Acta Scientific Agriculture (ISSN: 2581-365X)

Volume 1 Issue 4 September 2017

Research Article

Hydrological Impacts of Chashm Dam on the Downstream of Talar River Watershed, Iran

Gholami V[1], Khaleghi MR[2]* and Zabardast Rostami HA[3]

[1]Assistant Professor, Department of Range and Watershed Management and Department of Water Engineering and Environment, The University of Guilan, Faculty of Natural Resources, Sowmeh Sara, Iran

[2]Torbat-e-Jam Branch, Islamic Azad University, Torbat-e-Jam, Iran

[3]Mazandaran Regional Water Company, Iran

***Corresponding Author:** Khaleghi MR, Torbat-e-Jam Branch, Islamic Azad University, Torbat-e-Jam, Iran.

Received: September 09, 2017; **Published:** September 27, 2017

Abstract

Dam construction causes hydrological and environmental problems on the dam's downstream. Chashm dam will construct to provide the drinking water of Semnan province on the Talar river. The present study evaluates the hydrological and environmental effects of Chashm dam on the Talar watershed downstream. At first, some data were provided using topographic maps and GIS capabilities such as: watershed physical model, the effect the area of the rain gauge stations, the percentage of impermeable areas. Then, a rainfall-runoff model was presented to simulate the watershed hydrologic behavior using SCS method for simulating flow hydrograph, Initial/Constant method for estimating runoff values and Recession method for estimating base flow. Then, the model was optimized and validated. After validation, Chashm dam was simulated in the validated model to simulate the hydrologic response of dam multi-purpose reservoir and flow routing in the multi-purpose reservoir. Also, a comparison was done between the water needs of the downstream ecosystem and Chashm dam partnership in the water provision of Semnan province and also the comparison was done between input and output flows of the dam. The results showed that the volume of annual input water cannot provide Semnan water demand and downstream ecosystem water needs simultaneously.

Keywords: Hydrologic Effects; Dam Multi-Purpose Reservoir; HEC-HMS Model; Water Demand

Introduction

Recently increase and growth in population rate, industrial modernization and urban development caused to increase in water demands and necessitates various water resources supply such as dam construction and groundwater [1-5]. In the last century, there has been an increase in the number of dams used for various purposes such as drinking and sanitary water and other industrial purposes [6]. In order to water resources management and also to conserve the environments downstream from upstream dam construction effects, it is necessary to concern all dimensions of flow requirements [7]. According to many previous studies, reservoirs have an important role between the involved components of the upstream and downstream reservoirs such as environment and water ecosystem [8]. Manipulation of natural resources by anthropogenic activities results in an increase in peak dis¬charge and runoff volume of the watershed [9-12]. To assessing of the integrated water resources development and management, multi-purpose reservoirs are one of the most effective measures and play an important role [2,13-15]. One of the main important objectives of dam constructing is water supplies for versatile uses [6]. Defiance of the adverse effects of dam-induced flow regime change on downstream river properties and the accessibility of water resources, it seem there are significant changes flow and sediment regime between river reaches and over time [16]. In order to elevate the problem of operation of reservoir systems depend on goal; various optimization techniques have been presented [17]. Depend on the rate of needs to water supply, in various times of the year, various strategies are applied to water reservoirs in order to optimal control of reservoir systems such as in-taking and up-taking [18]. Magilligan., *et al.* [19,20] believed that an important change in the timing of downstream river flows can decrease and even eradicate aquatic biodiversity. Mikhailov., *et al.* [21] investigated various effects of Zambezi River flow induced on its lower reaches and observed that has occurred considerable changes in lower reaches over the several last years. Although there have been attempts to generalize the hydro-geomorphic effects of dam construction, it remains difficult to predict hydrological and environmental effects of dam construction on downstream of dams because of differences in dam operation modes since their construction. This is especially true for the lower Talar river. Our intention here is to highlight hydrological and environmental effects of Chashm dam on the downstream of Talar river watershed. The main and primary purpose of the Chashm dam construction on the Talar river's tributaries is water supply for Semnan province. It is important to say that the Talar river has acute and critical conditions from the point of the strategies of flow management and water discharge. In recent years, because of the uncontrolled exploitation of agricultural streams, river bed in downstream has been limited and cause the changes in channel plan-form or bed elevation downstream of multi-purpose reservoirs and this process continues. Despite these circumstances, to meet the water demands of the Semnan province, Chashm dam construction on the Talar river's tributaries and inter-basin transfer of water in the basin is considered. In this paper, it will be shown that the construction of the dam will reduce the availability of water resources, reduction of base flow, changes in river ecosystems, reduction of river transport and consequently an increase in sedimentation and adverse environmental effects and hence, the issue of environmental effects of dam on the downstream has become controversial recently [22,23]. Hence, it is necessary to study the effects of dam construction on the environment, flow discharge and the impoundment and pre-impoundment natural flow regime (the pre-dam and post-dam hydrologic regime) of Talar river. Isik., *et al.* [24] investigated the effects of anthropogenic activities on the Lower Sakarya River and concluded that human activities can alter the downstream properties such as hydrological, hydro-ecological, geomorphic and environmental characteristics of the downstream of a river watershed [25,26]. Also, no such study has been carried out in the north of Iran despite intense human impacts on the river flows associated with dam construction activities. To avoid catastrophic water shortage during droughts, Guo., *et al.* [27] implemented some parametric rules and achieved a legal rule to sustainable water management. Casado., *et al.* [28] in related to the influence of flow regulation on the river thermal behavior of river water demonstrated that there is a link among the meteorological parameters and also temporal fluctuations in water temperatures. However, little research has been undertaken to study the problem of environmental effects of dam construction on the downstream of a river watershed and finally water supply. Further investigations are needed to investigate the above problem. This method proved to be effective for solving a number of various problems.

