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Phreatic aquifer water upwelling: causes, consequences and remedies

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***Abstract*—** Ouargla has suffered a lot from water upwelling that has affected negatively human and environment. The present paper consists in presenting the quality of phreatic aquifer water, exposing the causes of water upwelling, consequences of the rise of water level over the surface ground and impacts of the mega project of fight against the water upwelling that has been realized between the end of 2006 and 2009.

Obtained results from the comparison between stats of phreatic aquifer before and after works have shown that there were a positive impacts in the Ouargla city center: downwelling of phreatic aquifer water, reduction in salt concentration and elimination of nitrate nitrogen.

Key-Words— phreatic aquifer, water upwelling, mega project, impacts, Ouargla.

I. INTRODUCTION

Increase in water demand in Algerian Sahara has led to recourse more and more to the exploitation of groundwater. This has entailed an important increase in exploited water flows, as much in new agriculture perimeters as in traditional palms groves, associated, especially, with a use often badly reasoned of water resources, which has led to important wasting, revealing appreciable amounts of water surplus.

Ouargla constitutes a typical case in which overexploitation of groundwater, deteriorated by an absence of an effective device of management of these resources downstream, has led to appearance of enormous quantities of water surplus that made this oasis a sick basin of too much water.

II. AREA STUDY

Ouargla is one of main oases of Algerian Sahara, It is situated at a distance of 800 km from the capital Algiers (31° N, 005° E). It is installed in a basin, which constitutes an outcome of hydrographic course of oued M'ya and it presents a morphological context favorable to water stagnation.

For its climate, Ouargla is situated in zone with extreme climatic conditions. It is characterized by clearly marked aridity and an almost permanent drought.

The average annual temperature, measured over the period 200-2012, is 23.4 °C, maxima average and minima average are of 44.8°C and 2.8°C, respectively, during July and January, the average annual thermal amplitude is thus of about 42°C. For precipitation, the average annual, during the same period, is 56.7 mm.

In Ouargla, as for all Algerian Sahara, water used in different sectors is an underground water. Besides the phreatic aquifer, there are two large sets of water-bearing formations well known: continental intercalaire (CI) and complexe terminal (CT).

The phreatic aquifer water is characterized by a high total mineralization that exceed, sometimes, 6g/l. water of the CI and the CT are of mediocre quality; their measured values of electric conductivity indicate a high mineralization because

they are globally more than 1 mS/cm. furthermore, they correspond to values of total mineralization exceeding world health organization (WHO) standards (1.5 g/l) [1]. For water temperature of different aquifers, measured values indicate: about 20°C for phreatic aquifer, between 25°C and 29°C for the CT and more than 55°C for the CI [2].

III. CAUSES OF WATER UPWELLING

The problem of phreatic aquifer water upwelling is of an unbalance between brought volume of water and that evacuated. According to Côte [3], in traditional system, mobilized water, coming from wadis and phreatic aquifer, is discharged in cesspools after domestic use and in spraying areas after agricultural use. Non-evaporated part percolates and joins the phreatic aquifer. Between brought volume of water and that evacuated a balance becomes established on long term and water level in the phreatic aquifer remains stable.

According to the same author, appeal to big aquifers, because of the increase in water demand, generates an unbalance. Strong flows introduced into circuit of water use are at origin of strong volumes of wastewater that do not return to deep aquifers (CI and CT), neither are they evacuated outside of hydraulic pond (morphological context favorable to the stagnation of water). They will, unfortunately, join phreatic aquifer, which they swell of so much.

When water brought coming from the depth (large aquifers) is powerful and continuous in time, water level in the phreatic aquifer rises, eventually close to ground surface. There are cases when phreatic water appears on ground surface, reveling an ecological imbalance.

IV. CONSEQUENCES OF WATER UPWELLING

Water of phreatic aquifer in Ouargla are of bad quality. By referring to made studies, phreatic aquifer water is of alkaline character (pH>7) [4], with an electric conductivity of more than 1000 µS/cm and which reaches sometimes 6000 µS/cm and more, either of a total mineralization exceeding WHO standards (1500 mg/l). According to WHO standards of water drinkability, total water hardness of phreatic aquifer water in Ouargla exceeds 54°F , which shows that this water is very hard. Chemical facies of water samples of phreatic aquifer show that water is sodium and potassium chloride [4].

Concerning pollution parameters, analyses of water samples have shown that nitrate nitrogen concentrations are very high (10 to 114 mg/l). Same remarks have been done for orthophosphate with concentration of more than 1 mg/l. These high concentrations are caused by the discharged wastewater that join the phreatic aquifer. Therefore, for concluding, we can say that water of phreatic aquifer is salted and polluted.

This phreatic aquifer water quality has negative effects on soil, plants, constructions environment, etc…

According to El Fergougui and Boutoutaou [5] and El Fergougui et al. [6], in Ouargla water level in phreatic aquifer is close to ground surface (0-1.5 m). In the presence of very severe climatic conditions, evaporation process from phreatic aquifer contributes, largely, to the salinization of soil and its degradation [5, 6, 7]. The degradation of soil affects crops and plants, especially palm groves [8].

Saltwater, very close to ground surface or which appears on ground surface, affects rhizosphere what is going, possibly, to kill crops and plants.

Concerning constructions and according to Saggaî et al [9], water upwelling, because of the bad quality, affects negatively constructions (buildings, roads, etc…). For sulfate, majority of registered values were between 446 and63280 mg /l, which means that this water was of high aggressiveness for constructions if we refer to standards [10]. Concerning chlorine, values were between 655 and 169797 mg/l, these values exceed tolerated values [11], and by consequence a fatal effect on constructions. Finally, for magnesium,