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Model prediction of Al Azim changing water level and power relative due to climatic changes

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ABSTRACT

The influence of water level and force change in Iraq's Al-Adhaim bowl (AARB), multi-relapse, hydrologic affectability, and hydrologic model reproductions were used to evaluate expectation models related to environmental change and anthropogenic intercessions. As Iraq's second-largest city, Kirkuk is reliant on the Al Azim River, which provides the city with much of its water supply. Environmental change may be contributing to more severe dry seasons and floods, since ongoing examinations have revealed that the bowl water has become increasingly inconsistent. The Pettitt, precipitation-overflow twofold aggregate bend (PR-DCC), and Mann–Kendall methodologies were used to better understand the near- and long-term implications of environmental change on water assets in the study region. There was a consistent annual streamflow change in all three methods. There was also an important role for environmental instability, which was the primary cause of streamflow reductions, which ranged from 66 to 97 percent between 2003 and 2013, while anthropogenic intercessions caused drops of 4 to 34 percent. Hydrologiska Byran's Vatten balansavdelning (HBV), Ge'nie Rural a Daily 4 Limits (GR4J), and Medbasin models have all been successfully deployed in an effort to undermine this multi-model mix idea (SAM). the impact of human activity on the environment and the city of Al-Adhaim The process by which many models are combined -Multi-regression A study of the impact of water on the environment In this case, the reproduction of run-off.

Keywords: Climatic Changes, Tiger River, Rainfall, Al Azim Dam

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1. Introduction

Because of a specific pattern, samples of the environment can alter. Due to an increase in surface air temperature and a decrease in precipitation over the last century, this example underwent a rapid transformation. Standard and man-made factors [1] are the principal causes of this rapid transformation. Hydrology parameters such as streamflow and residue yield are influenced by environmental change [2]. A short period of drought might be followed by widespread flooding. By 2021, it is expected to have a 12.5 percent impact on precipitation in Turkey's upper Tigris River and a 26 percent impact by 2030 [3]. Furthermore, by 2040, the overflow will have been reduced to 30%. Complex challenges in Iraq's water asset sector, including water asset use, contamination, and desertification [4, 5], have been examined for many years [4–5]. Iraq is located in a semi-arid region of the Middle East, where extreme weather events have occurred on a regular basis for many years. An extreme dry spell in southern Iraq from 2007 to 2009 was followed by unprecedented precipitation within a few months, with an amount that was more than twice the average [6]. Streamflow changes due to environmental change and human intervention have been a major focus of hydrological considerations for some time now [7, 8].

Precipitation designs are heavily influenced by environmental change. There is no doubt that anthropogenic interferences have a geographical impact on water resources. Because of this, streamflow is at risk of systematic degradation and a water crisis in dry or semiarid geological areas. Several studies have examined the effects of environmental change and anthropogenic mediations on bowl streamflow [10, 11] and found considerable concerns [9, 10]. Due to the fact that geological location affects these impacts, researchers try to study them as regionally as feasible, such as on a sub- or bowl-scale. More than 64% of the declining annual average streamflow was expected to be attributed to this environment changeability, as predicted by Dibaba et al. [12-14]. Using methods for calculating the effects of climate change will be the next step forward. The influence of the ecological change period can be limited to the benchmark era by using the hydrologic years preceding the adjustment as a measure. Because of the various factors that contribute to the impact, they include land use, direct water extraction from a surface or subsurface stream for metropolitical and flow-related applications as well as a number of other uses. A grouping of philosophies have been presented to perceive the impacts of climate changeability and anthropogenic interventions on streamflow. For example, the diversion of precipitation overflow model diversion is the most often used system to predict the impact of precipitation and probable evapotranspiration on the mean overflow. After that, the streamflow impacts of anthropogenic and natural changes were evaluated utilizing the approach. A precipitation flood show is an examination of the thorny hydrologic issues that arise in the weather. Water cycle enigmas can be solved using this technique [15, 16]. Precipitation flood forecast models have come a long way from being accurate to being finally determined to be passed on. The use of a specific model could be a tremendous advantage in spotting serious hydrological problems. Hydrological evaluation precision has been improved throughout time. But there are other flaws, such as model borders, information, and the model's first blunders, that can be displayed (Jiang et al., 2014). In the past few years, hydrological flaws have been examined [17, 18]. Zhang et al. found that model proliferation outcomes are influenced by the limitations of hydrological models [19, 20]. During wet seasons, model reproduction is more vulnerable than in dry seasons. There are a variety of models for precipitation overflow, each of which depicts hydrologic cycles. Bowl precipitation overflow norms cannot be captured by a single model under any given set of circumstances. By using multiple models and combining their output, multi-model approaches can enhance hydrological speculation precision [21, 22].