The purpose of this paper is the demonstrating of the dam management application to water supply. This research has been carried out to investigate the hydrological and environmental effects of Chashm dam on the downstream of Talar river watershed in the northern Iran.

Materials and Methods

In the course of this study, we will limit ourselves to the Talar river watershed. Talar river originates from Alborz Mountains in Mazandaran province, in the southern Caspian Sea basin, in the north of Iran and flows parallel with Firouzkooh-Ghaemshahr road and it arrives at Caspian beach area in Malekola village. In order to supply the water requirements of Semnan city, the construction of Chashm dam on the Talar river's tributaries placed on the agenda of the Ministry of Energy (Figure 1). However, because of the uncontrolled exploitation of agricultural streams and invasion of privacy riverbed, the Talar river has acute and critical conditions from the point of hydrologic and environmental. To study the hydrological impacts of Chashm dam, Talar watershed was considered with an area of approximately 1057 km^2 of Polesefid hydrometric station using a rainfall-runoff model. As shown in figure 1, the Chashm dam is located in the middle reach of the Talar river. Talar watershed is located between 35° 44' 41" to 36° 19' 13" East longitude and 52° 35' 38" to 53° 23' 56" North latitude. Chashm dam studies initiated in 2004, is a multi-functional water control system built in the main river reach of the Talar river. In the study watershed, the average elevation in the watershed is 2149 m. The average slope of the main channel is 2.6%, the length of the main channel is 70 km and the drainage density is 1.89 km/km^2. Its average annual precipitation is variable between less than 250 mm in the southern part of the basin (Semnan province) to more than 600 mm in the northern part of the basin (Mazandaran province).

Figure 1: Study area, rivers, hydrometric and rain gauge stations, location of Chashm dam and a view of the dam multi-purpose reservoir and the Talar river.

Modeling of the rainfall-runoff process

In this study, a rainfall-runoff model was developed to simulate the behavior of the hydrological watershed. The hydrologic model (HEC-HMS) has been used in runoff-rainfall modeling that is an applied model to simulate river flow hydrograph [29-31].

The physical model of the watershed has been simulated using the HEC-GeoHMS (extension in GIS media) and the digital elevation model (DEM) [12,32-37]. In the next step, the data on the rain in the precipitation of rain recorder stations and the flood hydrographs of the Polesefid hydrometric station were applied for the model. Proper use of the capabilities of GIS and HEC-HMS model will bring favorable results in the simulation of the hydrological behavior of a watershed [38-42]. The area of affected of rain gauge stations was determined to simulate the daily rainfall with non-uniform intensity in the study watershed. Also, the soil conversation service (SCS) method, Initial/constant method and Recession curve method were used for simulating flow hydrograph, for simulating the height of runoff and for the estimating the base flow in the rainfall-runoff model, respectively. A digital soil map is available for the study area describing soil textures, relative permeability and average slope. It is assumed that in the Initial/constant loss method, the maximum potential loss rate of precipitation remains constant during a rainfall event. If the Initial/constant loss added to the model to the presentation of depression storage and interception, until the cumulative rainfall over the impervious surfaces does not exceed the amount of the initial losses, we have no runoff. In fact, this model has two main inputs: Initial and constant loss rate.

These two parameters are determined based on soil characteristics, land use, vegetation and antecedent moisture condition (AMC) [35,43]. Krakauer and Temimi [34] developed a procedure for visualizing the recession curve for a given river that has been widely used and adapted. A family of functions describing river recessions is given by the power law (Equation 1):

$$Q_t = Q_0.e^{-at} \quad ....(1)$$

Where Q_t is discharge at time t, Q_0 is the initial discharge, e is the base of natural logarithm and a, is a constant. Normally e^{-a} is replaced by K, which is called the recession constant. This curve, plotted on semi-log graph paper, is presented as a straight line with slope –a.

