step-change improvements in governance at different institutional levels** when carried out in conjunction with water auditing.

A significant attribute of water auditing is it can play a role in **identifying and/or predicting good opportunities or space for promoting change**.

Finally, water auditing without water accounting is as risky as water accounting without water accounting because it can result in change being promoted that, for biophysical reasons, has little chance of delivering benefits and, in some circumstances, may even make things worse for some water users or uses.





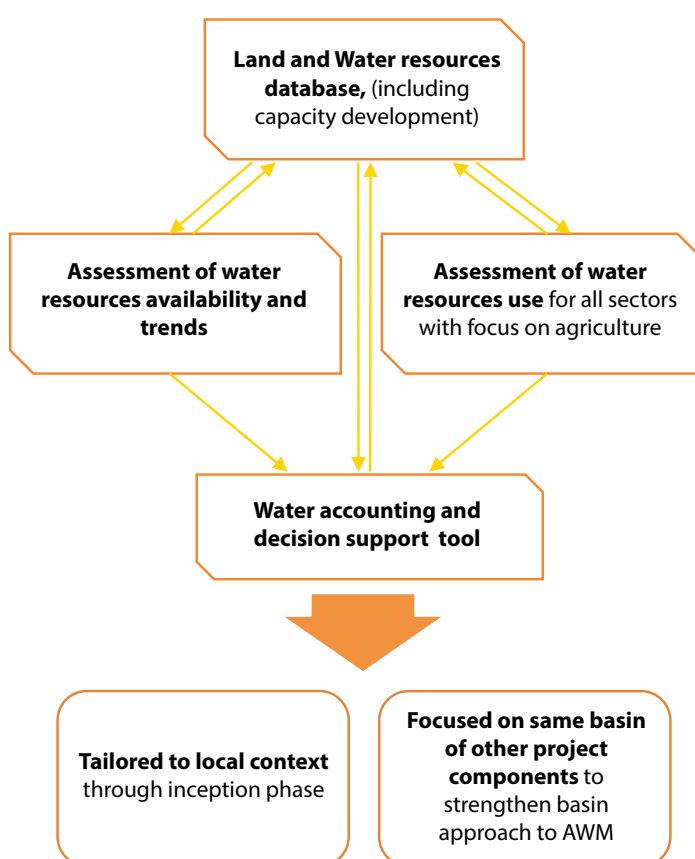
# The project development approach

A problem-focused approach was applied in the project to address relevant challenges in AWM and ensure a detailed assessment of water use in the agricultural as well as in other sectors are produced. These will provide countries with a clear insight on how to adapt relevant national water policies and improve their overall water management.

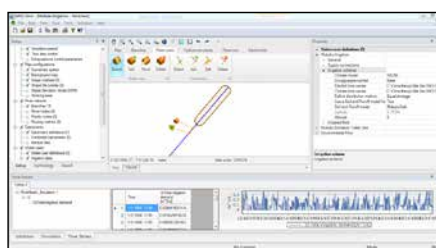
**Step 1: Review and stocktaking of available information and data gaps identification through GeoNetwork** resources needed (time) to maintain the database and make it available to all relevant institutions.

**Step 2: Analysis of status and trends in precipitation, discharge and groundwater levels** (supply side), **taking into consideration all water uses in the relevant domain of interest** (demand side) potential use of remote sensing derived evapotranspiration maps to monitor consumptive use.

**Step 3: Build on available tools and capacities to elaborate water balance analyses**, differentiating consumptive and non-consumptive uses, **and to assess potential impacts on water balances due to changes in management practices** strengthened adoption of existing methods, given the lack of a pre-defined, standard tool.



