Quantifications of dam-induced hydrological alteration in Gilgel GibeI watershed

Besho Homa[1], Dr. Ing Adane Abebe[2] and Dr. Fikadu Fetene[3]

1. Arba Minch University, Natural science Faculty department of Meteorology& Hydrology, Ethiopia, beshohm@gmail.com
2. Arba Minch University, water technology institute, Department of Water resource &Irrigation Engineering, Ethiopia adaneabe@gmail.com
3. Arba Minch University, water technology institute, Department of Water resource & Irrigation Engineering, Ethiopia

Abstract

Flow alteration due to the climate variation/ change and Anthropogenic activities are common. In this, we investigate the impact of climate variation and human activity particularly Gilgel Gibe dam I construction on total flow of Gilgle Gibe I watershed for pre and post dam construction period. Man-Kendall trend test used to analyze climate variation, Simhyd model were identify the effect of climate variation and human activity by comparing simulate and observed flow statistically and also land use and land cover change of two district period classification were analyzed by Arc-GIS for the pre and post dam period. The Indicators of Hydrological alteration software were used to quantify the total flow of Gilgle Gibe I watershed at dam site. And we get the significant effect of climatic variability for pre-dam construction in this study area the data such precipitation, temperature and evapotranspiration were used to analyze the trend over the range of 1988–2010 at annual timescale. Change to rainfall trends of the Asendabo and Limmu station shows the decreasing trend where the temperature and Evaporation of the two stations shown the increasing trend which contributed to decrease the stream flow change in watershed but this was statistically insignificant. We also simulate and calibrate the Simhyd conceptual model for pre and post dam construction and the result show they were the significant anthropogenic impact on the streamflow during the post dam. LULC change was examined for two distinct periods of the 2000 and 2010 using Arc GIS10.1. This trend was not reflected in climatologically drivers such as rainfall, evaporation and temperature (which shows a positive trend), but rather is attributed to the substantial changes in land use and land cover in the watershed. The significant shift from forest and woodland to grassland, cropland and water body results in a decrease of actual evaporation and subsequent increase in (dry season) runoff. We used the 'Range of Variability Approach' to quantify hydrological alteration at Gigle GibeI Dam site. The analysis shows that the five groups of hydrological characteristics natural flow regime using the IHA (magnitude, timing, duration, frequency and variability), only those related to magnitude were found to show significant trends, with the main trend being the increase of flow during the dry season.

Key words:Gilgel Gibe I dam, climate variability, Land use/cover change, IHA and RVA, Simhyd model

1. INTRODUCTION

The natural flows of almost all major rivers in the world are noticeably regulated, particularly by the construction of water reservoirs (Chen, et al., 2002)and are providing great deal of socioeconomic benefits for human development (Kummu, 2007). On the contrary, dams profoundly affect the basin hydrology ultimately producing a hydrologic regime that significantly differs from the pre-impoundment (Hu, et al., 2008).The natural flow of a majority of the world's rivers has been substantially altered through dam construction (Petts, et al., 1993). Rivers for transportation, water supply, flood control, agriculture, and power generation. However, the lakes that form behind these dams often destroy upstream riparian habitats (Ohmart, et al., 1988), while in downstream areas, changes in flow regimes have been shown to lead to extensive ecological degradation and loss of biologic diversity (Baxter, 1977). The elimination of the benefits of seasonal flooding downstream of dams may be the single most ecologically damaging impact of dam construction.

The magnitude change in the hydrologic regime of the Tana River in Kenya due to dam construction had negative impact on the unique riverine forest occurring along the Tana (Maingi & Marsh, 2002). Responsible water management requires sensitivity to a wide range of issues and a starting point understands the impacts of present and future water development systems.

The study of Maingi, et. al (2000) has revealed that the effects of major dam construction on the hydrologic regime of Kenya's largest river, the Tana River, over a 100-km stretch downstream of the town of Garissa. Construction of dams results in an important negative shock for the environment, like reduction in river connectivity (Maiolini and Bruno, 2007), changes in riverbed, bank morphology, delta, estuary and coastline due to altered sediment load (Park, 1981), alteration of hydrologic processes (Zhao et al, 2012a). Deterioration of water quality, nutrient load, turbidity, dissolved gases, concentration of heavy metals and minerals (Maingi, J.K. and Marsh, S.E., 2002), and changes in the river ecosystems, to list a few. Of all changes, the shift in behaviors of hydrologic regime is recognized as one of the most sensitive (Zhao, et al., 2012a)) as it is the primary driving force of the structure and function of river natural balance (Poff, 2007). It varies with stream typology (Maiolini and Bruno, 2007). Probably that is the main reason why dam-induced hydrologic alterations and associated ecological changes in both upstream and downstream ecosystems have been attracting scientific interests since recent time (Zhao et al., 2012b). On the subject of constructed dams, Africa contains some of the world's largest dams including; Owen Falls of Uganda, Kariba of Zimbabwe and Aswan High of Egypt (ICOLD, 2003) and the forthcoming Ethiopian Renaissance dam. Understanding the hydrology of a river and its historical flow characteristics is essential for water resources planning, developing ecosystem services, and carrying out environmental flow assessments. Key hydrological variables can used to characterize the natural flow regime (NFR) of a river. These can assessed statistically to understand the extent of change to that flow regime and support of hydrological and ecological assessment for ecosystem conservation.

The NFR approach was introduced in aquatic ecology to support the conservation and restoration of ecosystems. It is defined based on five major hydrological characteristics: magnitude, duration, timing, frequency and variability (Richter, 1996) and has recently been widely used in hydrology to analyses the characteristics of stream flow. Additional to characterizing the NFR, the parameters used to describe the NFR support the analysis of change resulting from changing climatological and hydrological characteristics. Anthropogenic activities such as damming, impounding, land use land cover (LULC) change, diversion and abstraction of water and geomorphological change can impact the natural flow regime. Longer-term climate change will also influence hydrological flows (Risbey and Entekhabi, 1996). These changes will result in changes to hydrological characteristics such as magnitude, duration, timing, frequency and rate of change of flow, and it is important to study these as they provide indication of the wellbeing of the riverine ecosystem (Lytle and Poff, 2004).

Furthermore, the Omo-Gibe River Basin, which drains to southern direction from central and highlands of Ethiopian, has only three existing hydraulic structure like Gibe I dam, Gibe II diversion weir and Gibe III under construction and regulating flow on January 2015and starts power generating this October . However,there are many more planned like Gibe IV and Gibe V, Halale Warabesa I and II, which are under study.

