REGULATIONS OF MAIN CANALS IN LA MOULOUYA SCHEME
CASE STUDY ON TRIFFA DOWNSTREAM MAIN CANAL

by

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Introduction

Low Moulouya scheme covers a total area of 335 000 ha, out of which about 71 000 ha are irrigated from Oued Moulouya (Oued = *river*). Flow regulation of Oued Mouloudya is ensured by the hydraulic complex Mohamed V- Mechraa Homadi.

The capacity of Mohamed V reservoir, initially at 730 millions M3, is now estimated to be at 410 millions M3 (1993 measurements). The reduction in the useful capacity is the result of sediment deposit since the completion of the dam.

The Mechraa Homadi dam is a regulation and diversion structure, feeding two main canals. Its current capacity is 10 millions M3.

The scheme is made of 4 distincts areas where irrigation is practiced since the earlier developments in 1951. The Triffa scheme is composed of:

⇒	Right bank	Triffa valley	36 000 ha	
⇒	Left bank	Zebra area	5 600 ha	
⇒	" "	Bouareg area	10 178 ha	
⇒	" "	Garet area	13 500 ha	
⇒	" "	PMH	5 722 ha	(PMH = Small and Medium Systems)
		Total	**71 000 ha**	

1. INFRASTRUCTURE EQUIPMENT

1.1 Right and left banks main canals of the Moulouya river

Those canals amount for a length of 241.13 km. The continuous sediment deposit occurring in them is a major concern. Sediment deposit creates favorable conditions for aquatic plants to develop. As the result of deposit and plants, an important reduction of the flow capacity occurs (decrease of the flow section, increase of roughness). This situation creates difficulties in operating the systems.

1.2 Secondary canals

They represent a 337.3 km canal length with varying size from diameter 800 mm to 1400 mm.

1.3 Tertiary canals

Canals amount for a total of 808 km, the size varies from diameter 390 to 700 mm. The tertiary network allows to deliver water to collective or individual outlets. They are equipped with numerous structures and specific equipment for water distribution.

1.4 Run-off and drainage network

The run-off network is 378 km long. All areas in Mouloudya scheme are equipped with a network of streams designed to protect irrigated areas against flooding. This network diverts run-off towards natural streams. Run-off flows are heavily loaded with solid materials which provoke here and there large

deposit that requires every year to undertake works for reshaping stream profile and maintain its full capacity. Those works are realized with mechanical as well as human means.

The length of the drainage network is 651 km.

1.5 Unpaved road network

The scheme disposes of a grid of unpaved roads (1195 km) to transport inputs and outputs related to agricultural production.

1.6 Pumping stations

Moulouya scheme relies on 29 pumping stations for its functioning:

- ⇒ Pumping stations used for the drainage.
- ⇒ Units to supply irrigation for upstream areas in Triffa and Garet.
- ⇒ One new unit, to pump the run-off flow downstream Mechraa Homadi dam. It allows for an additional 70 Millions M3/year.

Quality of service and water charging are highly dependent on the capacity in maintaining this equipment which irrigates 16000 ha and drains 2700 ha in the Madagh.

2. CONSTRAINTS ON WATER RESOURCE MANAGEMENT

2.1 Deposit and capacity reduction in Mohamed V reservoir

Initial reservoir capacity (1967):	730	Mm3
Measured capacity (1993):	411	Mm3
Rate of deposit:	12	Mm3/year
Estimated current capacity:	374	Mm3

2.2 Losses and evaporation

They are estimated at more than 120 Mm3/year

2.3 Low supplies at Med V Dam

This was the case in 1993 when supply amount only at 170 Mm3.

2.4 Degradation of hydraulic infrastructure

Roughness increases in main canals.
Failures and degradation of control structure in main canals.
Decrease of transport capacity:

Main Triffa canal		Left Bank main canal
Q initial	18 m3/s	Q initial 17 m3/s
Q actual	14.5 m3/s	Q actual 14 m3/s

2.5 Multiple use of main canals for irrigation and for domestic water consumption

This multiple uses of water makes difficult if not impossible the undertaking of repair works.

