



The impact of climate changes on the acceleration of reservoir siltation in arid regions the Algerian case study

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ABSTRACT

In this paper, one will treat the increase in the rate in silting and his impact on the reduction in the total capacity in the dam during these twenty last years. In a first approach, the grounds eroded by the streamings will increase the content of sediment in the wadis, and consequently one will assist with the formation more and more currents of density in reserves in arid and semi arid areas. The results showed that the dam Djorf Torba (Bechar), SMBA (Tiaret) and Ksob (Msila) which were classified like dam has weak rate of silting during the years four twenties, today are threatened by the silting; their rates of sedimentation increased considerably. Dam like that of Fodda wadi saw its sluices of drainings blocked following an acceleration of the muddy deposits.

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Introduction

Algeria is a country vulnerable to the climate warming. The rise of the temperatures and the fall of precipitations in the area of the Maghreb will have negative impact on water runoff and storage. In the arid and semi arid areas of Algeria, hydrous erosion has increased since the beginning of the four twenty ten years causing a silting and accelerated loss of capacity of millions m^3 /year. Hydrous erosion is a process which is directly related to climatic factors, particularly rainfall. The fact that an expected increase in floods during the hydrological year and especially in autumn, will increase the tonnage of sediment eroded to the extent that events (floods) come after a long dry period or the ground is bare or sparsely covered by vegetation and therefore much more sensitive.

The rate of sedimentation evolved/moved these last years, because of the strong erosion of the basins slopes. Already at the beginning of the years four twenties, approximately 120 million tons of sediments torn off annually on the catchments level of the areas of Algerian north (Demmak A., 1982). Part of this mass settles in 57 dam which Algeria holds. One annually evaluates the sedimentary deposit in these dam to 45 million m^3 (Remini B and Hallouche W, 2007). The volume of mud estimated in year 2006 is 1,1 billion m^3 , that is to say a rate of filling of 17%.

Erosion and silting of the dam

Hydrous erosion corresponds to separation between the particle and its support, without including transport and sedimentation, even if there is always a micro transport (Rampon A., 1990). The erosion of the basins slopes is very widespread in the area of the Maghreb, since all the conditions are met to start and develop such a process: the climatic

irregularities, low vegetable density of cover, the nature of the grounds which is not very resistant to the flow and the violence of the risings. Indeed, the area records the highest values of planet. Several examples testify to the gravity of the problem. In Algeria the specific rate of erosion reaches the value of 5000 t/km^2 /year on the catchments area of Wadi Agrioum (Demmak A., 1989) (fig. 1). In the basins slopes of Martil, of Ouergha, Lakhdar, and Tessaout in Morocco, the rate of erosion exceeds 2000 t/km^2 /year (Badraoui A. and Hajji A., 2001). In Tunisia, hydrous erosion degrades the cultivable grounds. 1,2 million hectares are seriously affected by erosion in north, and centers it of Tunisia, that is to say 25% of the total surface of the grounds (Bouzid A., 1991).

There are currently 57 dams in exploitation (fig. 2) that, all to varying degrees, gradually silting up of 45 million m^3 /year, which represents an annual loss of capacity equal to 0.65% of capacity total.



Fig.1. Un vue sur le bassin versant très dégradé du Beni Chougrane (Ouest Algérien)(Remini B., 2008)

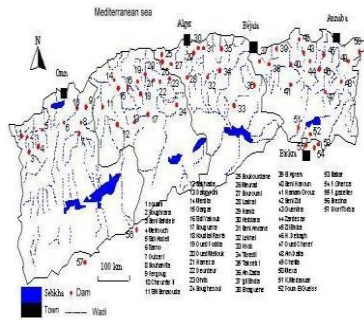


Fig.2. Distribution of the dams in exploitations in north Algerian

It is thus noted that the incidence of the silting can be significant, since an office plurality of 1.1 billion m^3 settled into 2006 in the dams reservoirs, the equivalent of a loss of 17% of the total capacity (fig. 3). It is also seen that one should not exaggerate the importance of the phenomenon and one can say that the rate of silting of 0.65%/year means that the dam can last 140 years. It is necessary thus to banish the idea too usually allowed that the silting condemns the dam in Algeria. It is a significant phenomenon, certainly, but it is necessary to take care not to regard it as a fundamental data of hydraulics in Algeria and that any study water-supply engineering must take into account this parameter. It is to be announced that the rate of silting has much to increase at the beginning of the years two miles, that due to the dryness which A prevails our country during the years four twenty ten, is especially followed wet years. This alternation of dry and wet years caused a strong erosion of the basins slopes. Indeed the Nineties (dry) were characterized by a weak vegetable cover and dissected and loosened grounds.