Base flow recession is the portion of stream flow that comes from the sum of deep subsurface flow and delayed shallow subsurface flow. On the other hand, the declining rate of recharge of a stream fed by only base-flow for an extended period. Base-flow recession onset is the third inflection point on the logarithmic graph of the falling limb of the storm hydrograph. To do the stream routing, it was used the lag time (travel time) method. Also, the impervious land percent was estimated in the GIS media using topographic maps 1:25 000. Also, ETM+ satellite images have been used for evaluating the land cover and also land use. Thus, daily precipitation records of three rain gauge stations based on their area of influence and annual hydrograph (the mean daily discharges) of the years 2000 to 2010 were entered into the rainfall-runoff model. Rainfall-runoff model was provided based on the first five years of the years 2000 to 2010 to simulate the watershed hydrologic behavior and then the model was optimized by the initial loss and lag time parameters of the sub-basins (SCS-Lag) and in the next step, using data of four years at the end of the years 2000 to 2010, efficiency of the optimized hydrologic model was confirmed by comparing the results in the simulated the flow hydrographs with the observed hydrographs.

Simulation of Chashm dam and its multi-purpose reservoir operation

For simulating the Chashm dam operation, it was used from elevation-area and also outflow-elevation-area methods. Using these two methods, for different heights with specific steps, the area and volume of the multi-purpose reservoir were estimated in GIS media using digital plan of the dam multi-purpose reservoir (scale 1:500). The advantage of this method is the ability of the model for updating during the time associated with sediments deposition and the reduction of the multi-purpose reservoir volume. After the calculation of multi-purpose reservoir volume, the Chashm dam was simulated in the validated rainfall-runoff model including the weir, physical dimensions, the upstream drainage basin and the volume of the dam multi-purpose reservoir. In the next step, after validating the model and confirming its capability in simulating the hydrologic behavior of the Chashm dam, the following results were followed: a) flood routing in the dam multi-purpose reservoir and simulation of inlet and outlet hydrographs of the dam multi-purpose reservoir. b) Determining of storage volume and the rate of reduction of flow discharge and volume decreasing in downstream due to dam construction (execution of Semnan water demand).

The effect of dam construction on the downstream flow regime of Talar river

In order to evaluate the effect of dam construction on the downstream flow regime (i.e. total discharge, flood flows, baseflows, the shape of the seasonal and flood hydrographs, seasonal and inter-annual variability), rainfall-runoff model was run as two cases to analysis of pre-and post-dam hydrologic changes from dams that cover the spectrum of hydrologic regime across the Chashm dam to document the type, magnitude, and direction of hydrologic shifts because of impoundment [25,44].

The effects of dam construction on the downstream ecosystem

Given a number of environmental water rights, it was evaluated the effects of river flow discharge reduction on downstream areas due to dam construction. To estimate the rate of water demand of dam downstream farmers, the area of farmlands have been determined using the GIS capabilities and the data of remote sensing by implementing visual interpretation techniques and satellite images. When considering the water demand of each species and cultivation area, the water demand of dam downstream was determined. Also, on the basis of existing reports, the water demands of human communities and industries were estimated. Finally, changes in water access due to dam construction and its analysis were done in relation to downstream water demand (domestic, industrial, agricultural and environmental water rights). The goal of this paper is to evaluate the minimum estimated environmental water rights as a criterion so that using its results; one can negotiate with sponsors of dam construction.

The quantitative criteria values (Performance indicators)

In order to recommend which model approach is suitable, following statistical performance criteria were taken into account for the model calibration and the validation.

Nash-Sutcliffe efficiency (NSE)

The Nash-Sutcliffe efficiency (NSE) is a normalized statistic that is computed as shown in Equation 2 [45]:

$$NSE = 1 - \left[\frac{\sum_{i-1}^{n} (Y_i^{obs} - Y_i^{sim})^2}{\sum_{i-1}^{n} (Y_i^{obs} - Y_i^{mean})^2} \right] \quad \ldots\ldots\ldots\ldots\ldots\ldots (2)$$

Where Yi^{obs} is the i^{th} observation for the constituent is being evaluated, Yi^{sim} is the i^{th} simulated value for the constituent being evaluated, Y^{mean} is the mean of observed data for the constituent being evaluated and n is the total number of observations.