GeoNetwork interface

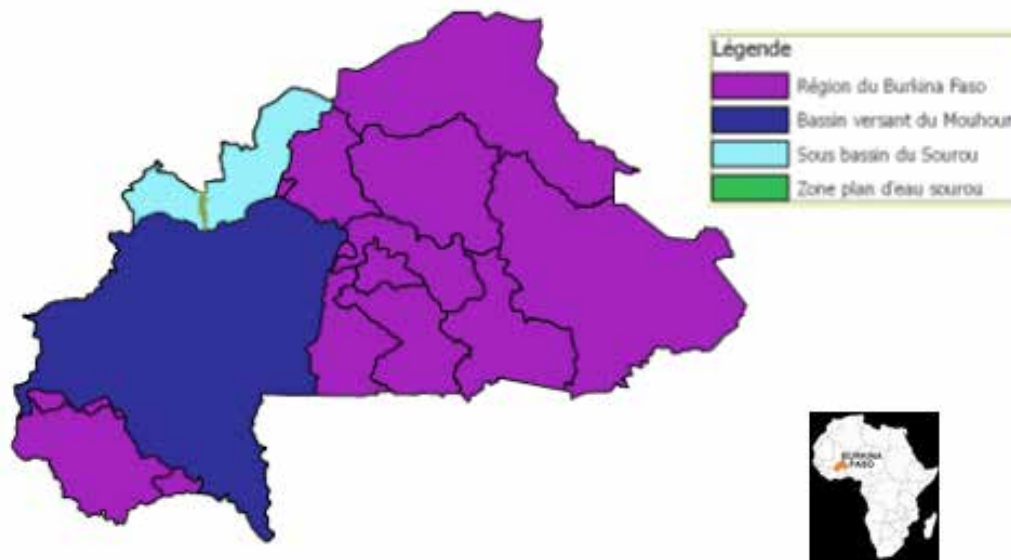


Mike Hydro interface



# Pilot site – Vallée du Sourou

## The location of the project area



Source: 2iE, Ouagadougou

## The in-country project development

- Review the outline of the Sourou Basin as adopted by National Institutions, the Transboundary Integrated Water Resources Management Committee of the Sourou Basin (CTGS), and international and national project. In accordance with above, produce a Digital Elevation Model (DEM) based on the outline of the Sourou Basin.
- Collection and organization of existing GIS data and completion of a structured water database, complemented by a descriptive metadata compatible with ISO metadata standard adopted by FAO GeoNetwork
- Report of hydro-meteorological trends at Sourou basin level
- Assessment of the different water uses at basin level, including agricultural, municipal, industrial and environmental uses, through the employment of geo-referenced information and alignment with FAO AQUASTAT terminology
- Completion of water resource database for Sourou basin, in collaboration with 2iE University and description of available data and gaps for water management in the basin
- Assessment of capacity development needs, taking into consideration the information systems for water management employed at national and local level (Basin Agency)
- Train relevant staff on GeoNetwork. In the specific: (i) training on database operation and maintenance addressing staff in charge of irrigation systems in Ouagadougou; (ii) training on sensitization and capacity building addressing staff from the basin agency in Dédougou

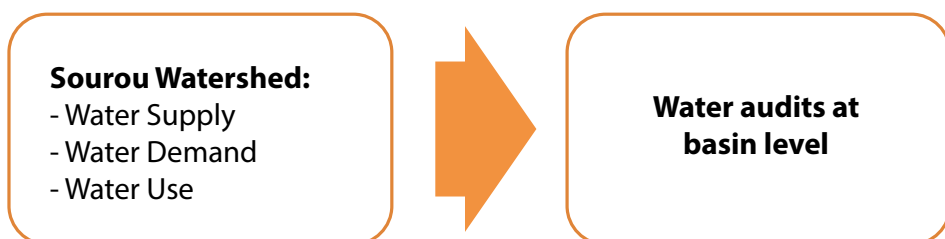




# Objectives

## General objective:

*Application of Water Accounting to enhance agricultural water resource management in the Sourou watershed*



Photos: © Laura Guarnieri

## Specific objectives

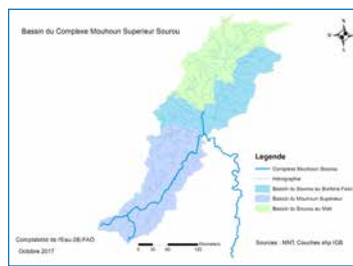
- Collect, structure and analyze available data from the water sector-relevant Regional Directorates
- Model the structured spatial (vectors and raster) and non-spatial database (Excel tables, text file)
- Produce metadata for all data embedded in the database
- Publish the database obtained on the FAO platform "Geonetwork"
- Train staff working in the Sourou Basin on water accounting and on the use of the FAO Geonetwork platform



# Outcomes

## Knowledge management:

- Boundaries and scale of the basin defined and a digital elevation model (DEM) produced.
- GIS database of water resources (rainfall, reservoirs, boulis, marre, wells, boreholes) and related relevant information (breeding, fishery, agriculture, irrigated and rainfed areas, agro-economic products) elaborated.
- Geo-referenced digital assessment of water uses in the watershed, including all relevant sectors, prepared.