The Dams are weather for flood control, irrigation, hydropower, or other purpose they are all associated with storing water and subsequent releases. This storing component significantly affects the release timing, and greatly disrupts the pre-impact natural flow regime’s expected timing of flows. This effect occurs on the scale of total monthly streamflow magnitude and in the timing of extreme maximum and minimum flows but of all changes, the shift in behaviors of hydrologic regime is recognized as one of the most sensitive as it is the primary driving force of the structure and function of river natural balance. It also varies with stream typology. There were so many methods/ techniques applied to asses this change like Probably that is the main reason why dam induced hydrologic alterations and associated ecological changes in both upstream and downstream ecosystems are becoming a major point of concerns. In this study, we analysis the shift in hydrology (spatiotemporal variation) like total stream flow (timing and magnitude), evapotranspiration of pre and post of the Gigle Gibe I dam in Omo Gibe River Basin with and without climate Variation respectively.

2. Objectivesof the study

The main objective of this study is to investigate Gilgle Gibe I Dam-induced hydrological alterations in pre and post dam construction period.

Specific Objectives

- ✓ To analysis, the Variability of important hydrologic input parameters in the region of the watershed of with and without dam in absence of anthropogenic alteration using Simhyd model.
- ✓ To investigate the alteration of natural stream flow (magnitude, timing, duration, seasonal, frequency, Variation and rate of change)of specific flow event at gauged sites
- ✓ To test the hypothesis that dams homogenize regionally distinct river flow regimes for case of Gilgel Gibe watershed, independently of climatic variation.

Material and Methodologies

Study area

The Gilgel Gibe 1 project is located in the south-western part of Ethiopia, in Oromia Regional state. The reservoir is located at 7º49`52.45``N latitude and 37º19`18.79´´E longitude. The project is purely a hydropower scheme, with an installed capacity of 180MW. The reservoir has a live storage capacity of 657x106m3 the catchment area of the Gilgel Gibe basin is about 5125km2 at its confluence with the great Gibe River and about 4225km2 at the dam site. The Gilgel Gibe basin which drains in to the Gilgel Gibe I reservoir is located in between 7º 19´07.15´N and 8º12´09.49´´N latitudes and 36º31´42.60´´ E to37º25`16.05´´E longitudes. The first plant, Gibe I, is a conventional hydroelectric power plant with a capacity of 220 MW. Started in 1986 and completed in 2004 (after being interrupted in the early 90's) was the Ethiopia's largest power plant.

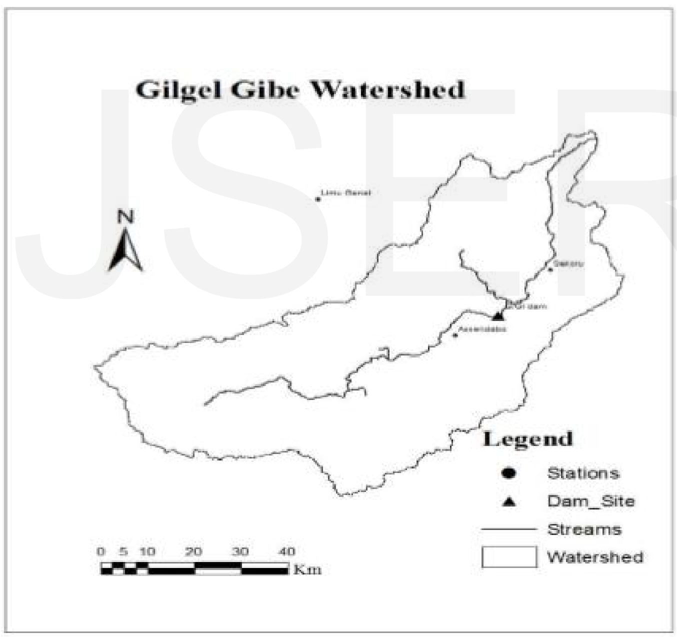


Figure:1Location of study Area.

The methodology of this study is summarized in a form of a flow chart as shown in Figure below. The flow chart depicts the steps followed in carrying out the modeling at dam site.

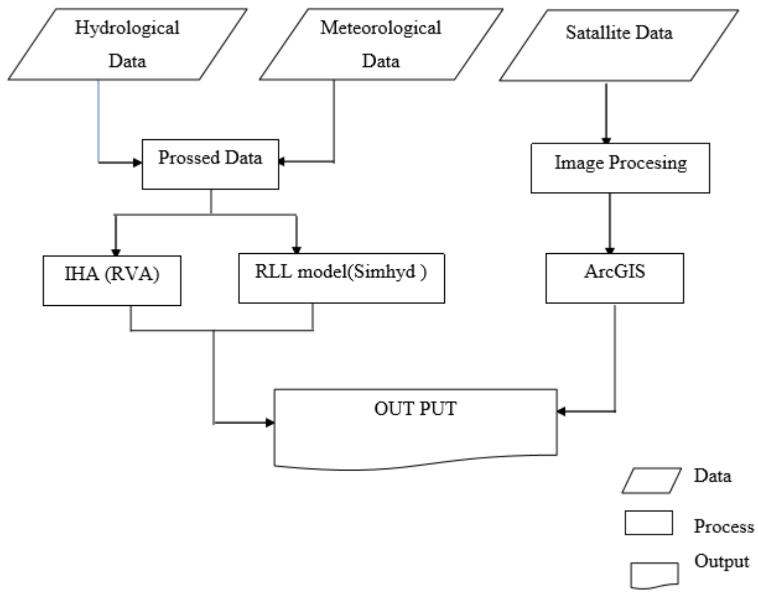


Figure: 2Conceptual framework of the study adopted in this thesis work.

Data analysis

The sources and details of data used for the purpose of this study includes Daily flow and Digital Elevation Model (DEM) 90m resolution data and information satellite data from the Landsat-5

Row year month date band number for both 2000 and 2010 The Arc GIS tool used to delineate the basin and sub basin. Classify the Land use and Land cover of the study area.Digitizing and Processing of Land use/cover and classify the by using supervise Maximum likelihood Supervised classification uses the spectral signatures obtained from training samples to classify an image after create the principal component of the satellite and Mann Kendall trend test was used.

Hydrological Models

The Simhyd is one of the rainfall–runoff models in the RRL (Rainfall–Runoff Library), a software product in the Catchment Modelling Toolkit and a daily conceptual rainfall-runoff model that estimates daily stream flow from daily rainfall and areal potential evapotranspiration data and Indicator of Hydrological Alteration and Range of Variability Approach and was used in this study.

Given a lack of empirical stream flow–ecological response data, hydrology-based flow regime characterizations statistically assess the degree of hydrologic change to define acceptable levels of flow regime alteration as management targets.