2.6 Decrease of distribution network capacity

It occurs in secondary and tertiary canals, where many buried pipe sections have been created to diminish the inconvenience of surface infrastructure. In sectors under rotational distribution, the duration of irrigations are then greater than 20 days.

2.7 Degradation of portable equipment for sprinkler irrigation in Garet area

2.8 Fragmentation of fields

3. DYSFUNCTIONING OF THE REGULATION IN DOWNSTREAM AREA OF TRIFFA

The main canal in the downstream part of Triffa, called CPBS, is 84 km long. The difficulty in operating is related to the following aspects and constraints:

- ⇒ conjunctive use of canals for irrigation and domestic supply.
- ⇒ a multiple mode of regulation.
- ⇒ pumping stations for lifting and pressurizing.
- ⇒ the additional supply from Moulay Ali pumping station.
- ⇒ the canal is not entirely managed by ORMVAM.

3.1 Canal Principal Bas Service (CPBS) (Lower Main Canal)

Discharge issued at the head of the canal is controlled by a combination of a disk-type level regulator and a set of baffles totaling 20 m3/s. Canal design capacity is 18 m3/s.

CPBS can be divided into three sectors:

- ⇒ Sector with upstream controlled technique (weir) down to 30,8 km.
- ⇒ Sector with mixte regulation, equipped with 6 mixte gates down to 59,6 km.
- ⇒ Sector with upstream regulation based on a set of Amil gates and weirs.

It is important to say that the way the canal is structured is the result of modifications made after the first completion. Modifications were based on changes between initial plans and later on development of the project. For example, the last part of the canal was designated to downstream control, when the second one should behave as a reservoir to compensate the difference between the upstream and the downstream.

3.2 Failures of current system

a. Failure of hydraulic and mechanical structures:

Limited means allocated for maintenance did not allow to maintain the functioning of hydraulic and mechanical structures at a satisfying level.

Equipment	Number	Comments
Mixte gate		Do not play their initial role, i.e., compensate for deficit by using reaches storage capacity and avoid spilling when downstream water demand decreases.
Avis gate (downstream control)	1	This gate is no more consistent with existing regulations modes
Amil gate (upstream control)	7	Oscillations occurs because of poor state of bumpers
Slide gate	-	Initially designed to only partition and isolate sections of canals, they are now used for manual water level control along portions of canals.

b. Fixed Structures:

They are essentially broad crest weirs, called Giraudet (water level regulators). They are 8 of them with a length varying from 32 and 40 ml, equipped with two bottom slide gates, for drying-up of the upstream pool.

Although those structures are efficient to control water level and deliveries at close-by offtakes, they create important hydraulic singularities, which ultimately provoke a diminution of the canal capacity.

4. FRAMEWORK FOR IMPROVEMENTS OF THE CURRENT REGULATION

4.1 Study of current CPBS regulation

To better diagnose the current situation and design appropriate solutions, ORMVAM has undertaken a study of the regulation with the following goals:

⇒ Phase 1 Analysis of existing technique and creation of a simulation model.

⇒ Phase 2 Technico-economic studies, quantitative and qualitative aspects of possible solutions, and choice of the more appropriate one.

⇒ Phase 3 Deeper study of the choose solution and design of a detailed project for implementation.

This study has allowed to embrace the issue of regulation in a global perspective, and also pointed out current dysfunctionning, which are spilling in the upper part of the canal and excedents or shortages in the downstream part.

Several solutions presenting variable degrees of complexity and automation had been studied:

1. Manual regulation
2. Remote Monitoring
3. Remote control
4. Full automatic control

The full automatic control though more expensive than the manual solution has been preferred. It was felt that the financial difference does not compensate for the day to day difficulties, linked to manual operation.

Recommendations of the study are summarized in the following sets of actions:

Restoring the initial capacity:
Preliminary works aiming to reestablish initial capacities in conveyance and control capacity where problems have been stated.

Creation of damping storages:
- linear storage capacity (8 000 M3), in two reaches using mixte regulation, in the medium sector of the canal.
- downstream pond of 30 000 M3 at the diversion point of Branch A and B.

