IMPETUS MOROCCO

P10

Economic Aspects of Water Management in the Dr, a Valley

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The Problem Setting in the Dr, a Valley

Background

The D, a catchment is characterised by very low rainfall, which makes irrigation mandatory for agricultural production. Water for irrigation is mainly delivered by the Dr, a river and its tributaries which originate in the High Atlas. In the beginning of the seventies, the Mansour Eddahbi reservoir was built, and since this time water distribution has become subject to centralised planning. Among other considerations, such planning should be based on the economic value of water in its different uses, namely farming, consumption, industry and power generation.

Challenges on the water supply side

- Declining water supply from the rivers
- Decreasing water releases from the Eddahbi reservoir
- Increasing overexploitation of groundwater aquifers
- Drinking water shortages in some oases

Challenges on the water demand side

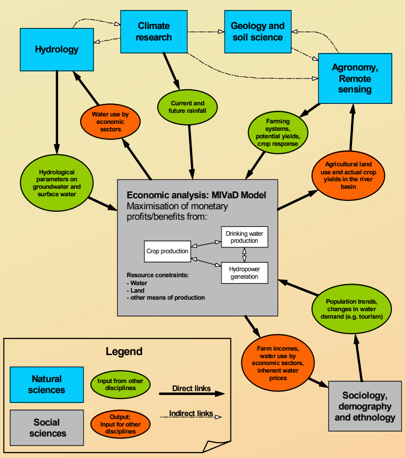
- Growing demand for drinking water: population growth, easier access to public networks, increasing tourism
- Competition between farming and other water uses
- Traditional irrigation works with high water losses

Research objectives

- What is the relationship between local, traditional (oases) and ëmoderní, centralised water management (Mansour Eddahbi dam)?
- What is the economic value of water for different water users?
- How do alternative water management regimes (centralised planning, water trade, water pricing) impact on water use?
- Will the agricultural use of water be constrained through competition from other water uses such as tourism?
- What are feasible strategies for sustainable water use?

Interdisciplinary Modelling of Water Management

Economic Water Management Analysis within IMPETUS-Morocco



The integrated hydrologic-economic model MIVaD is dependent on results from:

- natural sciences (hydrology, meteorology, agronomy, remote sensing)
- social sciences (demography, consumption-related research)

Integrated river basin modelling in turn offers results to:

- social sciences (sectoral water use, water prices, farm incomes, consumer welfare),
- hydrology (water use by location in the basin)
- agronomists and geographers (land use, actual crop yields)

Characteristics of MIVaD (ModËle IntÈgrÈ de la VallÈe du Dr, a)

- Integrated hydrologic-economic optimisation model at the river basin scale
- Water supply and demand are balanced while agricultural gross margins, profits from hydropower generation, and municipal/industrial water user benefits are maximised
- Nodes represent river reaches, reservoirs and demand sites (oases and villages); links represent the linkage between these entities (see chart)
- One-year time horizon with monthly steps

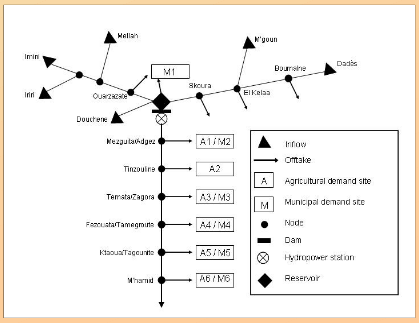
Components of MIVaD

- *Hydrologic components:* like flow balance for each node, water balance of the Mansour Eddahbi reservoir, and water balance in irrigated fields
- *Agronomic component:* crop yield functions on the basis of the FAO methodology $1-\frac{Y_{actual}}{Y_{max}}=k_y\left(1-\frac{ET_{actual}}{ET_{max}}\right)$
- *Economic components:* water use benefits from irrigation, hydropower generation, and municipal/industrial use

Technical implementation

- Coded in the modelling language GAMS (General Algebraic Modeling System)

Node-Link network of the Dr, a valley in MIVaD



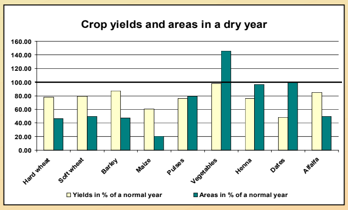
Simulations and Exemplary Results

Comparing Normal and Dry Years

Water supply in the Dr, a basin crucially depends on winter precipitation in the High Atlas. Based on meteorological data, water use in a dry year is compared to the situation in a normal year. MIVaD assumes the perspective of a central planner who distributes water among different users, maximising economic utility of all economic agents involved (farmers, consumers, hydropower producers).

Special assumptions for the simulation

- Normal year:
  - initial reservoir storage 234.9 Mio m^3, 343.2 Mio m^3 inflow into the reservoir
  - reservoir storage at the end of the year at least 50 % of the maximum storage capacity
- Dry year:
  - Initial active reservoir storage 65.9 Mio m^3, 80.3 Mio m^3 inflow into the reservoir
  - reservoir storage at the end of the year at least 15 % of the maximum storage capacity
- Gross margins for all crops have to be positive with the exception of dates.
- Date area is fixed (perennial crops), dates benefit from the irrigation losses of other crops.
- Water is distributed to individual oases and municipal demand sites in a way which simultaneously maximises the sum of agricultural profits, consumer welfare, and the income from hydropower generation.



Farmers primarily reduce cropping areas in dry years, while trying to retain the yield levels of the annual crops.

Results for the irrigated part of the valley

	Normal year	Dry year
Use of available crop area (%)	64.1	32.0
Agricultural river water use (mio cbm)	306.3	51.2
Agricultural groundwater use (mio cbm)	0.0	32.6
Total agricultural water use (mio cbm)	306.3	83.8
Shadow agricultural water price (DH/cbm)	0.1	1.5
Consumption water use (mio cbm)	7.1	6.5
Consumer surplus total (mio DH)	37.3	36.7

Agricultural water use is more reduced during droughts than urban water use, because the marginal value per water unit for irrigation purposes is small as compared to the willingness to pay of urban consumers.

Hotspots of interdisciplinary work:

- A better understanding of the complex hydrological processes in the Dr, a basin is achieved by **cooperating with the meteorologists and geo-hydrologists involved in IMPETUS**. Particular attention is paid on the role of groundwater in the hydrological cycle.
- Deeper insights into farming systems, crop yield response, and strategies of farmers to cope with droughts will be gained through agro-economic interviewing surveys in the D, a oases, carried out **together with agronomists in IMPETUS**.
- The MIVaD results on land use in the Dr, a basin are validated with the help of **geographers using remote sensing techniques**.
- Among other human factors, demographic change within the projection period requires special attention, as it is a major driving force of agricultural productivity and thus the use of irrigation water. This will be addressed **jointly with the demographers in IMPETUS.** Moreover, estimations of trends in non-agricultural water use for household consumption, industry and tourism are carried out.

Beneficiaries in the Dr, a Basin (Stakeholders)

Agricultural Office ORMVAO
(Office RÈgional de Mise en Valeur Agricole de Ouarzazate)
➔ Agricultural producers

Water authority DRH (Direction RÈgional de lëHydrologie)

The purpose of MIVaD is not to be the ëultimate management toolí for a central planner, but rather a decision support system to be embedded in the stakeholder dialogue!

Drinking water Authority ONEP
(Office National de lëEau Potable)
➔ Urban and rural consumers
➔ Industry and tourism

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