Techniques include using the sum of alterations to a range of hydrologic indicators (Richter et al., 1996), with developments focusing on ecologically-relevant scales of variability (Suen and Eheart, 2006) and comparisons between the natural and regulated flow duration curves (Petts 1996).

Indication of Hydrological Alteration (IHA) model to analyze per- and post dam construction of stream flow data. Indicator of Hydrological Alteration is best suited to assess hydrologic alteration and to quantify the effects of dam construction and other such as water resource-development projects on the flow regime via two-period analyses and the Range of Variability Approach. The RVA uses 33 hydrologic parameters to evaluate potential hydrologic alterations (Richter et al. 1997; TNC 2001). Of these parameters, sixteen hydrologic parameters focus on the magnitude, duration, timing, and frequency of extreme events and geomorphology; the other 16 parameters measure the central tendency of either the magnitude or rate of change of water conditions. Therefore, these 33 IHA parameters provide a detailed representation of the hydrologic regime for assessing hydrologic alterations.

The degree to which the RVA target range is not attained is a measure of hydrologic alteration (HA). HA, expressed as a percentage, can be calculated as:

$$\text{HA}(\%) = (\text{Observed frequency} - \text{Expected frequency})/\text{Expected frequency}$$

Hydrologic alteration is equal to zero when the observed frequency of post-dam annual values falling within the RVA target range equals the expected frequency. A positive value indicates that annual parameter values fell inside the RVA target window more often than expected; negative values indicate that annual values fell within the RVA target window less often than expected. TheNFR approach was introduced in aquatic ecology to support the conservation and restoration of ecosystems. It is defined based on five major indicators; magnitude, 5 duration, timing, frequency and variability (Richter et al., 1996; Poff et al., 1997b).

RESULTS AND DISCUSSIONS

Trends in the Rainfall and temperature series

Changes to Rainfall (precipitation), temperature and evaporation are to show the climate variability which may contribute to some changes in natural stream flow. The climatic data of precipitation and temperature in the study area analyzed for variation or trend over the range of 1988–2010 at a daily, timescale. Change to rainfall trends of thee nearby stations to the dam site have showed the decreasing trend and the temperature of the two station shows the increasing trend. This is one of the possible drivers of the change to the natural flow regime. We analyzed possible changes of rainfallgraphically as shown below at stati

Table 3: Results of Mann-kandella test for MaximumTemperature data

Station	Kendall's tau	S	Var(S)	p-value (Two-tailed)	alpha	Interpretation
Sokeru	+0.36	-24.0	0.0	0.12	0.05	Rejected
Asendabo	+0.30	-20.0	0.0	0.21	0.05	Rejected
Limmu	+0.52	-34.0	0.0	0.02	0.05	Accepted

Table 4: Results of Mann-kandella test for MinimumTemperature data

Station	Kendall's tau	S	Var(S)	p-value (Two-tailed)	Alpha	Interpretation
Sokeru	-0.515	+34.000	0.000	0.021	0.05	Accepted
Asendabo	+0.455	+30.000	0.000	0.045	0.05	Accepted
Limmu	+0.424	+28.000	0.000	0.063	0.05	Rejected

on of Asendabo and Sokeru and Limmu Gennet.

The Mean maximum and minimum temperature of the three station shows the insignificant trend.

Table 5: Summary of Mann-kandella test for Rainfall station of Study area

Stations	Kendall's tau	S	Var(S)	p-value (Two-tailed)	alpha	Test Interpratation
Limmu	-0.04	+9.0	0.0	0.24	0.05	Rejected
Sokeru	+0.04	+11.0	0.0	0.74	0.05	Rejected
Asendabo	-0.05	-13.0	0.0	0.55	0.05	Rejected

The Mann-Kendall test on (rainfall) precipitation data, results above shown in Table 5 were obtained for the three stations. If the p value is less than the significance level α (alpha) = 0.05, H0 is rejected. Rejecting H0 indicates that there is a trend in the time series, while accepting H0 indicates no trend was detected. On rejecting the null hypothesis, the result is said to be statistically significant. For this test, the Null Hypothesis was accepted the result was not significant statically. The Mann-Kendall test gives interesting understanding about annual temperature and precipitation data while The MK test Statistic (S) indicates that there is an increasing precipitation trend for the Sokeru station and decreasing trend for both Asendabo and Limmu, however The S statistic, ,implies that the is not very strong as compare to other stations. Decreasing precipitation trend at both Asendabo and Limmu gennet station could have the direct impact on the runoff and water resource development Project

In addition climateVariability the Land use and cover change also has the great influence the on hydrological alteration of the watershed. Classify the land use and land cover change to understand the impact of land use and land cover change on runoff since the hydrological alteration include the climate variability/ change and also the other human activities (land use and land cover change).

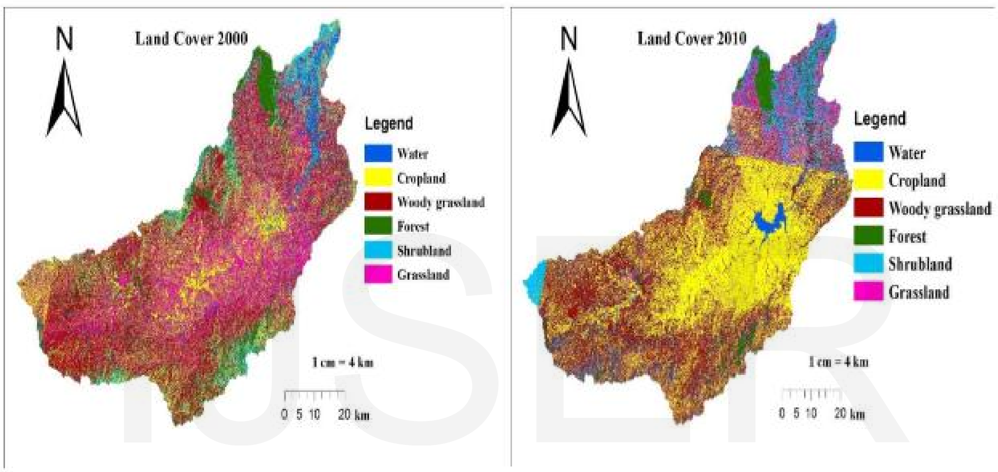


Figure 12: Land and use land cover of year 2000 and 2010

LULC change tested for two distinct periods using land use maps of the 2000 and 2010. The changes found were significant and expected as the watershed is dominantly because the GilgleGibeI Dam in addition to an increasing population of pastoralist and farming society, with a need of grass and farming areas. Forested land (FL), woody grasslands (WG), Grassland (GL) and shrub lands (SL) were declined. While both Water and croplands (CL) increased in the study area. This result also similar to those found in several other studies in Ethiopia (e.gFikadu F.2014) LULC change from FL, WL, WG and SL to CL and GL would be expected to contribute to educedinterception, less infiltration, lower actual evaporation and hence result in higher runoff but due to the increasing land cover of cropland and water the evapotranspiration of the watershed shows the increasing trend he. The trends found in the IHA indices, such as for the 7-day minimum flow, as well as changes to the dry season FDC between the first and second parts of the periods.