On the other hand, the years two thousand were characterized by intense rains and devastating for the grounds. Consequently, the risings of these five last years which were violent and brutal are the cause of a strong ablation of the surface layer of the ground. One noted that according to the last bathymetric surveys carried out into 2005 and 2006 by the national agency of the dam on dam that the rate of silting of certain dam increased considerably compared to that of 1986 (table 1).

Following the introduction of 26 new dam of which that of Beni Haroun, most dam of Algeria of a capacity of 960 million m^3 the storage capacity doubled in 20 years while passing from 3,2 billion m^3 in 1986 to 6,8 billion m^3 into 2006. This increase in the capacity will involve forcing an increase in the volume of mud.

For the only dam Beni Haroun, one considered the deposit annual of sediments at 9 million m^3 . For the moment, one estimates at 3,5 million m^3 of mud per year the rate of silting since its current capacity does not exceed 350 million m^3 .



Fig.3. Barrage envasé à 100% dans le bassin versant de Chellif (Ouest Algérien)

Mechanisms of the silting

The majority of reservoirs in Algeria have favorable conditions for the occurrence of density currents. Indeed, the strong concentration in sediments in the rivers especially in period of raw and the geometrical form (of channel type) give rise to the density current at the entry of a reservoir and can be propagated to the dam. One can say that this acceleration height of the deposits of mud in reserves is the consequence of an office plurality of sediments caused by the arrival of several density currents (fig. 4).



a)



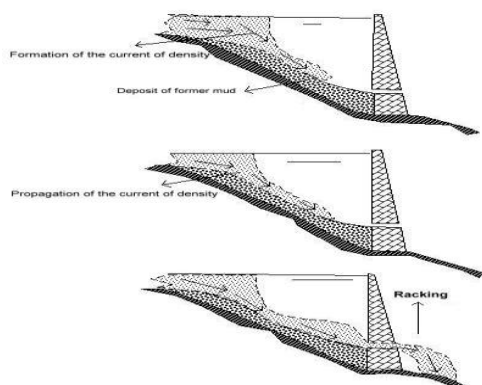
b)

Fig. 4 (a et b). Propagation du courant de densité dans un canal rectangulaire. Le courant de densité se propage au fond d'un réservoir sans se mélanger avec de l'eau. La vitesse du courant de densité dépend de la concentration des sédiments.

The characteristic of the dams in Algeria is that its currents of density appear in period of rising. With each rising, a significant quantity of sediments is drained by these currents. Thus, the currents arrive easily at the foot of the stopping. If the bottom outlets do not open at the time of the arrival of the latter, the silting accelerates (fig. 5). Actually, the appearance of this phenomenon is conditioned by two essential factors which are joined together the arid areas and more particularly Algeria:

The risings of the wadis can transport a significant quantity of sediment (the density can vary from 1,040 to 1,200), from where a factor of pressure $\Delta\rho / \rho_m$ significant ($\Delta\rho$ driving force of the currents of density). This strong concentration appears especially during October and September, succeeding the estival period during which the wadi is dry. It is not rare to see the wadis like Berd wadi, to roll muddy water whose load is higher than 100 g/l.

The geometrical form of the whole of reserves is of type "channel", which determines particular conditions of flow and sedimentation. The rate of the flow can certainly vary and sufficiently decrease to allow a deposit of sediments, but the flow will be able to keep a turbulent mode until in edge of the tank.



Conclusion

The silting of the dams is a natural process whose consequences can be dramatic. It has a direct impact on the tank by involving a progressive reduction of its capacity. Even if the intensity of the silting is different from an area to another for various reasons, the annual rate of sedimentation for the 57 dams in exploitation were evaluated to 45 million m³. The climatic changes have a direct effect on erosion and consequently on the

silting of the dams. The lifespan of some of them can reach 365 years, whereas for others it is reduced to 60 years. The loss of the capacity passed from 0.5 %/year to 0.65 %/year of total volume during the ten last years. This is due probably to the accelerated degradation of the basins slopes caused by the climatic changes. The volume of the mud deposited in 57 dam in exploitation borders the value of 1.1 billion m³ that is to say a loss of capacity of 17% of the total reserve.

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Table 1. Rate of silting deduced by the surveys from 1986 and 2004

Dam	Rate of annual silting deduced by the survey from 1986 (millions m ³)	Rate of annual silting deduced by the survey from 2004 (millions m ³)
SMBA	1	1,3
Djorf Torba	1,3	2,6
Ksob	0,3	0,6