2. Study area

The Greater Zab, Khbour, Lesser Zab, Diyala, and Al-Adham rivers are all important tributaries to the Tigris. Figure 1 shows the Al Adhaim river, also known as Nahr Al Uzaym, which runs through Iraq's upper east and rises out of the mountainous terrain. In Sulaymaniyah Governorate, it originates in the Zagros Mountains and meets the Tigris River around 34.002°N 44.293°E, some 230 kilometers (140 km) downstream of Samarra (from the east to the southeast). Iraq and Iraq, as well as Turkey and Iran, share these feeders, with the exception of the Al Azim River (Figure. 2). There are 12,965 square kilometers in its basin (5,006 sq mi). An effective stream occurs exclusively during the rainy season [23], and the best time to release water is between January and March when snowfall is little and precipitation levels are higher. Al-Adhaim generates around 0.79 cubic billion cubic meters of waste per year in conjunction with the Tigris River [25]. Balad is located around 13 kilometers downstream of the Tigris River [26]. It has a total length of 230 kilometers (from its headwaters to its conjunction with the Tigris). The Al-Adhaim bowl receives 80 to 330 millimeters of annual precipitation and experiences temperatures ranging from 2 to 48 degrees Celsius. The characteristics of each feeder's bowl are summarized in Table 1. As seen in Figure 2, the typical month-to-month stream systems of each feeder are shown. Figure 1 depicts the bowl outlet locations. The following is a brief description of the contents of each feeder. An examination of the monthly stream rate "at Dokan station, which is an important hydrometric estimating station" (scope 35530 0000N and longitude 44580 0000E) over the years 1991 to 2021 is the subject of this audit. Drought has been a problem in the area recently. The driest year on record was 2008. The Dokan reservoir releases water into the Lower Zab River in the pre-summer to service the horticulture industry and metropolitan clientele. The Al-Adhaim stream system is described as erratic and heavily dependent on rainfall. Between May and October, when the stream is dry, and November through May, when the stream is high, this is the time of year to visit. Al-Adhaim, on the other hand, is referred to as a dry bowl. Overall, 71% of the bowl's surface is covered by forest, whereas just 29% is covered by greenery.

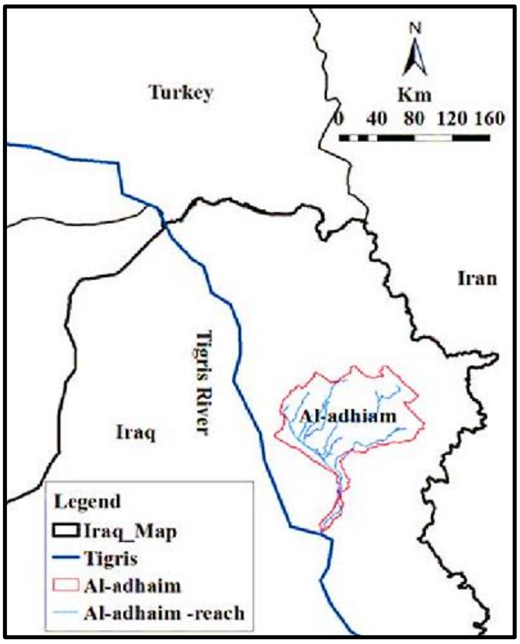

Figure 1. Al-Adham Basin.

