Development of an Erosion Reduction Management Strategy for Watersheds and Reservoirs in Algeria

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Résumé

Pour le compte du gouvernement algérien, Tecsult a obtenu le mandat d'élaborer une stratégie de protection de bassins versant afin de réduire l'envasement de 23 barrages. Dans un premier temps, divers modèles ont été utilisés pour localiser les zones les plus susceptibles à l'érosion en nappe, au ravinement et aux glissements de terrain. Par la suite, des zones prioritaires ont été établies et des interventions anti-érosives ont été suggérées. La stratégie propose aussi des actions pouvant enrayer un type d'érosion qui est non modélisable (érosion des abords routiers et le sapement des berges) ou encore provoquer le dépôt de sédiments dans les cours d'eau (retenues collinaires, ouvrages de capture de sédiments). Les coûts nécessaires à la réalisation de la stratégie ont été estimés. Finalement, la réduction des apports sédimentaires au réservoir associée à la réalisation de la stratégie a été estimée.

Introduction

In Algeria, water is a key component of the economic development and its scarcity requires the use of dams for its storage and distribution for human and irrigation use. The Agence Nationale des Barrages et Transferts (A.N.B.T.) projects to build new dams for a total of 70 by 2010. However, soil erosion has contributed to reduce existing dam's reservoir capacities of 20% since their construction. In 2003, the A.N.B.T. invited Tecsult International to conduct a study whose objectives were to identify sediment source areas and propose a comprehensive watershed management scheme to reduce erosion for 23 watersheds and reservoir siltation. The total study area covers more than 30 000 km^2 and the allowed time to realise the study was 18 months.

Materials and methods

The loads of sediments carried to the reservoir have been estimated using reservoir surveys for existing dams or with the equation of Saidi (1991) for projected dams. The slopes prone to erosion were localised with three models. The RUSLE model was used to map sheet erosion. The SINMAP model was used to localise landslide sensitive areas. Finally, slopes prone to gully erosion have been identified using a model developed in the context of the project. The results of these models were combined in order to create a consolidated erosion risk map. Using this resulting map, a management scheme for each watershed was developed in four steps. Firstly, priority areas were determined according to the following characteristics: proximity to the reservoir, proximity to a stream flowing straight to the reservoir, erosion types (sheet, gully and landslides), surface area affected by erosion and inhabited areas and population density. After, slope protection techniques were proposed (ex. stone lines, tree planting, conservation practices, check dams) according to local land used and erosion type occurring.

In order to reduce reservoir siltation before slope protection techniques reached their maximum efficiency, special erosion control actions were also suggested. Their aims are either to trap sediments that are presently store in the rivers (such as storage basins and sediment ponds) or to protect river banks and roadsides from erosion. The budget needed for realising the watershed management plan with the special erosion control actions were estimated for each watershed. Finally, the worth of each project was examined by comparing the total estimated gain of water in the reservoir over a time period of 50 years with the "without" scenario. The reduction of stream sediment loads was estimated by subtracting from the current loads (or estimated with the empirical equation), those that will be trapped in the check dams in gullies, sediment ponds and storage basins. The sediment ponds and storage basins had an expected lifetime of 10 years beyond which they could not store incoming sediments because their reservoir would be filled.

Results and discussion

In order to illustrate the strategy, the watershed draining into the Fergoug dam's reservoir has been selected. This dam is in operation since 1986 and its reservoir had at that time a water holding capacity of 18 hm^3 that is presently of 0.4 hm^3 due to siltation and will be soon completely full. Figure 1 presents the management scheme for this watershed.