Percent bias (PBIAS)

Percent bias (PBIAS) measures the average tendency of the simulated data to be larger or smaller than their observed counterparts [46]. PBIAS is calculated with Equation 3:

$$PBIAS = \left[\frac{\sum_{i=1}^{n} (Y_i^{obs} - Y_i^{sim}) * (100)}{\sum_{i=1}^{n} (Y_i^{obs})} \right] \quad \ldots\ldots\ldots\ldots\ldots (3)$$

Where PBIAS is the deviation of data being evaluated, expressed as a percentage. Percent stream flow volume error [44,46-48], prediction error and percent deviation of stream flow volume (Dv) are calculated in a similar manner as PBIAS. Table 1 presents brief characteristics of mentioned indicators.

Performance indicators	Ranges	The optimal value	Acceptable levels of performance	Unacceptable performance
Nash-Sutcliffe efficiency (NSE)	$-\infty$- 1	1	0 - 1	NSE < 0
Percent bias (PBIAS)	PBIASε lR	0	low-magnitude values	Positive and negative values

Table 1: Brief characteristics of Efficiency Criteria Values.

Results and Discussion

A runoff-rainfall was model presented to simulate the watershed hydrologic behavior using GIS and implementing of HEC-HMS model. Secondary data of climatology such as daily precipitation data of Zardgol, Shurab and Polesefid rain-gauge stations in the ways of incremental was entered into the climatic sub-model portion of the runoff-rainfall model and climatology sub-model was simulated. To apply the non-uniform spatial and temporal distribution of precipitation, the influence area of rain gauge stations was determined using Thiessen method and the GIS abilities. In determining the sub-basins boundary of the study area, the influence area of rain gauge stations was considered in order that the simulation of rainfall in the range of sub-basins to be done based on the influence area of rain gauge stations. The physical model of the watershed has been simulated using the HEC-GeoHMS (extension in GIS media), ArcView and the digital elevation model (DEM) and was entered into HEC-HMS media (Figure 2). Modeling process was done for five water years of the years 2001 - 2002 to 2005 - 2006. In the next step, optimization of mentioned five years was done by selecting the appropriate optimization parameters and appropriate objective function (by comparing and corresponding of the observed and estimated hydrographs). Two examples of comparing the observed and estimated hydrographs have been shown in figures 4 and 5. After optimizing the model, validation stage was done.

An example of comparing the observed and estimated hydrographs associated to four years in the stage of model validation has been given in Figure 6. After the validation of the rainfall-runoff model, the simulation of the Chashm dam in validated model including the simulation of physical dimensions and multi-purpose reservoir volume was done (Figure 3). What is important in this study is the determination of the rate of river discharge in the Chashm dam site and its downstream and also, the changes resulted from it after construction. The river flow discharge related to the Chashm dam site was estimated by model and has been given in table 2.

Water year	Discharge volume (million m^3)	Average discharge (m^3/s)	The precipitation conditions
2001 - 2002	8.301	0.26	Almost normal
2002 - 2003	10.156	0.32	Wet year
2003 - 2004	6.733	0.21	Wet year
2004 - 2005	8.612	0.27	Wet year
2005 - 2006	13.9	0.44	Wet year
2006 - 2007	7.362	0.23	Dry year
2007 - 2008	6.418	0.2	Dry year
2008 - 2009	8.182	0.25	Almost normal
2009 - 2010	7.960	0.25	Almost normal
Average annual water discharge 8.624 million m^3			

Table 2: The Chashm dam's watershed discharge in the various years (wet and dry years has been determined on the basis of raingauge stations data).

Figure 2: The rainfall-runoff model structure for the study area: the basin physical model, rainfall hyetograph of three stations as incremental and annual flow hydrograph of Polesefid hydrometry station.

Figure 3: The physical structure of the validated rainfall-runoff model for the study area

Figure 4: Comparison between simulated hydrograph (blue color) and observed hydrograph (red color) in the modeling stage, water year 2004-2005. A flash flood occurred in July that is man-made and the applied model cannot simulate it exactly.

Figure 5: Comparison between simulated hydrograph (blue color) and observed hydrograph (red color) in the modeling stage, water year 2004-2005.

Figure 6: Comparison between simulated hydrograph (blue color) and observed hydrograph (red color) in the modeling stage, water year 2008-2009.

Nash and Percent bias methods were used for evaluating the accuracy of the simulated hydrographs and have been shown in table 3. The results showed that the applied model can simulate river flow hydrograph with an acceptable accuracy. There are the differences in peak discharges in flood flows. This case is acceptable that the model has an error in the flood flows because of man-made floods occurrence and the extensive area of the study watershed (accuracy of the model input data).

