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Keywords:

Valley, Mzab, ground water, pollution, environment, Dam

CLEANUP AND VALUATION OF THE WATER TABLE OF M'ZAB VALLEY (Algeria)

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Abstract

The M'Zab Valley; an arid region known by low rainfall and sudden and devastating flooding. For centuries, the local population benefits from flood water to replenish groundwater through traditional dams made along wadi Mzab. Thanks to traditional wells, farmers irrigate their gardens even during dry periods. In this study we treat the consequences of the contribution of modern water harvesting techniques. Discharges of domestic water and upwelling of groundwater has contributed to the pollution of the water table.

Keywords: Valley - Mzab - Ground Water - Pollution - Environment - dam.

1. Introduction

In the M'Zab valley, flooding in times of floods and pollution of ground water are the main topics of concern to local inhabitants and authorities (Ouled Belkhir, 2002). Mozabites developed over centuries original architecture, listed as a world cultural heritage. This art is reflected both in the overall structure of the various Ksars that in the architecture of houses and mosques (Delta, 2006). Hydraulic developed by Mozabites over the centuries has been the subject of admiration by scholars. Hydraulic works were made in the M'Zab Valley as weirs, dams, tunnels and shafts. The wadis have been built with an original know how. Through a complex network of seguias, pipes and allows dispatchers to drive the water gardens. Part of this water recharges the groundwater. In times of drought, Mozabites capture groundwater by traditional wells by appealing the work of animals (donkeys, mules, camels). The contribution of new techniques of water harvesting (boreholes and pumps) has unbalanced the M'Zab Valley. This new situation has caused the rising water in several areas of the M'Zab Valley as if the Souf Valley (Bengurgoura Laradj and Remini, 2013).

2.1. Location of the M'Zab Valley

The Mzab Valley is located south west of Algeria, 600 km from Algiers (Fig. 1). Five ksours were built on Mzab valley: El'Atteuf in 1012, Bounoura in 1046, in 1053 Ghardaia, Melika and Beni in 1124 Isguen in 1347 (Benyoucef 1986). The area of five ksours is around 67 ha. The valley runs through a limestone plateau and ksours are on the rocks bordering the river where the soil consists of loam and sand. Agriculture is the main activity in the valley. Found in a date palm garden, fruit trees, vegetable crops and fodder. Concerning water resources in the region, surface water occur in flood periods, which recharges aquifers by conventional techniques (Ouled Belkhir, 2002).

2.2 Missions in the oases of Mzab

We have made several trips to the oases of Mzab during the years 2010, 2011, 2012 and 2013 Surveys of the population ksours were conducted during our missions. During these missions we observed a deterioration of the M'Zab Valley following the release of sewage into the river Mzab. Traditional structures are deteriorating from one year to another. Dams traditional of Bouchen and Touzouz are silted following the deposition of sediments.

3. Results and Discussion

3.1. The hydraulic structures of Mzab Valley

In the Mzab valley, there are a multitude of hydraulic works for the water harvesting and recharge of groundwater.

3.1.1. The dam on wadi El-Abiodh

The dam is located on El Abiod river upstream of the confluence with the river of Mzab was recently carried out just after the famous flood of October 2008. It is intended for flood control. This book essentially consists of a masonry wall supported by buttresses and a raft downstream. It is provided on the right bank of a weir equipped with a flat valve. Its objective is to ensure a recharge of the water table whose exploitation allows irrigation of surrounding agricultural areas.

3.1.2. The dam of Ahbasse Ajdid

It is among the oldest dam made along the wadi Mzab. It is intended for replenishing of the water table (Fig. 2). The dam consists essentially of a spillway sill at two levels which is closed directly on the existing track and the right bank which is made of a masonry wall supported by buttresses.

3.1.3. The dam of El Atteuf

This is the dam the most emblematic of the Mzab valley. The dam is to cross the wadi, is based on the slope on the right bank. The dam has a spillway and a topographical closure consists of a stepped embankment on a masonry wall (fig.3). The main dam has suffered a major breach after the flood of 2008. repairs and reinforcement has been made to restore its integrity.