Table 6: Land use land cover of 2000 and 2010 in Km2 and areal change change in %

Value		LULC of 2000 Area in (Km^2)	LULC of 2010 Area in (km^2)	Area change(%)	Interpration
1	Water	125.0	293.1	+3.28	increase
2	Cropland	1187.1	2049.0	+16.82	increase
4	Woody grassland	1652.7	1529.8	-2.40	decrease
5	Forest	319.4	200.2	-2.33	decrease
26	Shrubland	741.8	602.7	-2.71	decrease
43	Grassland	1139.1	465.8	-13.14	decrease

This table shown area of land cove change in percentage during two period of analysis, land cover by water-body was increased by 3.3% because of Gilgel Gibe1 dam impoundment and also cropland was increased by 16.8 %, but Woody grassland, Shrub land and Grassland was shown decreasing trend by 2.4 to 13% . These LULC changes clearly have a strong influence on the Stream flow of the watershed. Conversion of forest and wood land to cropland and water body can increase the surface runoff due to decreasing of infiltration rate of the land class of cropland and water body and decreasing of actual evaporation from these land covers compared to forest land and wood land which have high evaporation and infiltration capacity (Fikadu, et al., 2014).

The Simhyd model was calibrated and verified after we have taken one years of warm up (1988-1989). Then calibrated from 1990-1998 and verification was done for 1999-2003 Pre -dam construction the used from time range 1988-2003. The model have manual and automatic calibration and verification options and we have used automatic one. There is also an option to observe sensitivity analysis of the model parameters. The model parameters are base flow, impervious threshold, infiltration coefficient, infiltration shape, interflow coefficient, pervious fraction, RISC, Recharge coefficient, and soil moisture shortage capacity (SMSC). The uncertainty of the model and the result depends on how much the sensitive parameters are adjusted to fit the simulated model result to the observed flow. Hence, impervious threshold, interflow coefficient, pervious fraction and Recharge coefficient are highly sensitive, but infiltration shape, infiltration coefficient, RISK and soil moisture storage capacity (SMSC) are less sensitive parameters as sample shown for pervious fraction (Fig.4.7) infiltration shape.

Table 8: Statistical summary of observed and simulated value of calibration and verification of the model for the pred dam time.

Varaible	start	End	length	missin g	Total mm/day)	Mean (mm/day)	Std.Dev (mm/day)
Calibrated Observed flow	12/31/1989	12/31/1998	3288	0	13766.4	4.19	6.083
Verified Observed flow	12/31/2000	12/31/2003	1096	0	4067.700	3.711	5.692
Simulated flow	12/31/1989	12/31/1998	3288	0	10509.639	3.196	5.129
Simulatedflow	12/31/2000	12/31/2003	1096	0	3096.916	2.826	4.769

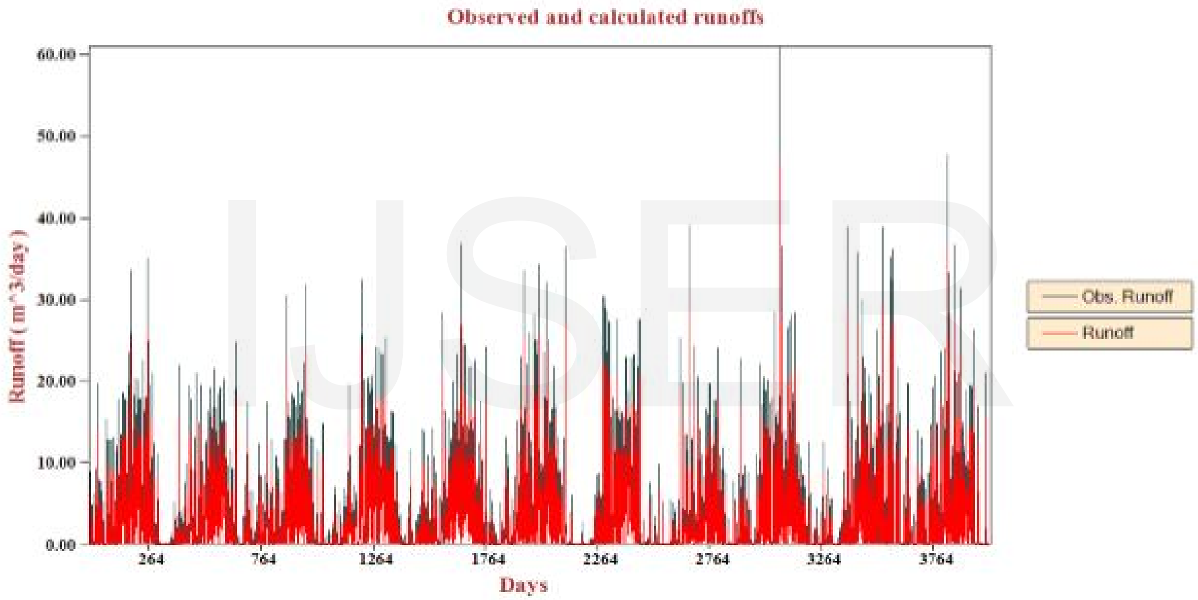


Figure 16: Daily caliberated simulated and observated value for pre dam period from 01/01/1989-31/12/1998

The simulated results compared with the observed streamflow for Gilgel gibe1 watershed are shown in the figure revealed that there is large difference between the simulated and observed stream flow during the testing period of 2004-2010, which indicates that human activities (damming) have played an important role for this difference. The reason for this big difference was the flow regulation by Gilgel Gibe I dam construction.

