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# Analytical Investigation of Sediment Formation and Transport in the Vicinity of the Water Intake Structures - A Case Study of the Dez Diversion Weir in Greater Dezful

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***Abstract*****—**Sedimentation process resulting from soil erosion in the water basin especially in arid and semi-arid where poor vegetation cover in the slope of the mountains upstream could contribute to sediment formation. The consequence of sedimentation not only makes considerable change in the morphology of the river and the hydraulic characteristics but would also have a major challenge for the operation and maintenance of the canal network which depend on water flow to meet the stakeholder's requirements. For this reason mathematical modeling can be used to simulate the effective factors on scouring, sediment transport and their settling along the waterways. This is particularly important behind the reservoirs which enable the operators to estimate the useful life of these hydraulic structures. The aim of this paper is to simulate the sedimentation and erosion in the eastern and western water intake structures of the Dez Diversion weir using GSTARS-3 software. This is done to estimate the sedimentation and investigate the ways in which to optimize the process and minimize the operational problems. Results indicated that the at the furthest point upstream of the diversion weir, the coarser sediment grains tended to settle. The reason for this is the construction of the phantom bridge and the outstanding rocks just upstream of the structure. The construction of these along the river course has reduced the momentum energy require to push the sediment loads and make it possible for them to settle wherever the river regime allows it. Results further indicated a trend for the sediment size in such a way that as the focus of study shifts downstream the size of grains get smaller and vice versa. It was also found that the finding of the GSTARS-3 had a close proximity with the sets of the observed data. This suggests that the software is a powerful analytical tool which can be applied in the river engineering project with a minimum of costs and relatively accurate results.

***Keywords*****—**Erosion, sedimentation, Dez Diversion weir, GSTARS-3

## I. Introduction

SOIL erosion in certain regions of the water basin where poor watershed management has been implemented and the vegetation cover is poor would be troublesome during the rainstorms. Under these conditions the run-offs gather momentum and their shear force erode the top soils and transport them with the flow along the water course thousands of kilometers away and precipitate them where the conditions allow it. The sediment loads can be either in the forms of suspended or bed loads. As the flow velocity is high the load appears as suspended and where the velocity decreases the sediments tend to settle along the water course. The analysis of this complex hydraulic phenomenon particularly behind the hydraulic structures such as the diversion weirs, regulating dams and even large hydro-electrical reservoirs is one of the crucial considerations in river engineering and hydraulics. For this reason, systematic study of this hydraulic phenomenon and its proper management whether in the feasibility phases of the project or during the construction of such an engineering project cannot be underestimated. Systematic consideration of such parameters will ensure sustainability of the physical structures as well as improving the performance parameters in the long-run [1], [2], [6].

Estimation of variation in the flow discharge and sedimentation process can also help minimize the environmental impact. Typical examples are sediment formation in the form of islands along certain reaches of the rivers such as the Dez that are reportedly instrumental in changing the hydraulic characteristics and flow behavior [2],[3],[4],[5],[6]. Which more often than not disrupt the performance of the hydraulic structures. For this reason, analysis of the sediment load transport, using mathematical and physical modeling, is emerging as one of the most important river engineering projects for the researchers and water resources-related experts. Examples of these are SHARC, TCM, SSIIM and GSTARS-3[4], [5], [6].

## II. Materials and Method

The present study was conducted along a river range including a range between the old Dezful Bridge and the Dez Diversion Weir in Dezful. The Dez irrigation and drainage scheme, the largest modern network in the Middle East which incorporates complex hydraulic installations to supply water for a command area of about 100,000 ha. It includes a 3 billion $m^3$ hydro-electrical dam, a regulating dam and a diversion weir feeding the western and eastern canals of about 230 $m^3$/sec capacity [1],[3],[4],[6].

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The data were used from the Operation and Maintenance of the Northern Irrigation and drainage System Company. The study area 49946 ft upstream of the Dez diversion dam with 5 cross-sections is introduced to the model with a pre-determined distance from the base. The data required for the study are shown in figures 1, 2 and 3.