Water year	NSE			PBIAS		
	Q_{Mean}(m3/s)	Q_{Max}(m3/s)	V_{Volume}(m3)	Q_{Mean}(m3/s)	Q_{Max}(m3/s)	V_{Volume}(m3)
2001 - 2002	0.980	0.972	- 601.822	2.777778	4.597	12.489
2002 - 2003	0.996	0.986	0.112164	5.945946	6.138	5.646
2003 - 2004	0.996	0.990	- 1.21029	6.122449	2.091	- 7.851
2004 - 2005	0.998	0.992	0.927758	3.466667	- 0.450	- 1.284
2005 - 2006	0.996	0.983	0.986392	5.714286	12.77	2.243
2006 - 2007	0.998	0.998	0.974402	3.243243	- 3.275	- 0.604
2007 - 2008	0.998	0.937	0.931256	2.173913	24.941	2.402
2008 - 2009	0.997	0.945	0.987387	5.106383	4.059	0.640
2009 - 2010	0.992	0.970	0.306541	8.695652	17.142	3.187

Table 3: Efficiency Criteria Values (Nash and Percent bias methods) used for evaluating the accuracy of the simulated hydrographs.

Average discharge of the study river is the base of modeling and water distribution management because of flash floods is man - made and we cannot simulate a flash flood exactly. Therefore, we did not evaluate historical flood (man - made flood) in the simulation of watershed hydrograph (annual river flow).

In order to the analysis of the effects of the Chashm dam construction, it needs to estimate downstream water demand and environmental needs of the region and these required data have been presented in table 4 based on the confirmed studies of TAMAB [49]. Finally, the effects analysis of the Chashm dam construction on the flow discharge and also the comparison of downstream water demand and river flow discharge, have been given in table 5. River discharge in the Chashm dam site and also monthly flow volume for the years 2000 to 2010 were estimated using validated rainfall-runoff model and hence the average discharge of the Chashm dam river basin was estimated.

Month	Downstream water demand (Million m^3)	Environmental water demand (Million m^3)	The total water demand (Million m^3)	Average discharge (m^3/s)
October	0.02	0.02	0.04	0.015
November	0	0.37	0.037	0.014
December	0	0.075	0.075	0.028
January	0	0.087	0.087	0.033
February	0	0.09	0.09	0.034
March	0.005	0.123	0.128	0.051
April	0.15	0.283	0.433	0.161
May	0.47	0.572	1.042	0.389
June	0.65	0.426	1.076	0.401
July	0.59	0.258	0.848	0.316
August	0.45	0.251	0.701	0.216
September	0.15	0.23	0.38	0.141
Annual average	2.48	2.452	4.932	0.156

Table 4: Monthly water demands of the Chashm dam downstream ecosystem and water demand of the Chashm dam downstream's lands to cross the Talar river (TAMAB, 2010).

Month/Parameter	Downstream water demand (m^3)	The minimum flow rate required for downstream (m^3/s)	Average discharge without dam construction (m^3/s)	Difference between water demands and discharge (m^3/s)
October	40000	0.015	0.33	0.015
November	37000	0.014	0.47	0.014
December	75000	0.028	0.51	0.028
January	87000	0.033	0.44	0.033
February	90000	0.034	0.45	0.034
March	128000	0.051	0.55	0.051
April	433000	0.161	0.53	0.161
May	1042000	0.389	0.52	0.389
June	1076000	0.401	0.38	Negative
July	848000	0.316	0.35	0.04
August	701000	0.216	0.31	0.09
September	380000	0.141	0.33	0.189
Annual average	4932000	0.156	-	-

Table 5: The effects of the Chashm dam construction on the dam's downstream discharge assuming that raised the need for water.

Figure 7 shows the comparison of the average discharge in the river downstream of the Chashm dam and water demands throughout the year. In order to analysis the performance of the Chashm dam multi-purpose reservoir, the comparison of input hydrographs to the Chashm dam multi-purpose reservoir (river discharge) and output hydrographs from the Chashm dam multi-purpose reservoir (downstream water demand) was done for the years 2000 to 2010 after the simulating of the Chashm dam multi-purpose reservoir hydrologic behavior in rainfall-runoff model. Figure 8 shows the storage and the outflow rates from the multi-purpose reservoir (downstream water demand). Times of the year the inflow hydrograph is lower than the outflow hydrograph, water discharge is less than water demand and so it is not possible to supply the full simultaneous water demand of Semnan city and dam downstream water demand. The inflow and outflow hydrograph of the Chashm dam were simulated using the flow routing of the Chashm dam and by considering the average water demand rate equal to 0.15 m^3/s and have been given in figure 9. Another discussion is the Chashm dam multi-purpose reservoir impoundage and impoundage duration and downstream discharge. With the release of the downstream flow demands and water evaporation in multi-purpose reservoir water, complete impoundage of the Chashm dam multi-purpose reservoir (six million cubic meters) will not be allowed.

Figure 7: Comparison between river average discharge in the Chashm dam site and dam's downstream water demands throughout a year.

Figure 8: Diagram of flow storage and outflow rates from the multi-purpose reservoir (water demands).