3.2. Environmental degradation

3.2.1. Flood

Floods nuisance of Wadi Mzab are dangerous and often cause adverse effects in the palm and crossing the urbanized areas. Floods cause damage to homes and residents. Floods are also the cause of livestock losses and sometimes human lives (floods of June 1991, September 1994, June 2004 and October 2008). The flows from the side wadis also pose risks to the population (Ouled Belkhir, 2002; Roche, 1996).

3.2.2. The waste water

Over the years, discharges of sewage into the river Mzab increased in an exceptional way. In many places, sewage encumber the bed of the river and pollute groundwater. This is due either to faulty connections (such as the connection of Ben Ghanem neighborhood to the main drain) or the absence or malfunction of the main. In areas where the main collector is not yet built, bleedings were performed in the bed of the wadi to channel wastewater to the next completed section of the drain (Fig. 4 and 5). Recharging groundwater percolation is thus favored and the upwelling of this accelerated table (Fig. 6).

3.2.3. Interference of drinking water systems and wastewater

The distribution of the population on both sides of the valley involves many crossed the bed of the wadi by the supply network of drinking water. However, some areas of the river are choked with sewage stagnant (Fig. 7). This is dangerous for the populations served, given the risks of waterborne diseases that made them run.

3.2.4. Solid waste

Wild dumps bulky bed of the river Zab (Fig. 8). During floods, these wastes are arrested by the valley crossings, thereby significantly reducing the flow section of the wadi and causing overflows on the banks. The solution can only come from the establishment of an effective waste collection service and the involvement of the populations concerned. Furthermore, it is important that such wastes are discharged to a sanitary landfill.

3.3. Impact of upstream rolling works

The objective of these dams is to reduce peak flood flows. Until millennial flood frequency, the maximum flow rate released by the dams on El Wadi of El Abiod and Haimeur will be 20 m3 / s and the released downstream of the dam of Bou Brik will be 5 m3 / s. For frequency of floods rarer still, as the flood of October 2008, the flows released downstream will be as follows (Roche, 1996) (table 1).

At the confluence of Wadi El Abiod, El Haimer and the right of El Atteuf dam, approximately at the beginning and the end of the urbanized area, peak flows of the hundred-year flood, natural and rolled by the upstream dams are following: (Ouled Belkhir, 2002; Roche, 1996) (table 2).

The protective effect of these works is extremely important since it allows to divide the cutting edge of design flood flow by a factor between 2.7 and 4. Depending on the position of the point considered along the valley, the effect of the intermediate catchment gaining in importance as one moves downstream. Thanks to this contribution and downstream facilities of the bed of the wadi, property damage and loss of life can be avoided. The other impact of these dams is to extend the flow time in the bed of the wadi. Thus for a centennial event, the flow time for floods occurring at various dam sites is amended as follows (Table 3).

This has two consequences: the water table recharge downstream of barrageset possible re-use of flood waters. This feature, which connects these deductions tradition of flood storage and spreading of dams built for centuries by Mozabite civilization, allows through a temporary adjustment of floodwaters to manage these contributions and hold and flexible in the project situation. It also limits this provision risks to traditional dams built along the river and mainly the side intakes such as the dam Bouchène (Fig. 9) (Ouled Belkhir, 2002; Roche, 1996).

3.4. Impact of the work in the bed of the river and on the banks

After the flood of 2008, the bed development work and reinforcement of the banks have been initiated in order to protect nearby homes against flooding. The design of hydraulic structures along the valley used to protect settlements against a hundred-year flood frequency. For example, the return period for the flood of 2008 can be estimated at about 100 years. Currently, the river became a Mzab discharge area wastewater deposit rubble and garbage (Benssaad 1998)

3.5. Discharges downstream of the treatment plant

A wastewater treatment plant was conducted in River of Mzab near the oasis of El Atteuf. At this stage the flow of treated water not used by agriculture will be rejected in the wadi. The environmental impact will not be as favorable. The discharged water have the following parameters: $DBO_5 \leq 50$ mg/l, SM ≤ 120 mg/l, Faecal Coliforms (FC): CF $\leq 5.10^4$ FC/100 ml, Helminth eggs: ≤ 1/L (German, 1995) . The conditions of the fauna and flora will be greatly improved over a few kilometers. The development of vegetation will however be controlled close to the treatment works to avoid negative impacts on flood conditions of passage.