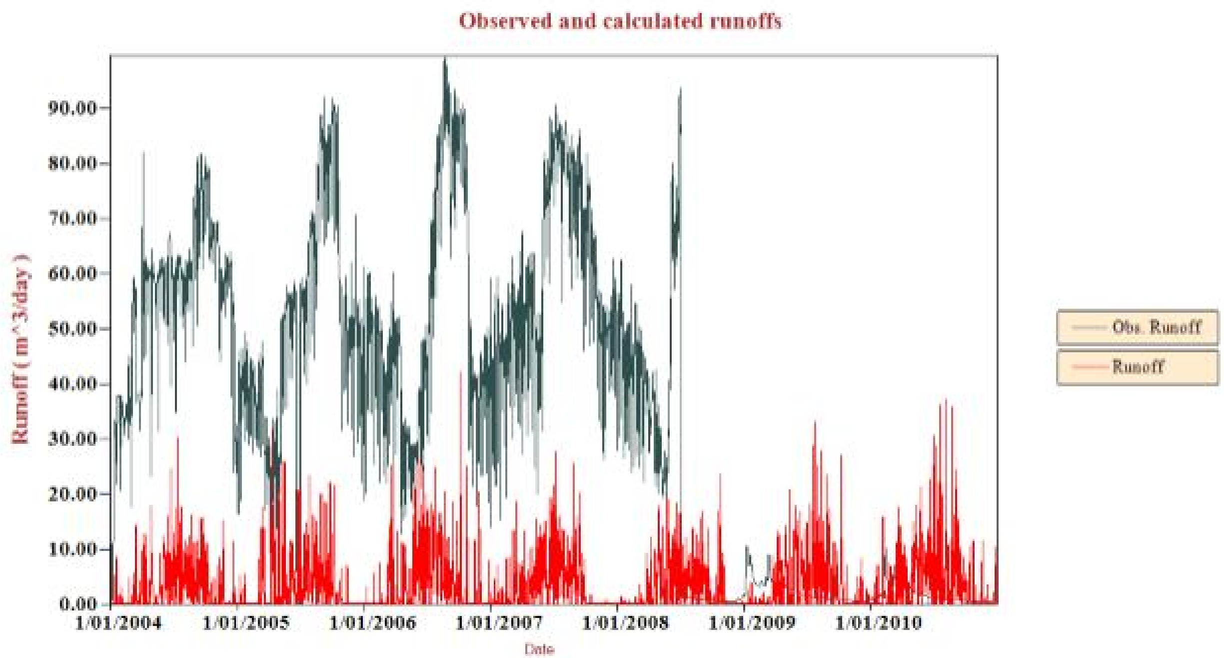


Figure 18:Daily simulated and observated runoff for post-dam time (2004-2010)

IHA and RVA results

Magnitude

Magnitude of discharge at any time interval is the amount of water moving past a fixed location per unit time. The mean river discharge for each month (ms1) is used to measure changes in flood magnitude from the pre- to the post-dam period. The monthly mean of the daily water conditions describes 'normal' daily conditions for the month, and thus provides a general measure of habitat availability or suitability. The IHA method includes 12 parameters each measuring the mean or median of the daily river discharge conditions for a given month. Similarity of monthly mean within a year reflects condition of relative hydrologic consistency. We have analyzed monthly HA and the result shownthere were the significant change During Months of July and August that is decreasing Middle HA. Similarly in the month of January, February, March, and April also HA the result shown the middle HA value negative.

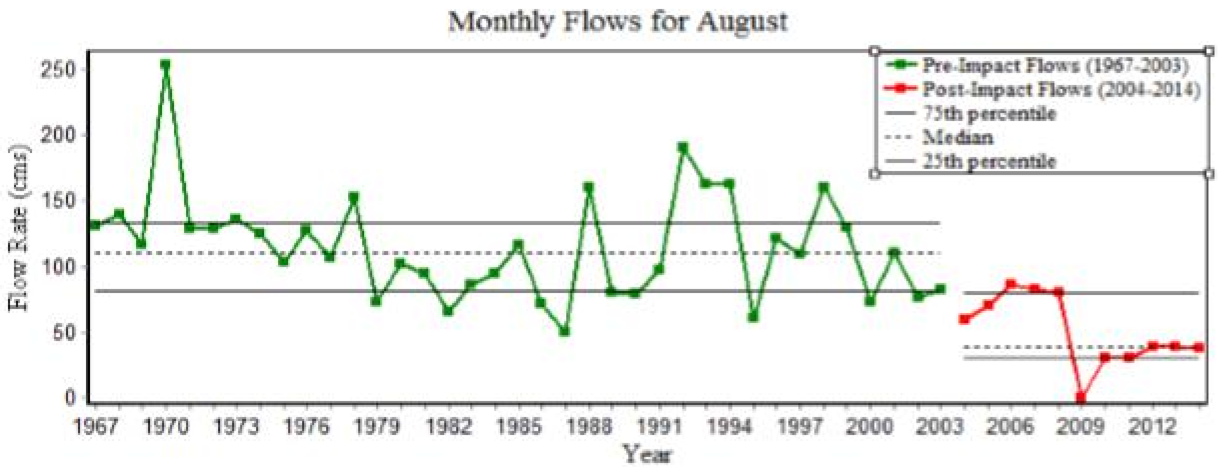


Figure 19: Monthly flow of wet season

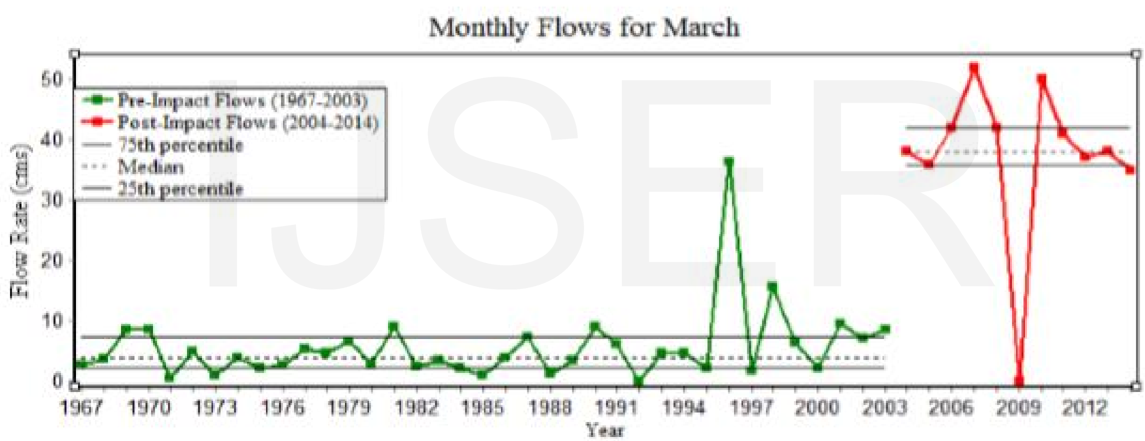
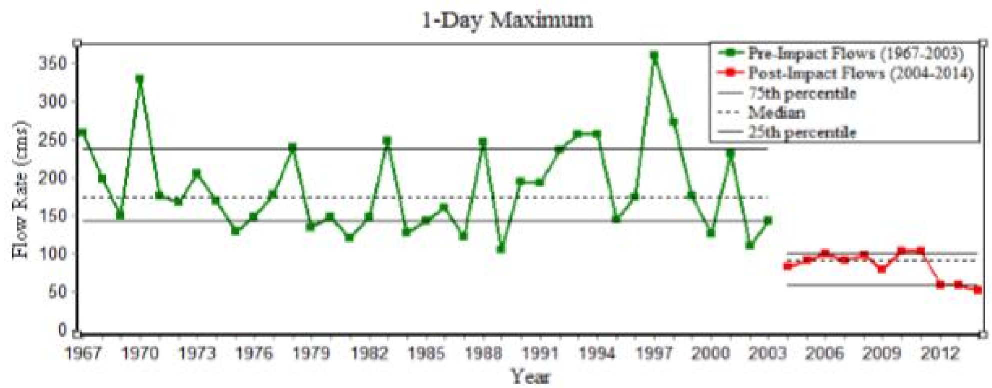