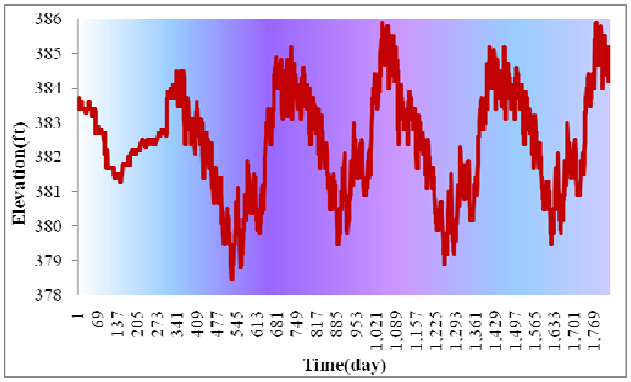

Fig. 1 daily water level curve

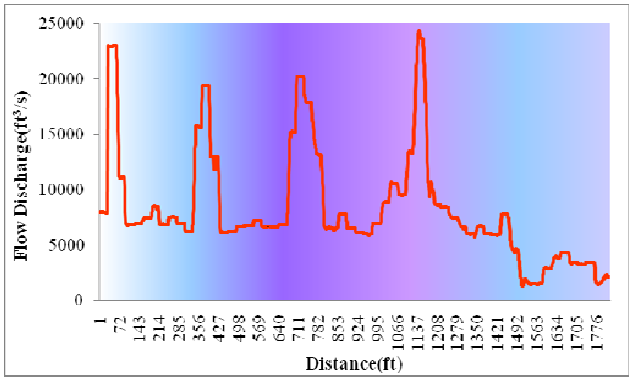

Fig. 2 daily flow discharge curve

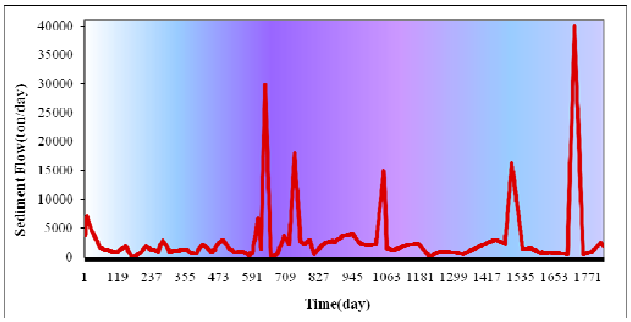

Fig. 3 daily sediment flow curve

## III. Results And Discussions

Results (figure 6) indicated that at 49946 ft at upstream of the diversion weir which incidentally is the furthest point in the study area is the greatest settling point. The underlying reason for such phenomenon is that the point in question is located along the path which the most bed scouring around the bridge pillars is occurring which in turn results in sudden diversion of the flow at those points. The fact that many of the rocks and the bridge pillars are situated along the river decreases the flow velocity which in turn leads to settling of the coarser grain sizes [3], [4], [6].

Results also indicated that at the point measuring about 45185 ft upstream of the diversion weir (figure 6), which increased in longitudinal gradient has had a corresponding increase in the flow entry which resulted in scouring and erosion(figure 5). As the investigation closes to the diversion weir at the cross-sections of 2553.9ft and 986.6 ft upstream, the increased bed gradient and increased in discharge flow will lead to increased in scouring effects and reduced in sedimentation of the materials. One of the main reasons for increased erosion and reduced sedimentation at the three cross-sections is to do with the type of the diversion weir and the ways in which it is operated and maintained.

Based on the results obtained from this study it can be deducted that the water entering this kinds of dams with minimum reduction in velocity relative to the initial velocity along the river course. Thus these kinds of velocities causes scouring and degradation upstream of the diversion weir [3], [4]. Given relatively finer grain size higher flow velocity, not only the sedimentation did not occur there but the degradation and erosion of the river bed was also observed. This shows a direct relationship between the bed slope with flow discharge and the degradation on one hand and inverse relation between these and sedimentation.

