THE PRELIMINARY ASSESSMENT OF HYDROLOGICAL ALTERNATION IN THE MANGLA WATERSHED OF PAKISTAN.

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ABSTRACT: *The natural flow in the river is effected by human activity and water uses which altering the hydrologic regimes around the world .Hydrological flows is very important to determining the biotic composition, structure and function of aquatic, wetland and riparian ecosystems. In this paper the preliminary study was conduct in the Mangla water shed to evaluate the impact of land use and climate change on the flow regime of Mangla watershed. The 33 hydrological parameters in five different groups were used to assess the Hydrological alternation in the Seven gauging station of Mangla watershed. The study indicated that Neelum Basin at Muzaffarabad having maximum number of high Alternation of negative values. The parameters of group -1 and group -2 were shows high frequency of alternation in the whole basin mean while The whole basin shows Medium Alternation on average which adversely affect and disturb the ecosystem of the flow regimen of Mangla watershed.*

Keywords: Hydrological Alternation (HA), Range of Variability Analysis (RVA), Mangla watershed, indicator of hydrology Alternation (IHA).

INTRODUCTION:

The flow of river is the driving force of ecological process which effects on the distribution, composition and the diversity of the lotic biota. [12, 17]. The Alternation in the stream flow modify the distribution and availability of river habitant with potentially adverse results of native biota.[14]. The ecosystem of river is the very important part of regional and global environment and the variability in the river flows plays vital role in the maintaining of the health of aquatic ecosystem[12]. The critical components of the river flow regime which regulate the ecological processes in river ecosystems are magnitude, frequency, duration, timing, and rate of change of hydrologic conditions[12]. Human perturbations that alter hydrologic connectivity include dams, stream channelization, associated flow regulation, and water extraction (from both the stream channel and groundwater). Factors such as sediment transport, acid rain, and spread of pathogens and exotic plants along river and riparian corridors are not only perpetuated by hydrologic connectivity, but also their effects are often exacerbated by changes in this property The construction of Dam and Diversion on the upstream alter the river flow in the downstream which results the dryness and mining of river bed and becomes the cause of channel narrowing and forest expansion on the flood plain which was a braided channe [1].The impact of climate change on the water resources significantly affaect on the hydrological cycle. The river flow alternation affect on the ecosystem with respect to Habitat suitability for freshwater dependent biota [25]. The hydrological indicator represent the severity of hydrological drought in the season. The safe water abstraction and allocation from the river adversely effects on the ecosystem of river[6].

1. Study Area:

The Mangla watershed is located between latitudes of 33^o 00’ N to 35^o 12’ N and longitude of 73^o 07’ E to 75 ^{o} 40’ E as shown in figure1. The area of Mangla watershed is 33455Km2. The range of elevation in Mangla water shed varies form 253 m to 6173 m above the mean sea level. The Mangla watershed consist of fiver Major basins Neelum, Kunhar, Poonch, Kanshi and Jehlum. The 55% area of Mangla watershed lies in India and 45% area lies in Pakistan therefore mostly river enter in the Pakistan from India. The Seven flow gauges Azad Patten (AZP), Domel ,Kohala installed on Jehlum river, Ghari.Habib Ullah (GHU), Muzaffrabad (MZP), Palote and Kotli are installed on Kunhar, Neelum, Kanshi and Pooch river respectively are selected in the study at different location in Mangla watershed as shown in Table 1.

Table1 : Gauges location in Mangla Watershed

Sr.No	Gauge Station	Latitude (dd)	Longitude (dd)	Install on River
1	Azad Patten (AZP)	33.7	73.6	Jehlum
2	Domel	34.4	73.5	Jehlum
3	Ghri.Habib Ullah. (GHU)	34.4	73.4	Kunhar
4	Kohala	34.1	73.5	Jehlum
5	Kotli	33.5	73.9	Poonch
6	Muzaffrabad (MZP)	34.4	73.5	Neelum
7	Palote	33.2	73.4	Kanshi

The Mangla watershed lies in the Monsoon Belt therefore the in summer the rivers are feed by rainfall and snowmelt while light shower of rain and snowfall in the winter season. The month of August and September is high flow season of Mangla watershed due to monsoon rain rainfall and Snowmelt flow. The flow in the rivers decreases in the month of February which is consider as a dry month [25]. The Jhelum, Neelum, Kunhar, Kanshi and Poonch contribute the flow of 41%, 34% 10%, 13% and 1% of the whole watershed flow respectively. The Snow Avalanches are also occurred in Kunhar Basin from December mid to May and continue till June at high altitude of basin[6]. The snow avalanches also effects on flows of rivers. The increase in air Temperature in the Kunhar Basin becomes a cause of Lake burst which alter the hydrological flow [6].