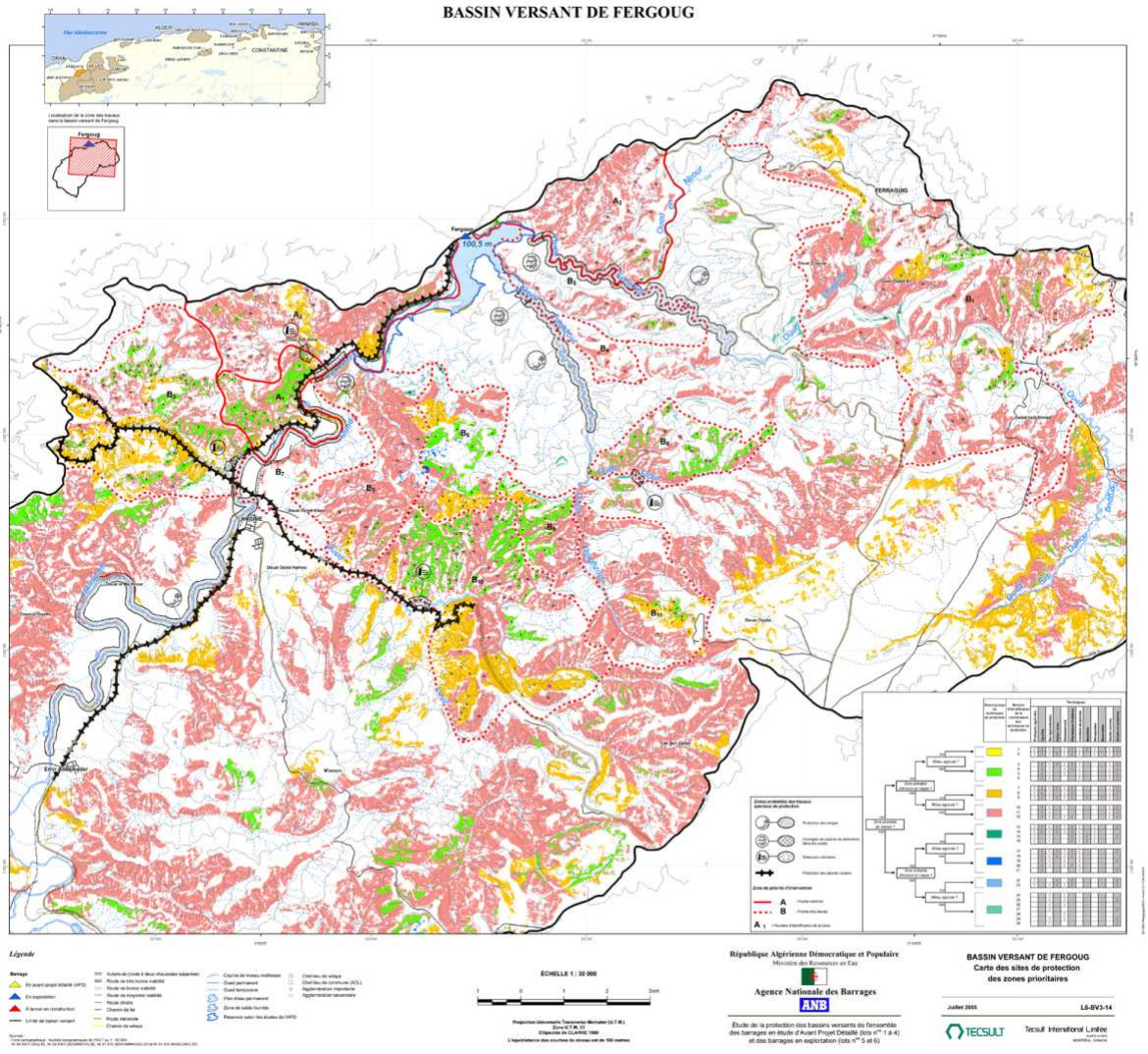

Figure 1. Example of a watershed management scheme.
Table 1 presents an estimation of the amount of slope protection techniques needed in the high priority areas.

Table 1 Amount of slope protection techniques needed on areas with a degree of priority either "extreme" (A) or "very high" (B).