Figure 20: Monthly flow of the Dry season

Magnitude and duration of annual extreme conditions

The 10 parameters in this group measure the magnitude of extreme (maximum and minimum) annual water condition of various duration, ranging from daily to seasonal. The duration we used follow natural or human imposed cycles and include the 1-, 3-, 7-day (weekly), 30-day (monthly), and 90-day (seasonal) extremes. For any given year, the 1-day maximum (or minimum) is represented by the highest (or lowest) single daily value occurring during the year; the multi-day maximum (minimum) is represented by the highest (or lowest) multi-day average value occurring during the year. The mean magnitude of high and low water extremes of various duration provide the measures of environmental stress and disturbance during the year.

Figure 21: D-day minimum flow pre- and post-dam period.



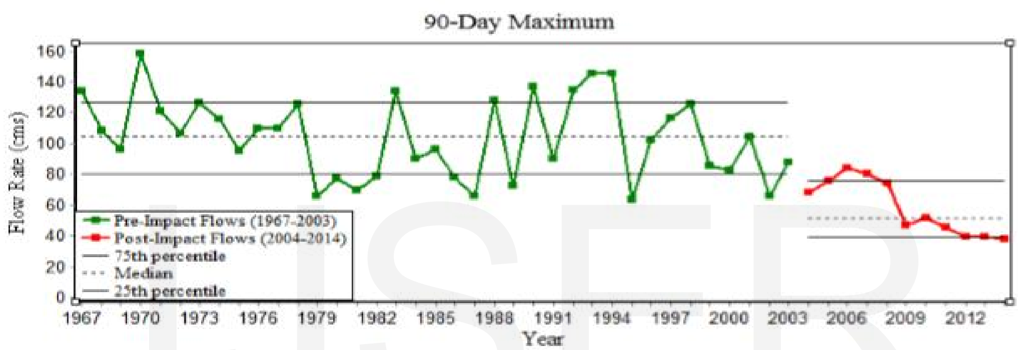


Figure 22: D-day maximum flow pre- and post-dam period.

From the result of D-day minimum and maximum flow, the natural flow regime of Gilgel-Gibe watershed have shown significant change after dam construction compared before dam.Where high variability during pre- dam period, but that were is the naturally occurred seasonal variability of streamflow in the watershed. Shown on Fig. (22), the D- day (1, 7, 30, and 90) maximum flow have significantly decrease for post dam period compared to pre dam period. However, D-day minimum flows have shown the increasing trend during post dam compared to pre-dam time. This is more described by monthly plotted hydrograph of mean flow, which show decreasing of peak flow of wet season during which storage will be high compared to dry season hydrograph which will show increasing in magnitude due to release of water during dry season more than natural flow to meet energy demand from storage water.

Timing of Annual extreme Conditions

These includes two parameters, one measuring the Julian date of the 1-day annual minimum water condition and the other measuring theJulian date of the 1- day maximum water condition. The timing of the highest and lowest water condition within annual cycles provides another measure of environmental disturbances or stress by describing the seasonal nature of these stresses. Humaninduced changes in timing may cause reproductive failure, stress, or mortality. In the below the date of maximum flow after 220 – 365 days and the minimum date from

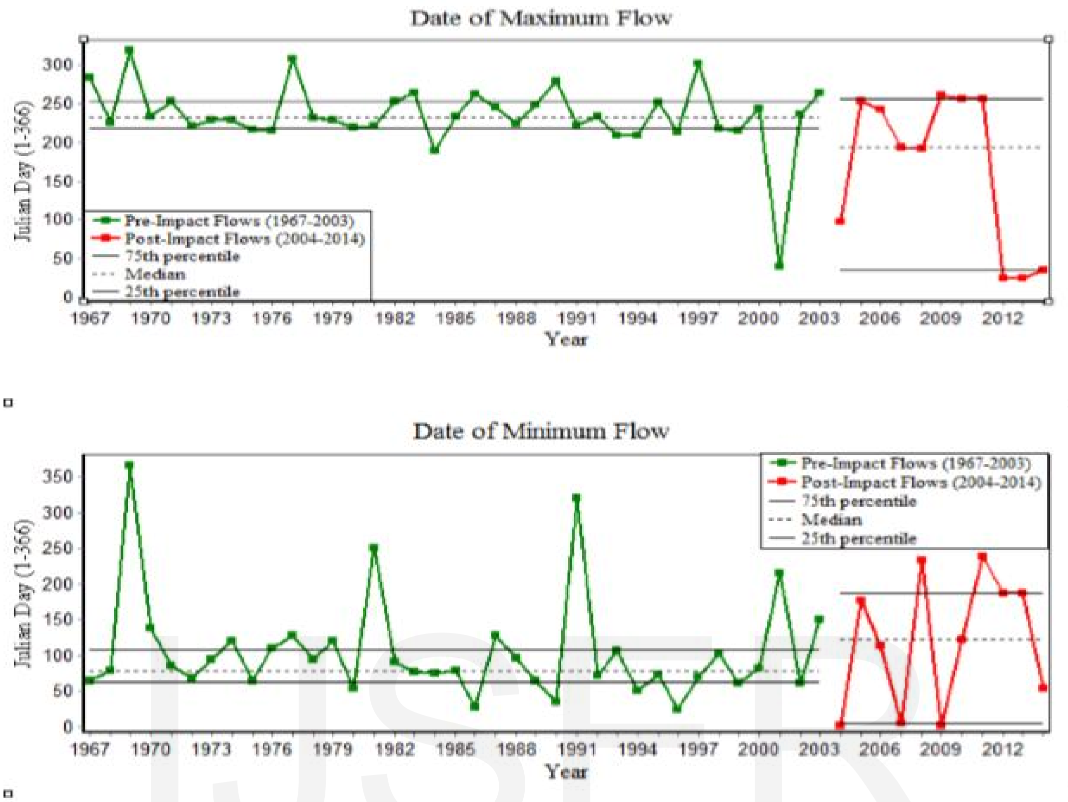


Figure 24: Timing of D-day maximum and minimum flow for pre- and post-dam period

From the above fig (24) we can understand that the Julian date (timing) of maximum flow decreased from almost 240 days from January 1 to 200 days, that is almost one month shift of one day maximum occurring time. But, for the timing of minimum flow, it increased during post-dam period from approximately 70 day to 120 days, i.e. almost two months shift.