3. Methodology

It is the goal of this investigation to determine how much anthropogenic mediations and environmental change affect the AARB's Change in Water Level and Power. Land use and land cover have a significant impact on stream bowl streams. Whatever the case may be, the AARB has taken into account point-by-point assessments of long-haul alterations in streamflow caused by anthropogenic intercessions. HBV models, one of the most commonly used overflow recreation methodologies, will also be used in this review:

To better understand the underlying causes of observed streamflow changes, scientists are investigating a variety of anthropogenic and environmental factors, such as land use and supply development, in-channel damming, and other practices. The results of this research will be used to help guide future streamflow studies.

3.1. Data collection and analysis

The following information has been gathered: Six monitoring stations collected daily climatic data from 1979/80 to 2012/13 for water changes, for example, P as delightfully as the majority and insignificant air temperature. The sub-top bowl's half is covered by environmental monitoring stations that range in height from 651 to 1536 m as in Table 1. The daily stream data from the Dokan hydrological station is useful for the water year fluctuation from 1931/32 to 2013/14. At this point, the catchment area of the Uzym stream is approximately 12,096 square kilometers. Officials in Iraq's Kurdistan Province have provided the data. Geospatial information: The Global Administrative Areas Database (GADM, Global Administrative Areas Database, 2012) and the Global and Land Cover Database have both provided access to Iraqi cutoff points and Uzym stream shape files. Afterward, the following evaluation was completed: Predictions of hydro-climatic assessment station position and Theissen affiliation, bowl limit, and stream follow have been made using the ArcGIS 10.3 programming tool The Statistical Program for Social Sciences (SPSS) 23 was used to examine hydroclimatic data sets, including models, monthly and annual summaries, modifications, and correcting true element gaps (ITS 2016). Using this free Excel Add-In, you can turn Microsoft Excel programming diagrams into photos with clearly specified evaluations and objectives. We relied on HBV storm fall runoff models to carry out this investigation. Programs that can be downloaded for free are used to re-create the floating headway's surface (Foehn et al., 2016). For 2011–2030, 2046–2065, and time skylines regardless of two measurement time frames, seven GMC outfits displayed SRA2 or SRA1B flood conditions simulated using LARS-WG5.5, as shown in Tables 2, 3, and 4. The buried period (1988–2000) deals with standard conditions. The RDI holds nothing sacred. Considerations for climate replacement and historical reenactment can be considered continuously during this time period. For the purposes of examining the impact of local environmental exchange on the existence of water, the second time period between 1980 and 2010 has been selected. Pioneers in the field of neighborhood environmental research are resurrected in the AR5 chronicle. Because of its sequential release, it is the most comprehensive assessment of the current close-by environment substitution assessments and serves as a model for appreciation and future efforts. It is an excellent resource. A major part of the recent warming is attributed to human activity, according to the AR5 study, which is currently Bextremely plausible (Bvery likely in the AR4 report). New insights into ice sheet advancement in an unfavorable climate have improved sea level forecasts significantly. Most of the Arctic Ocean is expected to be ice-free by the middle of the century under high nursery fuel radiation scenarios (the end of the century in the AR4 study). It's possible that the AR5 report will have minor changes based on the AR4 record and previous evaluation reports, such as going before the plans were distributed. Long-term improvements in hydrological approaches may be influenced by anthropogenic activities and the changing environment, at least in part. The M–K study has been used to identify long-term improvements in air temperature, precipitation, potential water evaporation and actual stream variables between 1979 and 2013. It was previously observed that the Uzym stream's air temperature rose to a maximum charge of 0.67 C_ over several decades, but its precipitation decreased to a maximum reduction of 1.51 mm/decade. 720 mm of rain falls on the Uzym stream every year. The wettest years were 1987/88 (1222 mm) and the driest years were 2007/2008 (250 mm) (Table 1). The annual rainfall in Kirkuk was 56 millimeters, while that in Sulaymaniyah was 1369 millimeters. The deteriorating bowl received a lower rating for precipitation. Uzym's evapotranspiration capacity has increased significantly over the past half-century due to the rise in air temperature. The example study found a 39-mm-per-decade rise in PET charge. Tolerable evapotranspiration rose from 962 mm in 1982/1983 to 1110 mm in 2007/2008, with an average cost of 1065.3 mm (Fig. 2). The immediate surroundings of the targeted area are becoming increasingly sweltering and desiccated as a result of the observed effects. Overall, the amount of precipitation fell. It became less significant as the average temperature rose. In most cases, these findings are based on previous research (Al-Ansari 2018). This is because the Uzym Stream's hydro-climatic elements are transmitted by currents rather than by precipitation at a specific time (Table 1). An average overflow of 0.22 was found throughout this study. There is a noticeable decline in popularity with each passing decade. According to Al-Ansari et al. (2014), the streamflow yield has become less effective over the past four years, as evidenced by a decrease in the run-off coefficient. [27] The Medbasin precipitation flood, GR4J, and HBV precipitation flood models were applied in today's investigation. [27] The Medbasin life measured model consolidates the two lumped hydrological models Medbasin-M and Medbasin-D for consistently (D) and month-to-month (M) data, with equipment for assessing certain climatic variations and drought circumstances. The two most critical change limits in the Medbasin M model are the soil storage capacity (Smax (mm) and the coefficient of significant saturation (C). Overflow is transferred from a monthly to a monthly basis when the stretch factor grows (Tigkas and Tsakiris 2004). Smax (mm) can be used to do a useful calculation.