Area	Best Management Practices (ha)	Opuntia (ha) (ha)	Grass cover (ha)	Shrub hedge (m)	Forest planting (ha)	Fruit tree (ha)	Stone lines (m)	Stone Walls (m)	Terraces (m)	Ridge (m)	Check dams in gullies (amount)	Drainage and waterways (m)
A_1	15	42	167	420	26	2	19 392	Ins.		Ins.	849	1 047
A_2		4	18		19	6	407				599	Ins.
A_3	62	8	49	1 541	39	4	1 691		180	56	1 179	730
B_1	122	43	221	6 083	240	13	15 298	Ins.		198	3 740	2 380
B_2			4		35	2	52				141	
B_3	233	58	247	11 634	30	7	26 801	Ins.		319	4 425	4 607
B_4			2								63	
B_5	19	8	45	965	91	7	775			49	1 133	343
B_6	68	20	85	3 398	16	3	14 256	Ins.		151	820	1 409
B_7	2	2	7	64	14		220				92	61
B_8		19	78			3	12 485				527	359

† Insignificant

The watershed scheme map also locates the special erosion control actions. For example, the Fergoug dam's watershed will need river bank and roadside protection on 34 km and 35 km, respectively. The map shows possible location for three sediment ponds and four storage basins. It is estimate that the protection of the reservoir will cost 664 million DZD (± 9.3 million USD). Figure 2 illustrates an estimation of accumulated sediment load in the reservoir site over a period of 50 years with and without the realisation of the watershed management scheme.

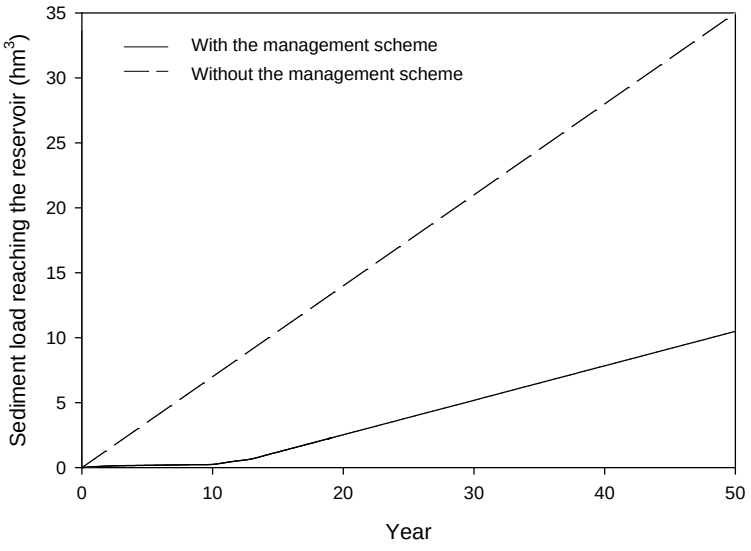

Figure 2. Sediment load prediction reaching the Fergoug's reservoir over 50 years after a with /without the management scheme scenario.

Without the realisation of the proposed management scheme, approximately 35 hm^3 of sediments will reach the reservoir after a period of 50 years. On the other hand, around 10.5 hm^3 of sediments will be carried to the reservoir over the same period of time if the management scheme is realised. This means that under the assumption of the "without project" the reservoir will be filled again in 25 years even if the reservoir is completely dredged today. On the other hand, this reservoir could still hold 8 hm^3 of water if the management scheme is realised after a period of 50 years.

This strategy was used for the 22 other watersheds and it was shown that there no is direct link between the estimated budget needed for the realisation of the management scheme and the associated gain of water in the reservoirs.

Conclusions

In conclusion, the creation of a consolidated erosion risk maps eased the location of all erosion types in a given watershed. The strategy developed by Tecsult in which priority areas are localised, erosion control actions are suggested, costs and resulting gain of water in the reservoir are estimated allows the ANBT to allocate more efficiently financial and technical resources at the national scale.

Literature cited

Saidi, A. 1991. Érosion spécifique et prévision de l'envasement. Actes du colloque sur l'érosion des sols et l'envasement des barrages, Alger. December 1-3 1991.