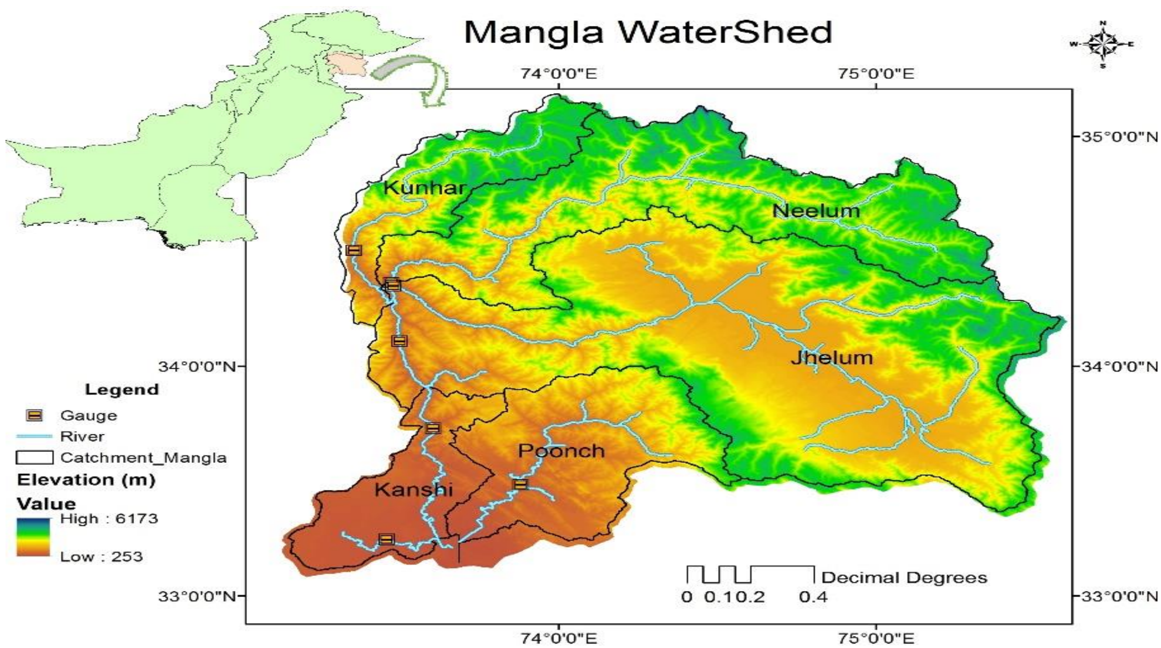


Fig1: Geographic location of Mangla Watershed .

2. DATA AND METHODOLOGY:

The daily flow data of each station of mangla watershed were use from 1976 to 2014. The Range of variability Approach (RVA) was use to study the hydrological alternation in the flow regime of the study area whicj incorporate the concept of hydrological variability and integrity of aquatic ecosystem[14] .The 33 hydrological parameters are used to assess the alternation in the term of flow magnitude, frequency ,duration and rate of change[14]. In RVA methodology we compares the hydrologic data of pre-impact period with a post-impact period and each period is represented by 19 water years. The degree of alteration is determined by a RVA which is based on the frequency of hydrologic parameters fall within the values of selected range from the distribution of pre-impact values [14].

The HA in the study area were evaluated on the basis of 33 hydrologic parameters which were divide in to five groups o the basis of magnitude , frequency , duration , time and rate of change . The parameter "number of zero-flow days" was not included in the study because the zero days of flow were not observed in the study area.

Group 1: The median of monthly flow of whole year describe the monthly flow conation of flow regime.

Group 2: In this group the magnitude and duration of annual extreme flow were evaluated on the basis of ten parameters of 1-, 3-, 7-, 30-, and 90-day annual maxima and minima which based on the cycles of daily, weekly and monthly. The base flow index is calculated by dividing the 7-day minimum flow with the annual mean flow.

Group 3. The 1-day annual maximum and minimum flow of Julian dates were evaluated which indicate the timing of annual extreme flows.

Group 4. In this group the parameters of low pulses and high pulses frequency and duration were evaluated. The magnitude of daily flows above the 75th percentile of pre-impact period were consider high pulse count while the flows below the 25th percentile flow of the pre-impact period were consider low pulse count.