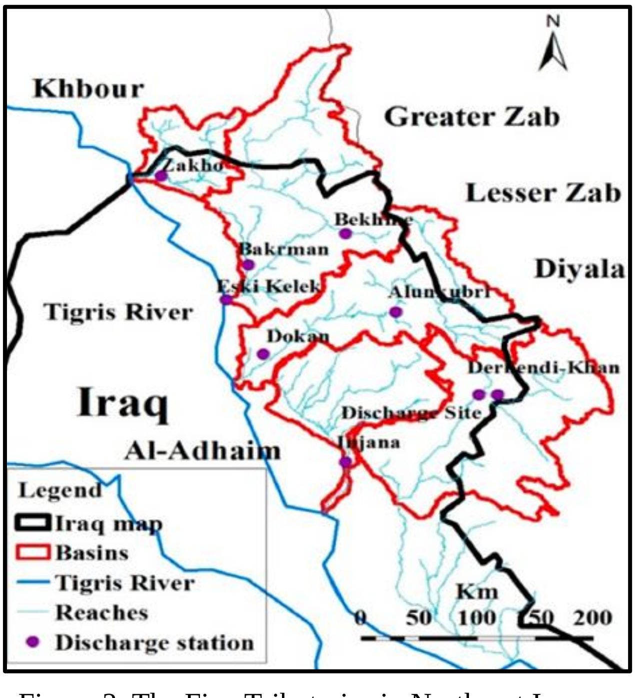

Figure 2. The Five Tributaries in Northeast Iraq

Table 1. Explanation of 5 Major Tributaries

River	*Khbour*	*Greater Zab*	*Lesser Zab*	*Al-Adhaim*	*Diyala*
Basin area (km^2)	6143	26,473	15,600	13,000	33,240
River length (km)	181	462	302	230	574
Max annual flow (BCM)	4.3	23.6	15.1	1.2	14.4
Min annual flow (BCM)	0.9	3.7	1.7	0.4	1.2
Mean annual flow (BCM)	2	12.7	7.8	0.80	4.6
Dams	-	-	2	1	3

Table 2. Station addresses, average precipitation, besides provided sub-area sizes.