Figure 9: Inlet and outlet (downstream water demand) hydrographs of dam multi-purpose reservoir based on water year conditions of 2008-2009.Water shortage will happen when the inlet hydrograph is lower the level of outlet hydrograph.

Simulation of the study watershed hydrological behavior showed that the Chashm river average discharge is about 8.6 million m^3. This value will have significant changes during wet and droughts periods. This situation is even more serious in recent years, as the water demands of the downstream increases dramatically for the agricultural and industrial water use and the new additional requirements for extreme drought resistance during the dry season [2]. Therefore, it is necessary and urgent to refill earlier for Chashm river. The minimum and maximum monthly discharge of the Chashm dam's watershed in August and February are equal to 0.31 and 0.45 m^3/s respectively.

The minimum and maximum monthly water demand in turn in November and June are equal to 0.014 and 0.4 m^3/s respectively and also the results shows that the river discharge in June is lower than the downstream water demand (Table 3). The minimum and maximum monthly discharge of Chashm dam watershed in turn in August and April are equal to 0.31 and 0.53 m^3/s respectively. Hence, in some abnormal dry months, the firm output cannot be satisfied and output will be decreased, and the storage level will be dropped below the water demand. This leads to a significant decrease in the downstream flows. Thus the monthly minimum flows frequently occur in the June to September (Figure 3). Thus, during dry years, the flows generally are lowest in the downstream from the reservoir dams. Figure 7 shows a comparison between the mean monthly discharge of the Chashm dam watershed and the mean water needs in the study watershed. According to the results, the water needs is more than river discharge in the May and June months.

The sharp decline inflows during dry years and the increase in flows during wet years lead to strong inter-annual variability of flows downstream from the reservoir dams in the August and September [2]. Based on confirmed studies of Water Resources Research Center (TAMAB), drinking water demand of Semnan province, water rights of farmers and downstream environmental demands are 4.54, 2.164 and 2.448 million m^3, respectively. This is despite the fact that the volume of annual input water is slightly lower than this value in normal conditions. In addition, the area of Chashm dam multi-purpose reservoir is about 110 hectares and given the minimum annual actual evaporation equal to 700 mm, about seven hundred thousand cubic meters of water stored in the multi-purpose reservoir will be lost. Due to the simultaneous occurrence of maximum water demand, maximum evaporation and minimum of water inlet to the Chashm dam multi-purpose reservoir in warm seasons, it seems that, it is not possible to provide needs based on these studies and without a doubt, in the case of water supply in Semnan province, we have to cease in river flow in downstream of the dam.

Conclusion

The results of this study and other studies [50] suggests that on many rivers large headwater dams have reduced the frequency and duration of floodplain inundation downstream and these changes lead to changes in downstream ecosystems. The results from the simulation and analysis of the Chashm dam in downstream are as follows: a) cease in river flow in downstream of the dam site, b) the sharp decline in river discharge in low flows, c) reduce the rate and water volume of the maximum flows, d) changes in the hydrological regime of the river such as base flow, cease in river flow, the frequent occurrence of the river bed with full discharge and competency which will make tremendous changes in the river morphology and downstream ecosystems; river morphology is determined by the combination of relatively low flows that play an important role in fine sediment transport and bed configuration as with relatively high flows that are effective at modifying the channel's morphology [16,19,22]. Any changes in the river flow regime will affect the river morphology and vegetation cover in a reach downstream of the dam following its construction immediately downstream of the dam and also by analysis of pre- and post-construction aerial photography we can find that riparian vegetation has significant encroachment onto previously active bar surfaces [22]. Whatever is not verified by modeling and forecasting studies is how to manage the multi-purpose reservoir. The amount of water stored in the multi-purpose reservoir and discharge to downstream is directly a function of the dam multi-purpose reservoir management [51-55].

Acknowledgment

The authors thank Mazandaran Regional Water Company and TAMAB (Researches Organization of Water Resources) for providing the data of discharge, maps and for helping us with data pre-processing.

Bibliography

1. Li X., et al. "Dynamic control of flood limited water level for multi-purpose reservoir operation by considering inflow uncertainty". *Journal of Hydrology* 391 (2010): 124-132.

2. Li Y., *et al*. "Deriving the optimal refill rule for multi-purpose reservoir considering flood control risk". *Journal of Hydro-environment Research* 8.3 (2013): 1-12.

3. Koch R and Bene K. "Continuous hydrologic modeling with HMS in the Aggtelek Karst region". *Hydrology* 1.1 (2013): 1-7.

4. Savkin VM and Dvurechenskaya SY. "Resources Related and Water Environmental Problems of the Integrated Use of the Novosibirsk Reservoir". *Water Resources* 41.4 (2014): 446-453.

5. Mensik P., *et al*. "Water Management Software for Controlling the Water Supply Function of Many Reservoirs in a Watershed". *Water Resources* 42.1 (2015): 133-145.