Implementation of a monitoring and control remote system:
This system will be made of 7 secondary postes (PS), one central unit in Berkane (PC) and two transmission relays.

Aware of the difficulty in implementing such a complex solution, ORVAM has proposed a stepwise implementation; the monitoring and control remote system is planned to be the last step.

4.2 Static regulation

In order to improve regulation in upstream parts of the canal, ORMVAM has built 3 broad crest regulators (Giraudet) to feed properly nearby offtakes. This solution will be however dropped in the future after implementation of the new regulation plan.

4.3 Extension of the study to the upstream sub-system and branch A and B

An additional regulation study is planned to cover the upstream sub-system and branch A and B, with particular emphasis on pumping station.

4.4 Rehabilitation of the Avio gates at the head of secondary canals.

4.5 Rehabilitation of the main canal to diminish its roughness and increase its effectiveness to better master time-lags.

4.6 Regular service of hydro-mechanical structures in the limits of means devoted to maintenance.

4.7 Building of the Ain Chebbak reservoir, 30 000 m3 capacity (already started in 1996).

Summary of activities to improve regulation

Designation	Schedule
Study of current CPBS regulation	Completed
Extension of the study to the upstream sub-system and branch A and B	1997/98
Building of the Ain Chebbak reservoir, 30 000 m3 capacity (already started in 1996).	Under works
Rehabilitation of the Avio gates at the head of secondary canals	Completed
Acquisition and settling down of hydro-mechanical devices for CPBS Triffa and rehabilitation of existing regulators	1998/2000
Acquisition and settling down of Avis gate for the upstream sub-system	1998/2000
Implementation of a monitoring and control remote system	1998/2000
Installation of five points of automatic measurements on the main canal	1997/99