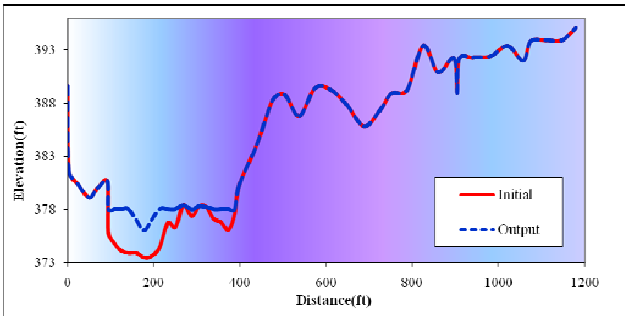

Fig. 4 No 1 cross section at 4994.6 ft upstream of the diversion weir

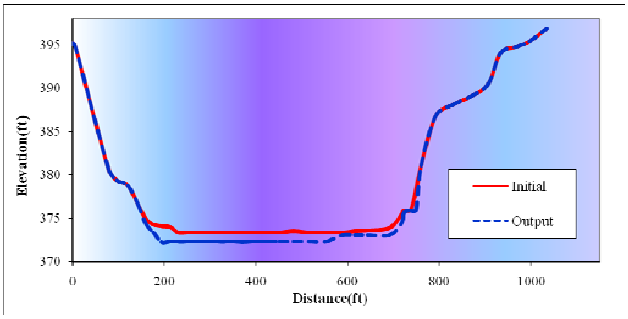

Fig. 5 No 2 cross section 4518.4 ft upstream of the diversion weir

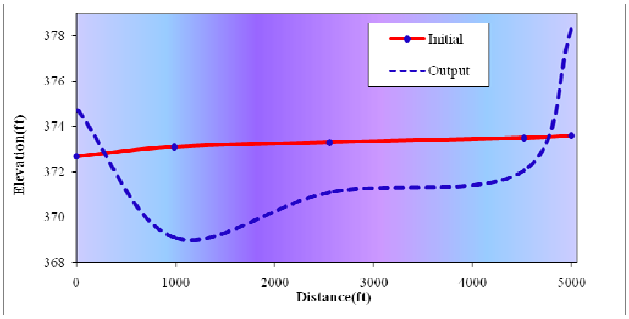


Fig. 6 longitudinal profile of the river bed and the model bed curve

Based on the longitudinal profile produced by simulation and calibration of the model (figure 6), little erosion and degradation at the closest point to the diversion weir was observed. The reason for that is to do with relative decrease in flow velocity. Given the curvature design feature of the western intake structure were diverted towards the eastern water intake structure. This was the underlying reason for the sedimentation processes and sediment formation on the vicinity of the eastern water intake structure which other researchers have already reported [3], [4], [6].

The overall conclusion being that the sedimentation process at the river cross-sections and in the same region where the eastern water intake structure is located the bed elevation has seen an increment in sedimentation and sediment formation. This has caused a change in the river morphology that manifested itself in shifting the hydraulic gradient towards the western intake structure that in turn has resulted in the increased in flow velocity and flow discharge towards that direction with serious consequences for the physical stability and operational safety of the structure in question. This difference in the elevation and shift in the gradient towards the western bank of the River Dez is interpreted to be linked with an increased in water flow entering the western intake, and from there, to the western canal on one hand and corresponding decreased in water intake in the eastern intake structure which the research investigation has already confirmed [3], [4]. It was found that the GSTARS-3 which was used in this investigation can be applied as a powerful analytical tool in feasibility studies and performance analysis of modern installations with a relatively high degree of accuracy and with low costs and high speed. Research concluded that as the study focuses on downstream, the sediment load size gets finer which substantiates the research findings elsewhere [4], [5]. Therefore the GSTARS-3 proved to be a powerful analytical tool for project feasibility study and the operation and management of the water related schemes.

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