Source: ZIE, Ouagadougou



Photos: © Fethi Lebdi

Transboundary watershed of Sourou extending between Burkina Faso and Mali obtained by extraction of a DEM

## Capacity building:

Managers and technicians from specialized agencies and institutions trained on:

- Water accounting standards with a view to applying them in the water management of the Sourou watershed.
- Geo-referenced identification of the resources producing or using water.
- Measurement of the different components of the water balance.
- Utilization of Geonetwork as a user and / or administrator.
- Maintenance of the database on the Sourou watershed.



Photos: ZIE, Ouagadougou

GeoNetwork training in Dédougou, November 2017



# Pilot site – Sous bassin de Ghdat

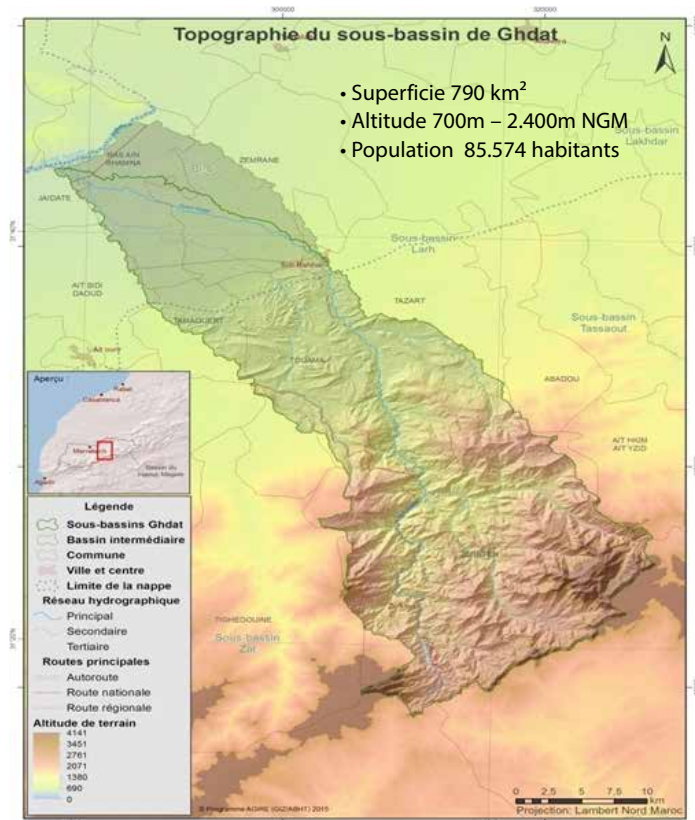
## The location of the project area

The Ghdat sub-basin is part of the hydraulic system of the Tensift Wadi. It is surrounded by the Larh sub-basin to the east, the Zat sub-basin to the west, the High Atlas mountains to the south-east and the Tensift Wadi to the north-east.

It represents around the 5 percent of the Haouz-Mejjate basin

## In-country project development:

- Identification of the pilot site, in consultation with national institutions (Tensift Basin and Ghdat sub basin)
- Preparation of the Ghdat land and water resource database, including: (i) geo-referenced time series on precipitation, river flow and groundwater level; (ii) basic information including weather maps and (geo-) hydrological maps, soil maps, maps of the dynamics of land use and vegetation cover
- Assessment of hydro-meteorological trends (rainfall, river flows and groundwater levels data)
- Assessment of the different water uses at basin level, including agricultural, municipal, industrial and environmental uses, through the employment of geo-referenced information
- Training of relevant personnel on the operation and maintenance of the water accounting tool

