Assessment of Environmental Flow Needs of Harirud Border Riverbed after Construction and Dewatering of Salma Dam in Afghanistan (by Hydrological Methods)

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1. Introduction

For the current age, with respect to the population growth and an increasing need for water, pressure on water resources has turned into a bioenvironmental challenge. This issue is seen more critically in dry and semidry countries such as Iran. In the same vein, flow-regime transitions as an initiative force to stabilize stream/river ecosystem is of significance since as a result of meddling with the natural areas of rivers such as dam construction, some bioenvironmental and geo-environmental adverse effects especially for downstream regions are the result. Therefore, the current study attempts to analyze the effects of the construction of Salma Dam on Harirud in Afghanistan which has raised issues in downstream regions (Iran Harirud) such as desert expansion, exacerbation of wind erosion in border regions of Harirud River, groundwater depletion, resulting in soil humidity decline, increase in soil salinity and so on. This study aimed to introduce the geo-environmental effects of Salma Dam construction and Harirud dehydration in Iran which has ultimately resulted in a decline of bioenvironmental potentials of the region. River dehydration has definitely natural adverse effects and challenges on the frontiersmen lives.

2. Study Area

Harirud in the eastern borders of Iran is viewed as the natural boundary, bordering Iran-Afghanistan and Iran-Turkmenistan. Our target area is about 190 kilometers long and five kilometers wide. The study area includes a zone featuring 61 degrees, 02 minutes and 61 degrees, 15 minutes in East longitude and 34 degrees, 55minutes to 35 degrees, 45 minutes in East latitude. The present study got the data from Harirud Hydrometric Station (Khatoon Bridge), founded in 1967, whose data range from 1977 up to 2016 were used. Before the Salma Dam was constructed, the natural medium flow was around 50 cubic meters. Moreover, the average annual rainfall of the eastern regions of Iran for Harirud basin is 188.7mm.

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3. Materials and Methods

The current study selected Harirud river for 190 kilometers long to Taibad and Doosti (Friendship) Dam Reservoir. To this end, ecohydrology models such as Tennant, tessman, Desktop Reserve Model (DRM), and flow duration curve shifting (FDC shifting) were used. In this case, the Tennant Model uses percental average of annual flow in order to determine the quality of fish habitats. This model was firstly used in Montana, Nebraska for 58 cross-sections of 11rivers, in which Wyoming concluded that at least 10 percent of annual average flow (AAF) is essential for fish short-term survival. In 1980, Tessman adapted Tennant Seasonal Model and integrated Mean Monthly Flow (MMF) and Mean Annually Flow (MAF) to determine the minimum amount of adequate monthly flow. Besides, Desktop Reserve Model (DRM) is capable of providing ecological flow requirements once a quick evaluation is needed and the data set is limited. In ecohydrological method, another model is flow duration curve shifting (FDC shifting) which has been proposed by Smakhtin and Anputas (2006), which intends to evaluate bioenvironmental flow in rivers, in order to provide protection in optimal ecological states and includes four major steps. All of these have been used in this study to analyze the river flow necessities of Harirud River, due to water decline as a result of Salma Dam construction.

4. Results and Discussion

According to the Power Ministry issues, and based on the Tennant Model, the acceptable levels for the first and latter halves of the year are 30% and 10% MAR, respectively. The logic behind the selection of six-month terms is two high-water and water-scarcity periods. Based on the hydrological data of the region, the two high-water and water-scarcity periods are from February to May and from July to December, respectively. Accordingly, for February to June and for July to December, the amount of bioenvironmental water needed based on Tennant Modified Model was calculated as 14.9 and 5 cubed meter per second, respectively. Bioenvironmental needs were met based on the study range in Tessman Model. According to the cases mentioned in Tessman Model for Harirud River, an average flow of 26.5 cubed meter per second (equal to 53% of Debbie Annual average) is needed. With regard to the ecological evaluation of the river, and based on the definitions in DRM Model, Level C (river changed state) was selected as an optimal ecological state. Since the river goes through two high-water and water-scarcity periods, that is, from march to May and from July to October, respectively, time series for monthly inlet flows were shifted two months (May was shifted to Day etc.). The results from the model showed for river life survival in level C, an average of 10.6 cubed meter per second was needed. GEFC software was used for FDC shifting. Flow duration curve shifting (FDC shifting) and target curves from bioenvironmental layers were studied in the river. With regard to the bioenvironmental importance of Harirud River, level C of biological classification (minimal condition for river survival) was selected as optimal. The statistics were conducted based on Tennant and Tessman hydrological Models and hydrological data in

order to meet bioenvironmental needs and the results obtained from these Models are not directly related to the ecological features of the river system.

5. Conclusion

In the current study, a vast range of ecological methods were used and attempts were made in order to exert modifications on how to apply the above-mentioned models, so that a near-natural condition could be studied. According to the classifications performed from the statistics, it was found that Harirud River zone is mostly located in level C of biological classification and in proportion to the vast area of Harirud River in Afghanistan and Iran, it holds an alarming condition which is definitely the result of Salma Dam construction and its water reservoir. It merits noting that the methods and the amounts recommended in this study are not the ultimate solutions for bioenvironmental issues of this river, since lack of comprehensive ecological data which is required in the studies of river ecosystem renders lower reliability in ecohydrological evaluations. But it is evident that as a result of a decline in the needs of bioenvironmental flows following water-scarcity, the quality of surface and subsurface water will drastically change leading in the aggravation of biosphere and eastern frontiersmen's lives. And that is because water degradation of Harirud River and its subsequent adverse results directly exert challenges for the region which is highly subject to and affected by agricultural economy, of which to name the natives' immigration to the larger cities where adverse consequences are created.

Keywords: Environmental needs, DRM, FDC Shifting, Tennant, Harirud River

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