3.6. Wastewater reuse for agriculture

The potential evapotranspiration (PET) is around 2 meters/year in Ghardaia. The extreme values of the ETP occurring in July and August are about 500 mm, more than twice as much as during the cold season. These differences are not without consequences on the agricultural practice. The report Rain / FTE is less than 0.03, which is extremely low by the standards of temperate countries. The large deficit must be offset by appropriate irrigation (Ouled Belkhir, 2002). The reduction in FTEs within a cultivated plot depends on a priority of the precautions taken at the time of its furnishings and its provision in the topography of the site, its orientation to the prevailing wind, the breeze afforestation winds, the succession of cultures and the operating system (high seeding) (Ouled Belkhir, 2002; Michel, 1993). In the Sahara, it is necessary to calculate the cheapest irrigation doses at different stages of culture by applying the adjustment coefficients called structural coefficients (Michel L, 1993). The breaks in irrigation will not have the same consequences on yields depending on when they occur, they can be catastrophic for culture at certain times of her cycle. Plants are often under stress in terms Saharan when sufficient blood flow, hence the need for adequate water supply, leading to privilege, with date palms, rather winter crops (barley and vegetables) planted in September and harvested in April. Advanced needs must be taken into account in the calculation of an irrigation water system. In summer it assumes volume of 2500 cubic meter / ha/month which is about 700 l/tree/day, for an orchard of 120 palms / ha (Delta, 2006). Based on a volume of water treated 23 000 m3 /day at the end of work and 46 000 m3/day project on the horizon, palm of the area it will be possible to irrigate respectively 275 hectares and 550 hectares. To allow the Administration to support a feasibility study of implantation of an agricultural perimeter site Kef Doukhane irrigated with treated wastewater, the terms of reference for such a study are given in Materials suspended and the risk of soil clogging. The irrigation system should take into account the content of suspended matter that we will exit lagoons, of the order of 120 mg/l. To avoid the risk of clogging of irrigation systems and limit soil sealing possibilities, it is important to use drip irrigation systems with irrigation equipment with large openings (Benyoucef 1986).

3.7. Fertilizing elements

The wastewater contains many nutrients which the plant needs for growth, such as nitrogen, phosphorus, potassium, zinc and copper. For wastewater containing a nitrogen content of 15mg / L, application of 100 mm corresponds to a nitrogen intake of about 15kg / ha. As with the use of fertilizers, it is necessary to avoid excesses, and we must strive to give the plant the amounts of water needed for its development, excess nitrogen or potassium can s infiltrate into the soil and into the groundwater (Fontaine, 1969; Lallemand, 1995).

3.8. Risks of contamination

The conditions of secondary treatment by lagoons can guarantee a water quality that can be used for irrigation not intended to be eaten raw crops. The permanence of good management of the treatment system is a necessary provision to prevent possible pollution. Care must be taken to avoid contamination with pathogenic bacteria operator personnel, and consumers. The irrigation system must be designed to limit direct contact with the treated effluent (Lallemand, 1995).

Conclusion

The positive impacts of the proposed decontamination and recycling are:
-The Guarantee the protection of property and vis-à-vis populations flood: the town is completely immune to this type of event up to a hundred-year frequency, thanks to the temporary retention structures in flood upstream and amenities of the bed of the river downstream.
- The recharge of the water table close to laval temporary flood retention structures
- The possibility for an extended period of reuse, with traditional infrastructure, flood waters, thanks to the works of the aforementioned rolling effect
- The protection of groundwater against pollution from waste water, improved sanitary conditions
- Clean the M'Zab Valley throughout the urbanized area and downstream of the dam of El Atteuf, also improving the sanitary conditions and the visual and olfactory impact.
- Rehabilitation of the bed of the river Zab, leading to a new image in the urban landscape, in particular by avoiding to consider it as a dumping ground
- The wastewater treatment outside inhabited areas
- The possible reuse, at least in part, treated water for agricultural irrigation with an area of 550 ha of palm trees on the horizon of the project
- The re-treatment sludge to agricultural land use purposes
- Offer the simplest and most reliable solutions possible: in particular this was an argument for the choice of wastewater stabilization ponds.