Station	Sub-Area (Km^2)	Av[a] P[b] (Mm)	Av[a] Pet[c] (Mm)
Sulaymaniyah	4479.57	772	1989
Mohabad	2593.31	886	920
Soran	1463.30	813	1433
Chem-Chamal	2827.46	738	2075
Sachez	1182.79	462	1550
Salahuddin	1641.07	652	2058
Halabcha	735.60	585	980

Table 3. Overall regular rainfall, mm in Al-Adhaim Dam period (1991 to 2021)

	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.	May	June
1991	0	0	0	3.1	0	0	0	0	0
1992	0	10.5	25	0	20.1	53	0	0	0
1993	0	30.2	30.4	27	13.2	1	182	7	0
1994	3	10	4	40	7	10	36	0	0
1995	1	55	18	6.5	50	32	24.5	0	0
1996	0	0	11	70.5	1	21.5	9	2	0
1997	0	0	20	3	3.6	14.5	10.5	0	0
1998	0	70	57	57	7	8	6	0	0
1999	0	0	1	16.2	44.5	0.3	2.5	0.5	0
2000	6	1.5	15.5	22.2	4.5	1.5	4.7	0	0
2001	13	32	72	48	20	64	27	0	0
2002	0	6	20	44	3.5	69.5	13.5	2.5	0
2003	0	1.5	122.5	0	0	0	0	0	0
2004	0	0	0	3	0	0	-	0	0
2005	0	30	40	0	0	0	0	0	0
2006	0	0	0	38.3	55.5	2	26	29	0
2007	0	7	25.5	46.5	27.5	1	37	3	0
2008	0	0	4	23.5	23	2	0	0	0
2009	27	10.5	0.5	16	12	16	2	0	0
2010	12	42.5	16	15.5	16.5	36	25	14.5	0
2011	1.5	1	3.5	44	13	4.5	9.5	2.5	0
2012	0	0.5	0	16	20	19.5	9.5	0	0
2013	9.5	48	16.5	70	0.5	0	0	13.5	0
2014	0	142	7.5	52.5	15.5	10.5	0	0	0
2015	0	0	0	0	0	0	0	0	0
2016	0	0	0	0	0	0	0	0	0
2017	0	0	35.3	10	9	53.6	14.3	20	0
2018	0	0	0	1	84.5	0	48	6	0
2019	11	106.25	67.7	55	34	56	48	8	3
2020	12	0	119	24.5	64.5	68	4.6	0	0
2021	0	3	11	20.6	11.4	3.4	0	0	0

4. Model evaluation criteria

Analysis of model performance was carried out by using the root square blunder (RMSE), the fundamental strategies document of the plan (IoA), r, and the coefficient of Nash–Sutcliff, which is known as the NSCE (Jones et al, 2004). It is also possible to examine the effects of human intervention on streamflow using equations (1) to (3) [3].

$$\text{RMSE}= \sqrt{\frac{1}{n}\sum_{i=1}^{n}[(R_{obs})_i - (R_{sim})_i]^2} \qquad \text{(Eq.1)}$$

$$\text{IoA}= 1- \frac{\sum_{i=1}^{n}[(R_{obs})_i-(R_{sim})_i]^2}{\sum_{i=1}^{n}[|(R_{obs})_i-\overline{R_{obs}}|+|(R_{sim})_i-\overline{R_{obs}}|]^2} \qquad \text{(Eq.2)}$$

$$r = \sqrt{\frac{\sum_{i=1}^{n}[(R_{obs})_i-\overline{R_{obs}}][(R_{obs})_i-\overline{R_{sim}}]}{\{\sum[(R_{obs})_i-\overline{R_{obs}}]\}^{0.5}\{\sum[(R_{sim})_i-\overline{R_{sim}}]\}^{0.5}}} \qquad \text{(Eq.3)}$$

$$\text{NSCE}= 1- \frac{\sum_{i=1}^{n}\left[((R_{sim}))_i-((R_{obs}))_i\right]^2}{\sum_{i=1}^{n}[|(R_{obs})-\overline{R_{obs}}|]^2} \qquad \text{(Eq.4)}$$