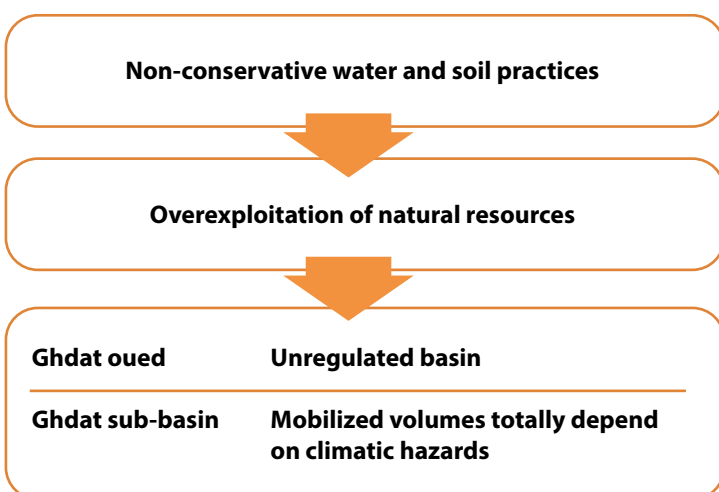




# Objectives

## General objective:

*Improve water management practices and strengthen water efficiency in the agricultural sector*



Photos: ABHT, Marrakech

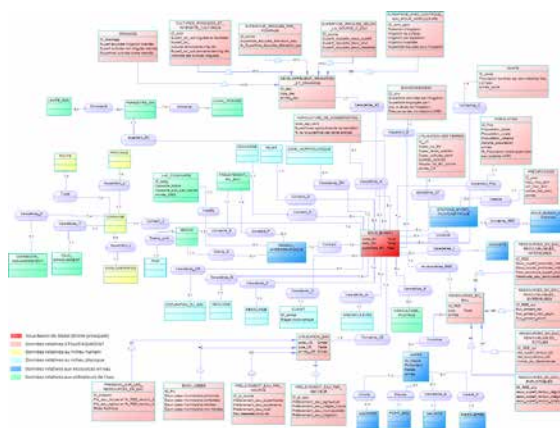
Ghdat sub-basin, Tensift basin

## Specific objectives:

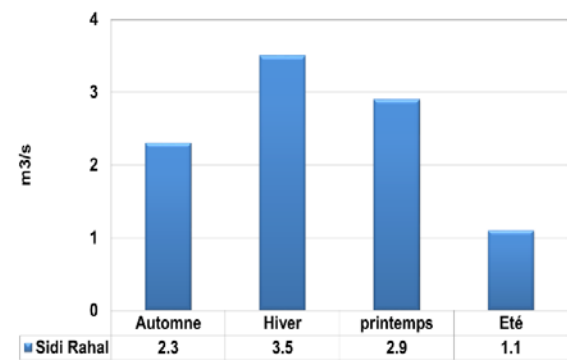
- Establishment of a structured database including existing GIS data and a Metadata description, compatible with FAO GeoNetwork standard.
- Assessment of capacity development needs in relation to information systems for water management, at regional/local level. Assessment of the coherence of existing information systems and opportunities for integration
- Elaboration, in collaboration with concerned institutions, of a strategy to align the sources of information on water resources
- Review of existing data and trend analysis of meteorological records, stream flows and groundwater levels in the Ghdat sub-basin
- Report on agricultural and irrigation practices (evapotranspiration spatial/temporal distribution, impact of alternative irrigation practices on groundwater recharge, groundwater potential trends)
- Training of staff in charge of the management and use of water resources at the sub-basin level on the use and maintenance of the WA tool

## Knowledge management

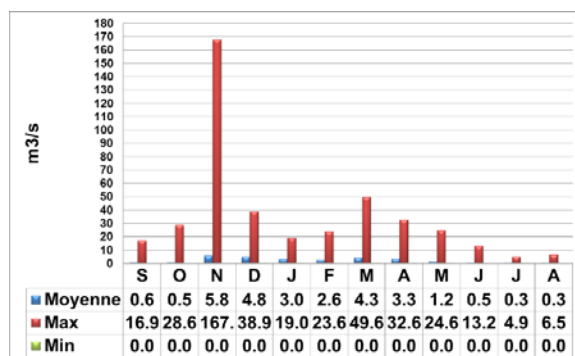
- Database preparation study for water accounting in the Ghdat Basin, inclusive of GIS data
- Ghdat basin comprehensive database and related Data Conceptual Model (Modèle Conceptuel des Données – MCD)
- Review of meteorological and hydrological data and records in the Ghdat basin