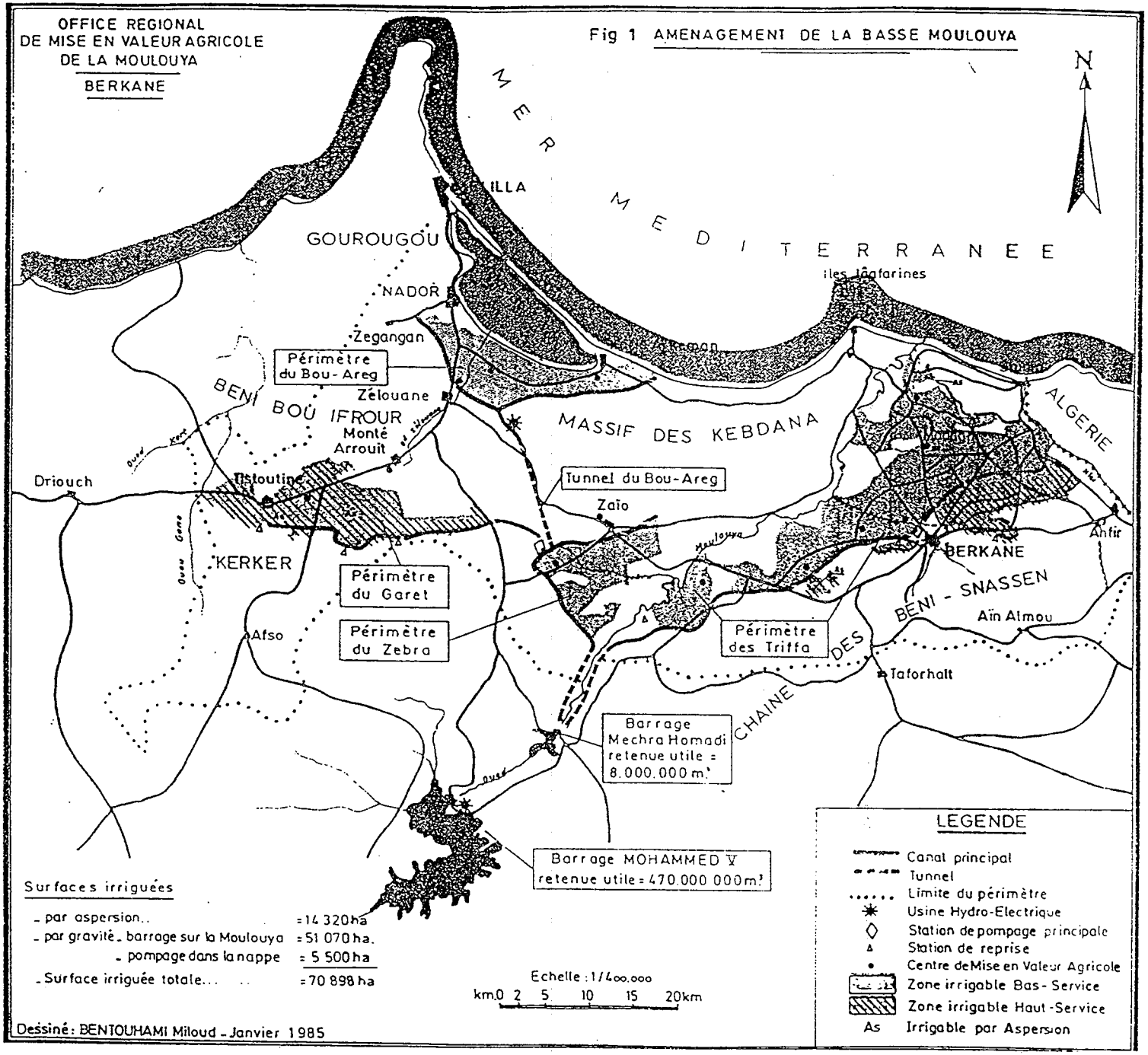
6. CONCLUSIONS

The analysis of the downstream scheme of Triffa, shows that solutions of regulation problems can only be found through a global approach of the system. Local intervention can have side effect leading to dysfunctionning the cause of which are later on difficult to detect.

It must be noticed that ORVAM has proved to adapt with many changes in the management of the system since its initial design and implementation. So far, the quality of water service has been maintained at high level despite low means for maintenance and in the context of limited water resources.

Furthermore, canal simulation showed the importance of having intermediate storage capacities, either through side ponds or on line. Volumes of storages are strongly related to the constraints included in the scenario. The higher the level of constraints to overcome, the greater the requirements of intermediate storage. This is why it is of great importance to make sure that scenario coincides with realistic constraints and objectives of the manager.

Last, the ORVAM experience shows that the quality of the service of water and water conservation are highly dependent on the proper functioning of the whole physical system. A strategy for regulation is essential to achieve the latter goal. This is why improvement of regulation techniques is considered by ORVAM as a high priority.


OFFICE REGIONAL
DE MISE EN VALEUR AGRICOLE
DE LA MOULOUYA
BERKANE
Fig 1 AMENAGEMENT DE LA BASSE MOULOUYA
N
MER MEDITERRANEE
ILLA
GOUROUGOU
NADOR
Zegangan
Iles Zaffarines
Périmètre du Bou-Areg
Zelouane
BENI BOU IFROUR
Monté Arrouit
MASSIF DES KEBDANA
ALGERIE
Driouch
Tistoutine
Tunnel du Bou-Areg
Zaio
KERKER
Périmètre du Garet
Périmètre du Zebra
Afso
BERKANE
Ahfir
BENI - SNASSEN
Aïn Almou
Périmètre des Triffa
Taforhalt
CHAINE DES
Barrage Mechra Homadi retenue utile = 8.000.000 m³
Barrage MOHAMMED V retenue utile = 470.000 000m³
Surfaces irriguées
- par aspersion.. =14 320ha
- par gravité - barrage sur la Moulouya =51 070 ha.
- pompage dans la nappe = 5 500 ha
- Surface irriguée totale... =70 898 ha
Echelle : 1/400.000
km 0 2 5 10 15 20km
LEGENDE
Canal principal
Tunnel
Limite du périmètre
Usine Hydro-Electrique
Station de pompage principale
Station de reprise
Centre de Mise en Valeur Agricole
Zone irrigable Bas-Service
Zone irrigable Haut-Service
As Irrigable par Aspersion
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