"where RMSE stands for a root mean square screw up" "dimensionless, IoA stands for rundown of comprehension" "dimensionless, R stands for coefficient of relationship" "dimensionless, Robs(i) is the recorded streamflow" "mm/month at time step I, Rsim(i) is the expected" "streamflow (mm/month) at time step I, Robs is the" typical proportion of the recorded characteristics (mm/month), and n is the data point number. Streamflow can be evaluated using the going with the flow method, which takes into account both factors:

$$\Delta R_{total} = R_a - R_b \qquad \text{(Eq.4)}$$

$$\Delta R_{total} = \Delta R_{anthropogenic} + \Delta R_C \qquad \text{(Eq.5)}$$

$$A_{nthropogenic} = \frac{\Delta R_{anthropogenic}}{|\Delta R_{total}|} \text{X}100\% \qquad \text{(Eq.6)}$$

$$E_{climate} = \frac{\Delta R_{climate}}{|\Delta R_{total}|} \text{X}100\% \qquad \text{(Eq.7)}$$

ΔR total (mm/month) explains the entire change in the stream, Ra (mm/month) means a streamflow subject to anthropogenic interventions, and Rb (mm/month) indicates a standard time span saw streamflow ΔRanthropogenic (mm/month) validates the ordinary yearly streamflow change achieved through anthropogenic mediation impacts. In contrast, ΔR_climate (mm/month) implies assortments in streamflow. Anthropogenic (rate) impacts anthropogenic interventions on streamflow, and |ΔRtotal| has a tendency through the worth of ΔR total. Furthermore, Ec climate (rate)addresses the effect of environmental change on streamflow.

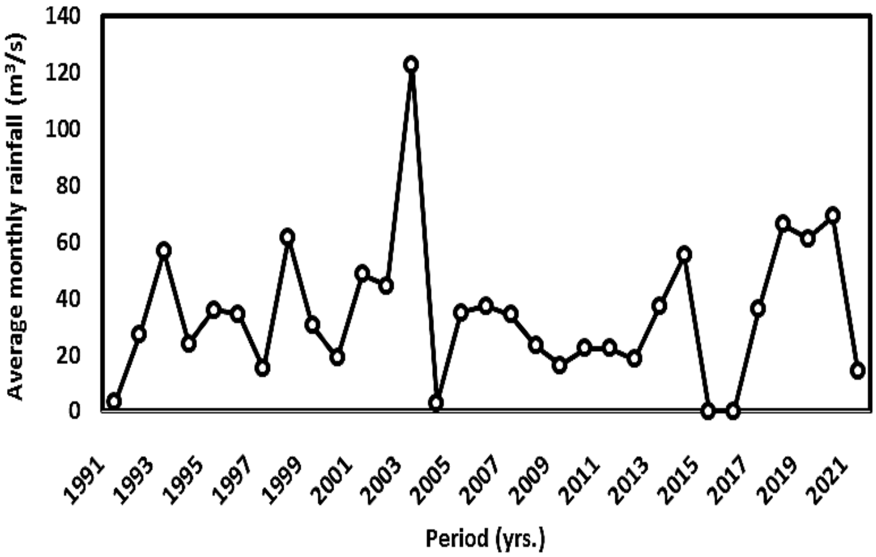

Figure 3. Typical monthly rainfall (m^3/s) of Al Azim River for the period from 1991 to 2021