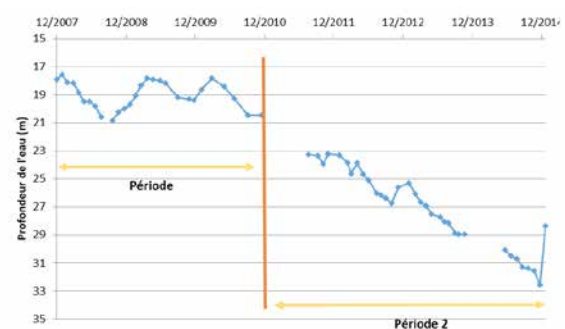
All data: ABHT, Marrakech



Average seasonal debits (1964-2017) Sidi Rahal station



Average monthly debits (1964-2017) Sidi Rahal station



Evolution of water depths at piezometer 2915/53

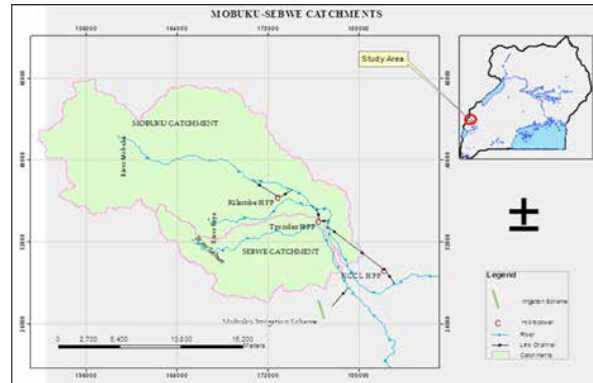




# Pilot site - Mubuku irrigation scheme

## The location of the project area:

- In Uganda, agriculture contributes to 44 percent of the total output and over 70 percent of national export earnings. It employs 80 percent of the labor force
- Over 160 million people employed in the agriculture sector in the Nile Basin. It represents more than 20 percent of the Nile Basin GDP



Source: NBI, Entebbe

## In-country project development:

- Collection of hydro-meteorological data, spatial data and relevant water use data of the Mubuku catchment and irrigation scheme
- Collection, processing and compiling of data on Mubuku irrigation scheme and future potential expansion plans, in consultation with local government and relevant Ministries
- Collection, processing and compilation of data on domestic, industrial and livestock water demand
- Collection, processing and compilation of data on existing hydropower plants in Mubuku catchment
- Processing of data and preparation of quality-controlled datasets
- Analysis of hydrological data for developing the water resources model of the Mubuku catchment





# Objectives

## General objective:

*Explore scenarios of Mubuku irrigation expansion coupled with other water uses in the catchment*



Photos: CIHEAM, Bari

Mubuku irrigation scheme

## Specific objectives:

- Development of water resources database for the Mubuku catchment
- Analysis of hydro-meteorological trends of the Mubuku catchment
- Assessment of water uses in the Mubuku catchment
- Training of staff from relevant Ministries and institutions on the operation and management of land and water database



© Eva Pek

### Results of the baseline model (run on a daily time step from 1956 to 2016):

- Domestic water demand satisfied under all conditions
- Environmental flow met under all conditions
- Irrigation water demand registered some substantial deficits



# Outcomes

## Knowledge management

- Comprehensive analysis of Mubuku catchment water resources, including: (i) Meteorological, (ii) ETo, (iii) Hydrological, (iv) Topographical, (v) Irrigation, (vi) Water use data



CIHEAM Bari



Dennis Besigye



CIHEAM Bari

## Capacity building

- Technicians and professionals from the Ministry of Agriculture Animal Industry and Fisheries (MAAIF) trained on GeoNetwork Opensource.



Photos: NBI, Entebbe



# Mubuku irrigation scheme –DSS for planning of water resources

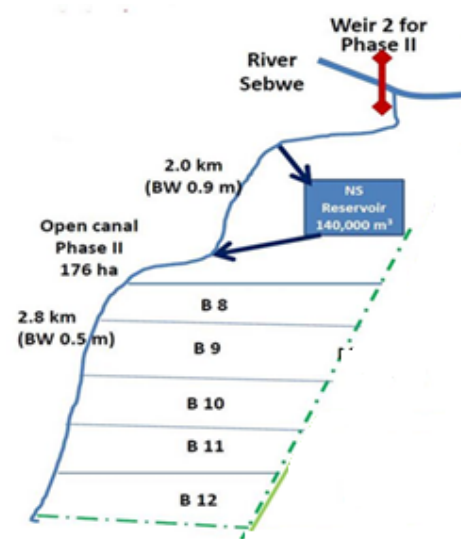
- The expansion of the selected irrigation scheme (Mubuku) is envisaged with a range of scenarios addressing improved irrigation efficiencies.
- A collaboration with the Nile Basin Initiative (NBI) is established to develop a Decision Support System (DSS) application for the planning of water resources management in the Mubuku catchment.