Frequency and Duration of high and low pulses

The four parameters in this group includes two measure the number of annual occurrences during which the magnitude of the water condition exceeds upper threshold,or remain below threshold, respectively, and two that measure the duration of such high and low pulses in fig. However, due to the frequently skewed distribution of river discharges, calculation of the lower discharge threshold could result in a negative value. As this was the case with our data, upper and lower discharge thresholds accordingly definedas flows corresponding to the 75th percentile, and the 25th percentile, of pre-dam river flows, respectively.These measures of frequency and duration together within a year in which the daily mean water condition either rises above 75th percentile (high pulse) or drops below the 25th percentile (low pulse pulse) of all daily the impact time period.

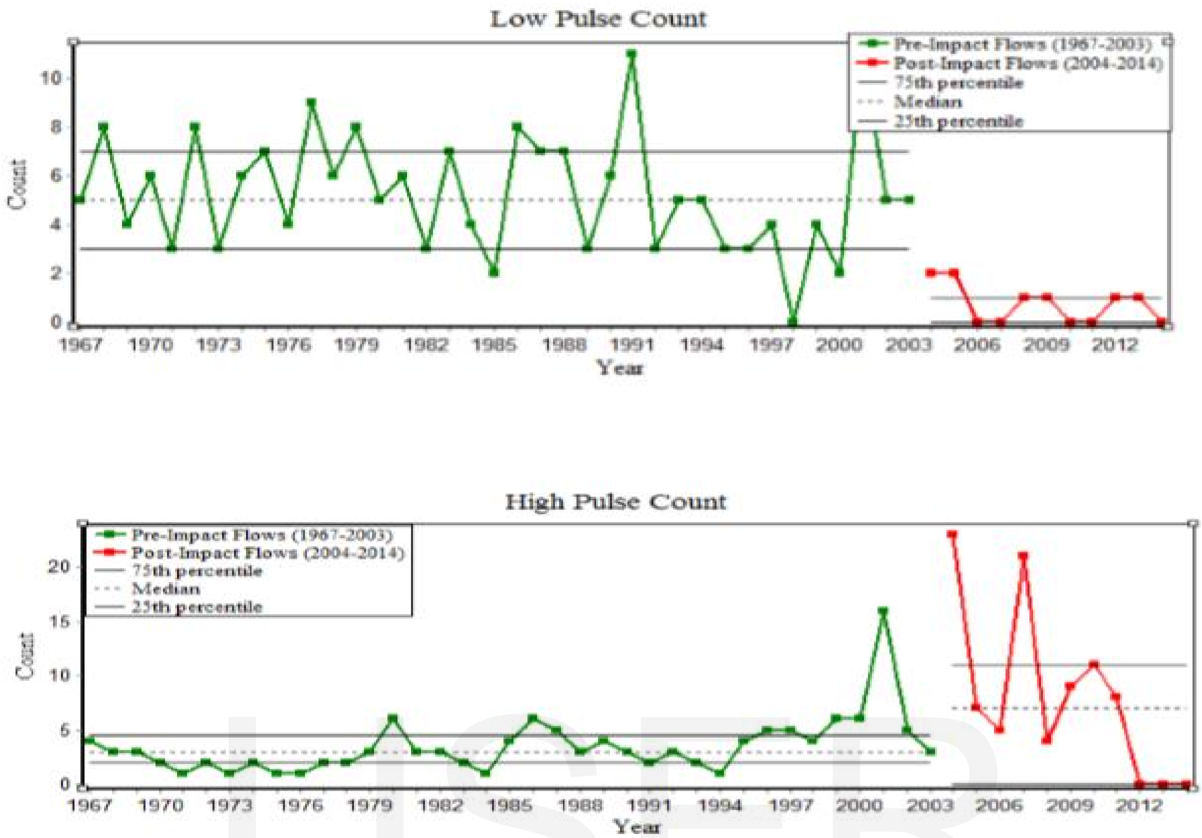


Figure 25 a: Frequencies of high and low pulses

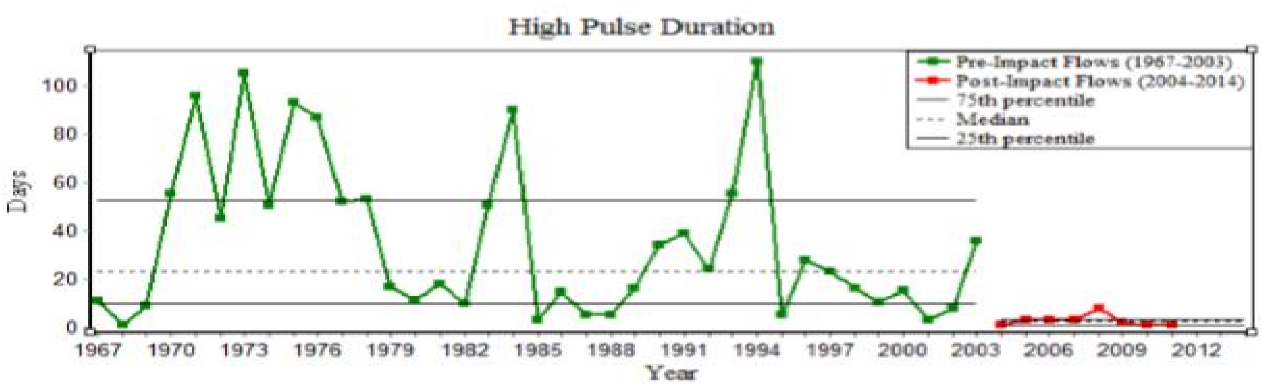


Figure 26b: Duration of high pulse

The duration of high pulse decrease during the post- dam that up to 5 days while the in the pre-dam condition it's about 50 days.

Rate and Frequency of Change in Conditions

The four parameters in this group measure the number and mean rate of both positive and negative changes in water conditions from one day to the next. These rate and frequency of change in water can be described in terms of the abruptness and numbers of intra-annual cycles of environmental variation and provide a measure of the rate and frequency of intera-annual environmentalchange.