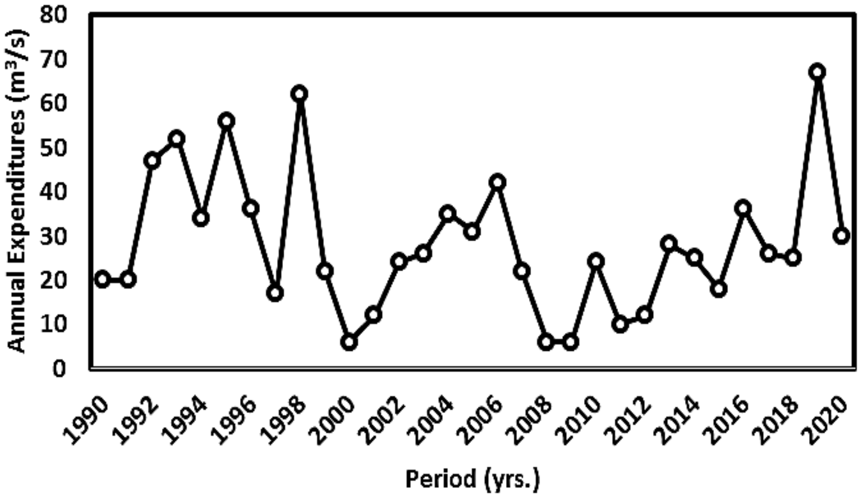

Figure 4. Yearly expenditures (M3/S)) of Al-Adhaim Dam Front (period from 1990 to 2020)

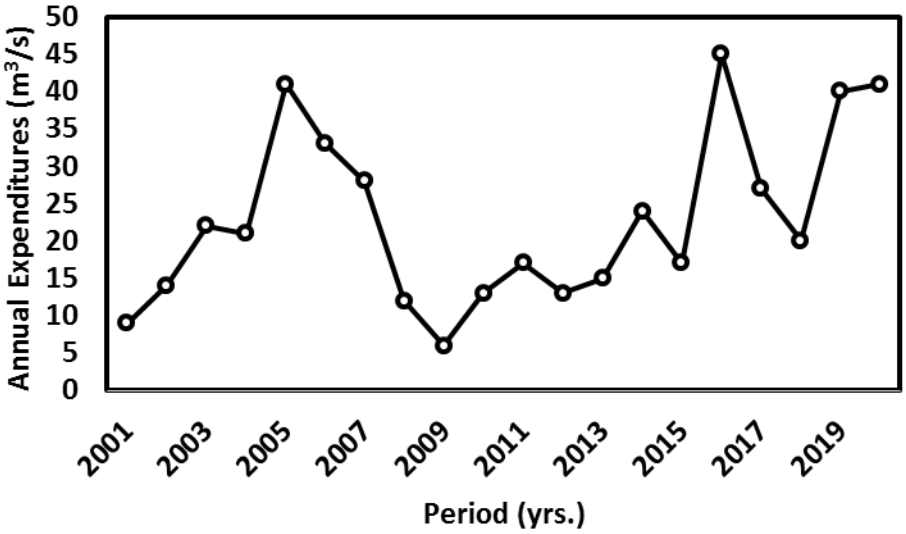

Figure 5. Yearly expenditures (M3/S)) of Al-Adhaim Dam Back (period from 1990 to 2020)

5. Conclusions and recommendations

Stream reenactment and weakening evaluations are carried out using a simple many-model approach. One of Iraq's most prominent northern parts (Adhim Dam), which appears to be so, adds to the extravagant cost of the River Tigris, as proven in the relevant inquiry (Fig. 1). Dishes like as Diyala and Al-Khabour can be found in the other three spaces (Adhim Dam). Since "continuous years," the northern Iraqi region has been affected by climatic variations, water needs, dry season and some loosened floods. A variety of areas in the overview region were adversely affected by the dry season. As a result of heavy precipitation and the absence of dams and contemporary drainage systems, flooding occurs only periodically during the winter and causes major social and economic harm. Over the last few years, the overflow of an imagined dam has decreased, as evidenced by more than a few studies3. The Adhim Dam flood abatement is mostly driven by human interventions such as dam improvement, archives, water framework, leakage systems, land use, and cowl modification, as well as a substitute microclimate (Bozkurt 2015). The Iraqi Association will influence striking plans in order to deal with the problems in the bordering environment. Efforts by Iraqi specialists to control the Adhim River's flow and prevent it from flooding the coastline have resulted in the treatment of the beachfront with sand to make up for the degradation of the beach and fix the soil. Observe the water and sewage systems in major Iraqi coastal metropolises by stopping the flow of rivers on dry land. In order to alter the circulation buoy at the Adhim Dam, no comparison is done between the entire human commitments and trade of neighboring climate. As part of the Adhim River's climate change adaptation efforts, experts are working to strengthen and advance dispersion networks, such as pipes, valves, tanks, and others.

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