## DSS application for Water Resources Planning:

- **BENCHMARKING:** Develop a Mubuku catchment model using extended meteorological records and river discharges
- **WATER RESOURCES PLANNING:** Develop a Decision Support System (DSS) application with extended records of water use by different sectors

## Outcomes:

- Develop alternative scenarios using DSS application to account for Mubuku irrigation expansion
- Analyse modelling results and synthesize the findings
- Prepare conclusions and the recommendations



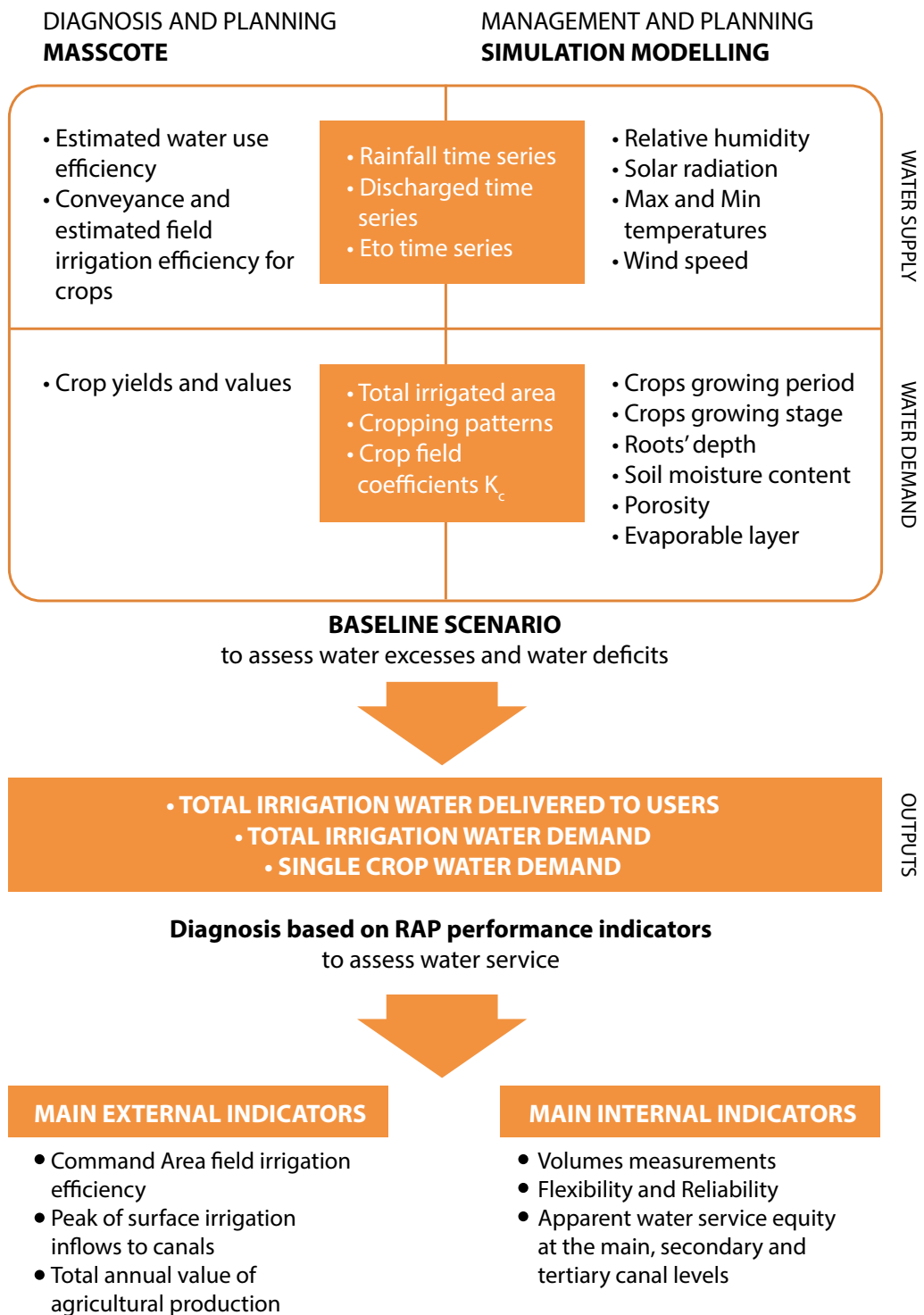
Source: CIHEAM Bari



## The approach:

- A knowledge-based Decision Support System (DSS) for Mubuku irrigation scheme is developed, integrating MIKE Basin Model and the Rapid Appraisal Procedure (RAP) of MASSCOTE approach as a water resources planning tool.

### DATA COLLECTION FOR:





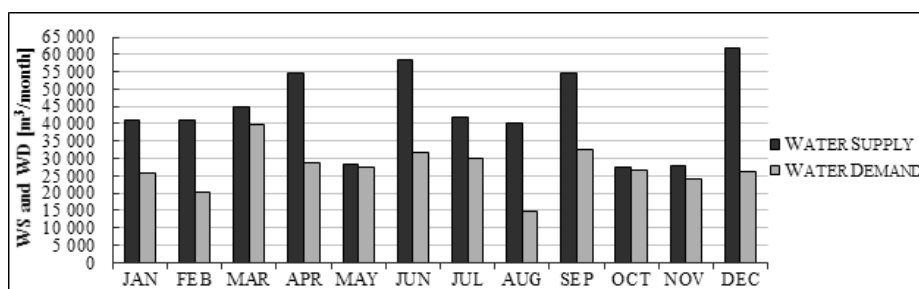