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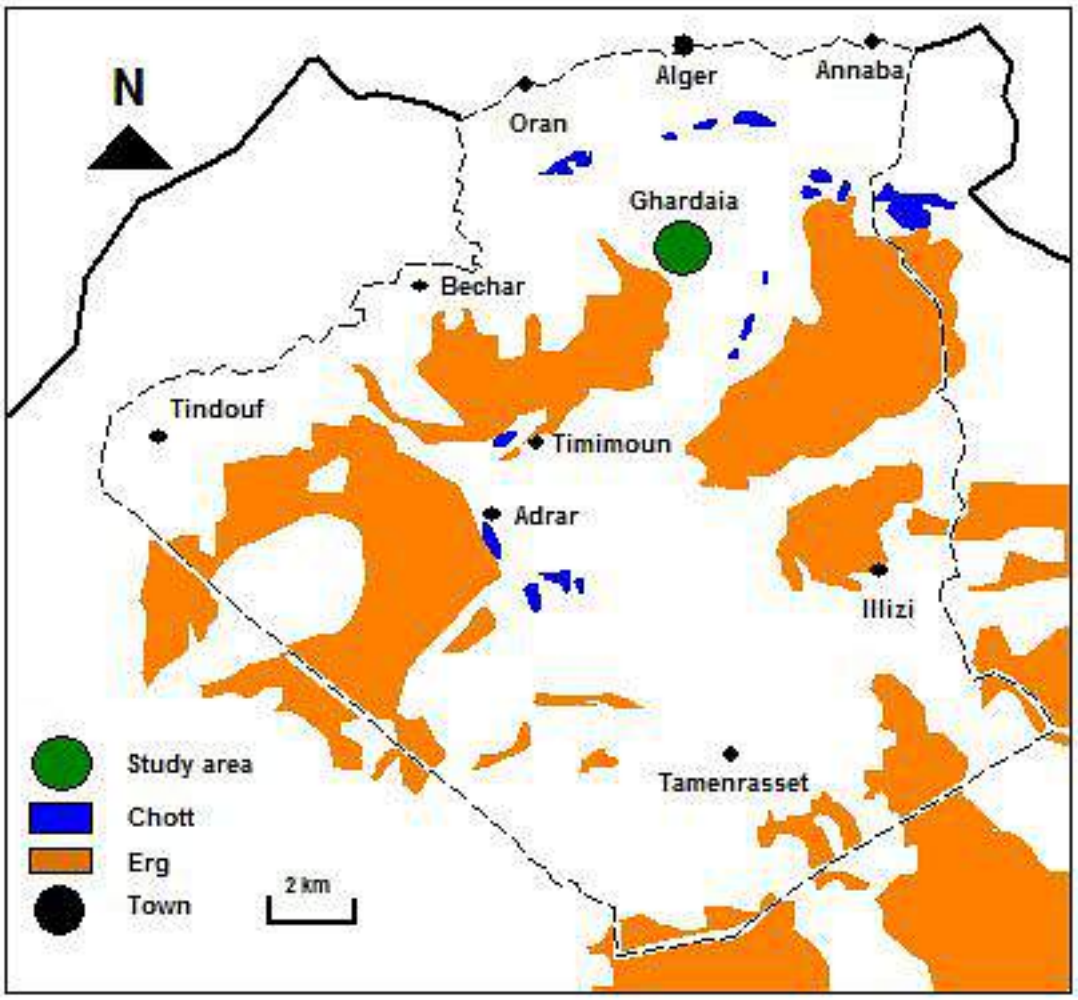
	Discharge (m3/s)	
Dam	Natural Discharge	Rolled Discharge
El Abiod	1400	240
El Haimeur	1030	250
Bou Brik	500	75

Table 2. Peak flow of the century flood at the confluence: El Abiod River - El Haimeur River and at the dam of El Atteuf

	Discharge (m3/s)	
	Natural discharge	Flow with upstream dams
Confluence	690	170
El Atteuf dam	780	290

Table 3. Flow time of year flood downstream of dams

	Time (Hours)	
Dam	Natural time	Duration of the rolled flood
El Abiod	25	250
El Haimeur	19	150
Bou Brik	7	105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