6. Nathan R and Lowe L. "The hydrologic impacts of farm dams". *Australasian Journal of Water Resources* 16.1 (2012): 75-83.

7. Lajoie F., *et al*. "Impacts of dams on monthly flow characteristics. The influence of watershed size and seasons". *Journal of Hydrology* 334.3 (2007): 423-439.

8. Zhou Y., *et al*. "Joint operation and dynamic control of flood limiting water levels for mixed cascade reservoir systems". *Journal of Hydrology* 519 (2014): 248-257.

9. Burns D., *et al*. "Effects of suburban development on runoff generation in the Croton River basin, New York, USA". *Journal of Hydrology* 311.1-4 (2005): 266-281.

10. Brilly M., *et al*. "Monitoring the impact of urbanization on the Glinscica stream". *Physics and Chemistry of the Earth* 31.17 (2006): 1089-1096.

11. Pappas EA., *et al*. "Impervious surface impacts to runoff and sediment discharge under laboratory rainfall simulation". *Catena* 72.1 (2008): 146-152.

12. Esmaeeli Gholzom H and Gholami V. "A comparison between natural forests and reforested lands in terms of runoff generation potential and hydrologic response (Case study: Kasilian Watershed)". *Journal of Soil and Water Research* 7.4 (2012): 166-173.

13. Tu MY., *et al*. "Optimization of multi-purpose reservoir management and operation with hedging rules". *Journal of Water Resources Planning and Management* 129.2 (2003): 86-97.

14. Chang FJ., *et al*. "Optimizing the multi-purpose reservoir operating rule curves by genetic algorithms". *Hydrological Processes* 19.11 (2005): 2277-2289.

15. Liu P., *et al*. "Derivation of aggregation based joint operating rule curves for cascade hydropower multi-purpose reservoirs". *Water Resources Management* 25.13 (2011): 3177-3200.

16. Ma Y., *et al*. "Channel adjustments in response to the operation of large dams: the upper reach of the lower Yellow River". *Geomorphology* 147-148 (2012): 35-48.

17. Valdes JB. "MANAGING RESERVOIRS FOR FLOOD CONTROL". U.S. - Italy Research Workshop on the Hydrometeorology, Impacts, and Management of Extreme Floods Perugia (Italy), November (1995).

18. Wang Y., *et al*. "Optimal early refill rules for Danjiangkou Reservoir". *Water Science and Engineering* 7.4 (2014): 403-419.

19. Magilligan FJ and Nislow KH. "Changes in hydrologic regime by dams". *Journal of Geomorphology* 71.1-2 (2005): 61-78.

20. Magilligan FJ and Nislow KH. "Long-term changes in regional hydrologic regime following impoundment in a humid-climate watershed". *JAWRA Journal of the American Water Resources Association* 37.6 (2001): 1551-1569.

21. Mikhailov VN., *et al*. "Impact of Reservoirs on the Hydrological Regime and Morphology of the Lower Reaches and Delta of the Zambezi River (Mozambique)". *Water Resources* 42.2 (2015): 170-185.

22. Choi SUK., *et al*. "Effects of dam-induced flow regime change on downstream river morphology and vegetation cover in the Hwang River, Korea". *Journal of Earth and Environmental Sciences* 21.2-3 (2005): 315-325.

23. Yuksel I and Sandalci M. "An investigation on flood control structures in the Sakarya Basin". *International Congress on river basin management* (2007): 516-526.

24. Isik S., *et al*. "Effects of anthropogenic activities on the Lower Sakarya River". *Catena* 75.2 (2008): 172-181.

25. Batalla RJ., *et al*. "Multi-purpose reservoir-induced hydrological changes in the Ebro River basin (NE Spain)". *Journal of Hydrology* 290 (2004): 117-136.

26. Williams GP and Wolman MG. "Downstream effects of dams in alluvial rivers". *US Geological Survey* Professional Paper 1286 (1984).

27. Guo X., *et al*. "Extension of Parametric Rule with the Hedging Rule for Managing Multi-multi-purpose reservoir System during Droughts". *Journal of Water Resources Planning and Management* 139.2 (2013): 139-148.

28. Casado A., *et al*. "Influence of dam-induced hydrological regulation on summer water temperature: Sauce Grande River, Argentina". Ecohydrology 6.4 (2013): 523-535.

29. Wehmeyer LL and Weirich FH. "Effect of historic land cover change on runoff curve number estimation in Iowa". *Journal of Hydrologic Engineering ASCE* 15. 9(2010): 692-695.

30. Nayak TR and Narulkar SM. "Effects of land use and land cover changes on water yield in Goi watershed of Narmada basin". *Journal of Indian Water Resources Society* 31.1 (2011): 35-44.