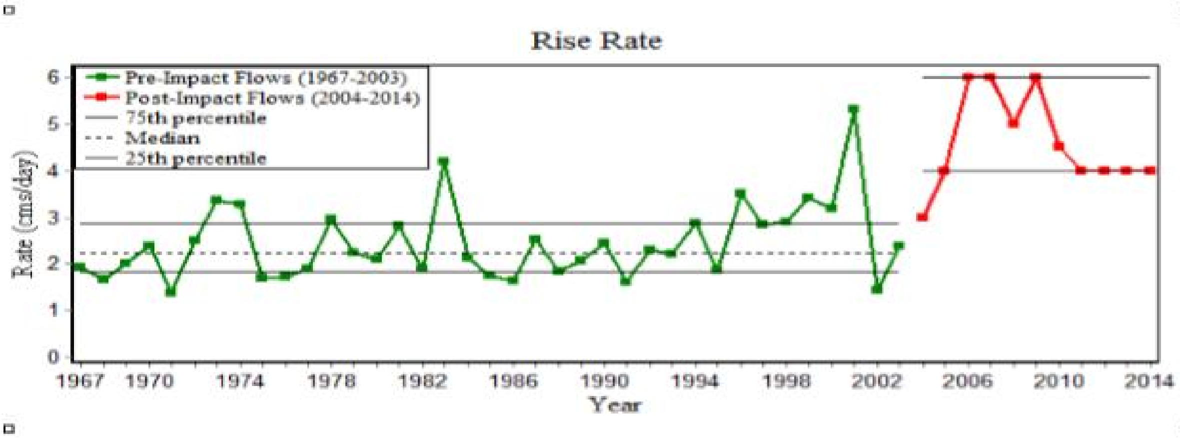


Figure 27a: Graph of Rise rate

The rise rate increase during the post dam

Figure 28b: Graph of fall rate

The fall rate and frequency decrease during the post dam

CONCLUSION AND RECOMMENDATION

The effect of climate variability and Land use land cover change on the stream flow of Gilgel Gibe-1 watershed have analyzed by Mann-Kendall trend test and Maximum likelihood classification respectively and we got the significant effect.

We have used SIMHYD software for rainfall-runoff model to simulate the stream flow for pre-dam and post-dam and calibrated and validated for pre-dam period (1988-2003) and compared model and regulated measured flow for post-dam period (2004-2010). We have got that pre-dam period the model simulated very well the flow from rainfall and the model performance (Nash-Sutcliff) value is near 0.85. However, for post-dam period, the simulated and measured regulated flow have big discrepancy due to regulation of dam.

We have also used IHA software to analysis the natural flow regime parameters like magnitude, duration, timing, frequency and flow rate change for pre-dam and post-dam period. In this regard, we have used RVA to characterize the natural flow regime parameters for pre- and post-dam period and it shown that there was significant change.

In general, dams are hypothesized to homogenize flows across distinct hydro climatic regions by decreasing maximum flows, rise and fall rates, and flow variability while also increasing minimum flows.

Recommendation

The RVA has proved to be a practical and effective approach to indicate the variation and helpful to for facilitating river restoration planning. However, there are some defects in previous reports on hydrologic alteration assessment. The validity of hydrologic alteration assessment must carefully consider when the flow records for pre- or post-impact periods or both are insufficient. Hydrology-based methods are often the most appropriate at the planning level or in low controversy situations because of their rapid, inexpensive but low-resolution estimates, (Tharme 1997). Many research consider only the impact of Climate change/variability but the human activity must be consider because the impact of human activity also have the significant effect on Water Resource.

REFERENCES

Chen and Y.D. 2002 Hydrologic alteration along the middle and upper East River (Dongxiang) basin, South China: a visually enhanced mining on the results of RVA method. [Journal] // Stoch Env Res Risk Assess. - 2002. - pp. 24: 9-18.

Kummu 2007 Sediment-related impacts due to upstream reservoir trapping, the Lower Mekong River. [Journal] // Geomorphology. - 2007. - pp. 275-293.

Hu; W; Wang, G.-x; Deng, W.; Li; S. - The influence of dams on Eco hydrological conditions in the Huaihe River basin, China [Journal] // Ecological Engineering, 33. - 2008. - pp. 233-241.

Petts G.E, 1984 and Naiman R.J., Decamps, H. & Pollock, M. The role of riparian corridors in maintaining regional biodiversity [Journal] // Ecological Applications, - 1993. - pp. 209–212.

Ohmart, R.D; Anderson; Hunter, B.W. &; W.C 1993. The ecology of the lower Colorado River from Davis Dam to the Mexico-United States boundary: a community profile [Report]. - United States: Department of the Interior Fish and Wildlife Service Biological Report.

ICOLD 2003 World Register of Dams [Journal] // International Commission on Large Dams, Paris France, p. 340 pp.

Baxter 1977 Environmental effects of dams and impoundments [Journal] // Annual Review of Ecology and Systematics, pp. 255–283

Maingi& Marsh 2002 Quantifying hydrologic impacts following dam construction along the Tana River, Kenya [Journal] // Journal of Arid Environments. - pp. 65-70

Maiolini and Bruno2007 The River Continuum Concept revisited [Journal] // Lessons from the Alps. Man & Environment. - p. 3.

Poff N.L., Olden, J.D., Merritt, D.M. and Pepin, D.M. 2007 Homogenization of regional river dynamics by dams and global biodiversity implications [Journal] // PNAS, 104 (14). - pp. 5732–5737.

Zhao, Wei Ouyang, FanghuaHao and Kaiyu 2012a.Song Cascade Dam-Induced Hydrological Disturbance and Environmental Impact in the Upper Stream of the Yellow River. [Journal] // Water Resources management, 25. - pp. 913-927

Richter, B. D., Baumgartner, J. V., and Braun, D. P1996, A method for assessing hydrologic alteration within ecosystems [Journal] // ConservBiol 10(4):- pp. 1163–1174.

Fikadu; Worku; F. Werner, M; Wright, N. Zaag, P., Demissie,S.2014 Flow regime change in an endorheic basin in Southern Ethiopia [Journal]. - [s.l.] : HESS, - Vol. 18.

- Besho Homa (MSc), master's degree program in Hydrology and Water Resource Management in Arba Minch University, Ethiopia, PH-+251913071502. E-mail: beshohm@gmail.com
- Adane Abebe (PhD), PhD degree program. E-mail: adaneabe@gmail.com
- Fikadu Fetene (PhD), PhD