With the baseline scenario established, external and internal indicators are processed in order to:

- evaluate alternative ones, towards the irrigation scheme performance assessment
- improve irrigation operations and water delivery services
- enhance efficiency of water management practices

## ALTERNATIVE SCENARIOS:

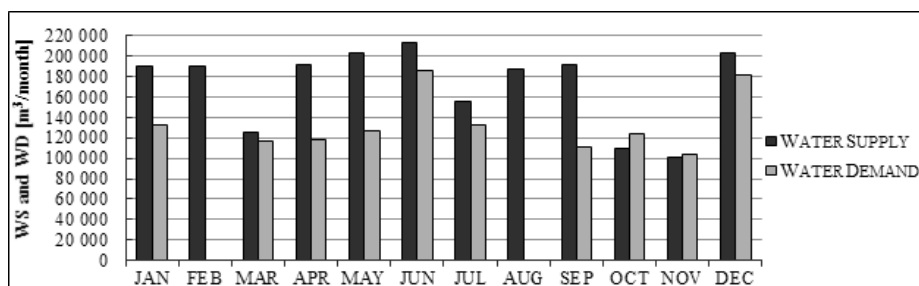
### *Flexible water service to increase field irrigation efficiency*

Indicator:  
field irrigation  
efficiency



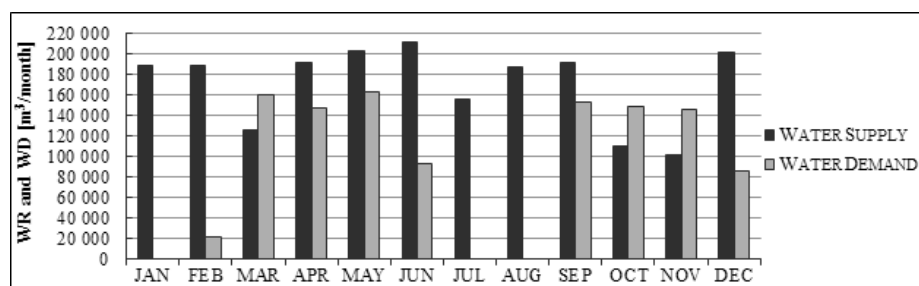
### *Market stability to verify DSS applicability for decreasing farmers' market risks*

Indicator:  
agricultural  
production  
value



### *Food security to verify DSS applicability for farmers' socio-economic conditions*

Indicator:  
food security



Source: FAO, 2018 (all)



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# AgWA

Partnership for agricultural water for Africa



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