31. Nayak T., *et al*. "SCS curve number method in Narmada basin". *International Journal of Geomatics and Geosciences* 3.1 (2012): 219-228.

32. Khaleghi MR., *et al*. "Efficiency of the geomorphologic instantaneous unit hydrograph methods in flood hydrograph simulation". *Catena* 87.2 (2011): 163-171.

33. Khaleghi MR., *et al*. "Regional Analysis Using the Geomorphologic Instantaneous Unit Hydrograph (GIUH) Method". *Soil and Water Research* 9.1 (2014): 25-30.

34. Krakauer NY and Temimi M. "Stream recession curves and storage variability in small watersheds". *Hydrology and Earth System Sciences* 15 (2011): 2377-2389.

35. Gholami V., *et al*. "Effects of impervious surfaces and urban development on runoff generation and flood hazard in the Hajighoshan watershed". *Caspian Journal of Environmental Sciences (CJES)* 8.1 (2010): 1-12.

36. Gholami V. "The influence of deforestation on runoff generation and soil erosion (Case study: Kasilian Watershed)". *Journal of Forest Science* 59.7 (2013): 272-278.

37. Gholami V., *et al*. "Evaluation of climate change in northern Iran during the last four centuries by using dendroclimatology". *Journals in Natural Hazards* 85.3 (2017): 1835-1850.

38. Nayak TR and Jaiswal RK. "Rainfall-runoff modelling using satellite data and GIS for Bebas River in Madhya Pradesh". *IE (I) Journal* 84 (2003): 47-50.

39. Zhan X and Huang M. "ArcCN-runoff: an ArcGIS tool for generating curve number and runoff maps". *Environmental Modelling and Software* 19.10 (2004): 875-879.

40. Fleming M., *et al*. "Continuous Hydrologic Modeling Study with the Hydrologic Modeling System". *Journal of Hydrologic Engineering* 9.3 (2004): 175-183.

41. Ozdemir H. "Application of SCS CN rainfall-runoff modeling using GIS and Remote Sensing: a case study of Havran river basin (Balıkesir)". Ankara Üniversitesi, Cog˘rafi Bilimler Dergisi, Cilt, Say 2 (2007): 1-12.

42. Ozdemir H and Elbas E. "Benchmarking land use change impacts on direct runoff in ungauged urban watersheds". *Physics and Chemistry of the Earth* 79-82.5 (2014): 100-107.

43. Camorani G., *et al*. "Effects of land-use changes on the hydrologic response of reclamation systems". *Physics and Chemistry of the Earth* 1.3 (2005): 561-574.

44. ASCE. "Criteria for evaluation of watershed models". *Journal of Irrigation and Drainage Engineering* 119.3 (1993): 429-442.

45. Nash JE and Sutcliffe JV. "River flow forecasting through conceptual models: Part 1. A discussion of principles". *Journal of Hydrology* 10.3 (1970): 282-290.

46. Gupta HV., *et al*. "Status of automatic calibration for hydrologic models: Comparison with multilevel expert calibration". *Journal of Hydrologic Engineering* 4.2 (1999): 135-143.

47. Singh J., *et al*. "Hydrologic modeling of the Iroquois River watershed using HSPF and SWAT". *Illinois State Water Survey Contract Report* (2004).

48. Fernandez GP., *et al*. "Development and testing of watershed-scale models for poorly drained soils". *Transactions of the ASAE* 48.2 (2005): 639-652.

49. Champaign, Ill.: Illinois State Water Survey. Available at: TAMAB. Regional Water Company of Semnan. The first stage studies of Chashm Dam construction, Kamandab consulting Engineering (2010): 386.

50. Page K., *et al*. "The effect of altered flow regime on the frequency and duration of bank-full discharge: Murrumbidgee River, Australia". *Environmental Earth Sciences* 21.5 (2005): 567-578.

51. Brandt SA. "Classification of geomorphological effects downstream of dams". *Catena* 40.4 (2000): 375-401.

52. Chien N. "Changes in river regime after the construction of upstream multi-purpose reservoirs". *Earth Surface Processes and Landforms* 10.2 (1985): 143-159.

53. Legates DR and McCabe GJ. "Evaluating the use of "goodness-of-fit" measures in hydrologic and hydroclimatic model validation". *Water Resources Research* 35.1 (1999): 233-241.

54. Pizarro-Tapia R., *et al*. "On Redefining the Onset of Base Flow Recession on Storm Hydrographs". *Open Journal of Modern Hydrology* 3.4 (2013): 269-277.

55. Sevat E and Dezetter A. "Selection of calibration objective functions in the context of rainfall-runoff modeling in a Sudanese savannah area". *Hydrological Sciences Journal* 36.4 (1991): 307-330.

Volume 1 Issue 4 September 2017