Group 5. The parameters of fall rate, rise rate, and number of reversals were evaluated which indicate the positive and negative changes in flow in two consecutive days.The nonparametric approach was applied in this study to define the Range of 25^{th} and 75^{th} percentile as targeted for variability of post period and the median (50th percentile) taken as central tendency value. The degree of Hydrological Alteration (HA) expressed as a percentage which can be calculated as

$$HA = \frac{observed - Expected}{Expected} \times 100$$

where "Observed" is the number of years having values of the hydrologic parameter fell within the targeted range for post period 1995 to 2014 and "Expected" is the number of years having values is expected to fall within the targeted range of pre period of 1971 to1994. (Richter et al 1998) [14] recommended the three-class to assess the Indicator of Hydrological Alternation (IHA).The degrees of HA were consider minimal or no alteration having HA between 0%–33%, moderate alteration between 34%–67% and high alteration having 68%–100%.

3. RESULTS AND DISCUSSION:

The IHA software version 7.1 were used to determine the degrees of HA for all the hydrologic parameters in the seven hydrological stations .The percentile values 25th and 75th were based on the available pre-impact records and post-impact records, with the low and high boundaries of the RVA target range. The results of the RVA analysis are shown in Table 2.

Table2: Hydrological Alternation (%)

Low HA | Medium HA | High HA

Groups	AZP	Domal	GHU	Kohala	Kotli	MZB	Palote	AVERAGE*
Group #1								
July	-45.71	-40.00	-86.43	-53.85	-59.28	-18.57	-18.57	46.06
August	-45.71	-70.00	-5.00	38.46	-59.28	-45.71	-45.71	44.27
September	-59.28	34.99	76.44	-30.77	-59.28	-59.28	49.29	52.76
October	-18.57	19.99	-15.56	3.84	-45.71	22.15	42.50	24.05
November	49.29	49.99	-18.57	-42.31	8.58	-32.14	35.72	33.80
December	-72.86	-22.86	-5.03	3.84	-45.71	-26.11	6.88	26.18
January	-59.28	4.99	-72.86	15.38	-52.50	-72.86	-71.51	49.91
February	-45.71	-40.00	-4.99	-30.77	-18.57	-32.14	-76.25	35.49
March	-16.87	49.99	-28.75	-30.77	-4.99	-88.12	-45.71	37.89
April	8.58	-25.00	18.75	-53.85	-18.57	22.15	-57.78	29.24
May	-45.71	-40.00	-45.71	-19.23	8.58	-59.28	12.26	32.97
June	-76.25	-40.00	-59.28	-19.23	-86.43	-72.86	-52.50	58.08
Group #2								
1-day minimum	-45.71	-25.00	-52.52	3.84	-5.00	-59.28	-52.52	34.84
3-day minimum	-32.14	-25.00	-18.57	15.38	8.58	-59.28	-28.75	26.81
7-day minimum	-32.14	-10.00	8.58	26.92	8.58	-59.28	-45.71	27.32
30-day minimum	-59.28	19.99	-45.71	3.84	8.58	-45.71	22.15	29.32
90-day minimum	-72.86	19.99	-32.14	-7.70	-4.99	-45.71	35.72	31.30
1-day maximum	-18.57	4.99	22.15	-53.85	-32.14	-59.28	-45.71	33.81
3-day maximum	-59.28	-25.00	22.15	-76.92	-32.14	-59.28	-59.28	47.72
7-day maximum	-45.71	-40.00	-18.57	-65.39	-45.71	-72.86	-45.71	47.71
30-day maximum	-59.28	-55.00	8.58	3.84	-32.14	-86.43	-45.71	41.57
90-day maximum	-45.71	-55.00	35.72	-30.77	-59.28	-86.43	-4.99	45.42
Number of zero days	0.00	0.00	-5.00	0.00	0.00	0.00	-5.00	1.43
Base flow index	-45.71	-10.00	-72.86	3.84	-45.71	-86.43	22.15	40.96
Group #3								
Date of minimum	-32.14	34.99	-45.71	-38.46	-4.99	8.58	-72.86	33.96
Date of maximum	-32.14	34.99	-45.71	-65.39	8.58	-59.28	22.15	38.32
Group #4								
Low pulse count	-5.00	5.03	-13.64	20.74	54.38	-15.56	-5.00	17.05
Low pulse duration	-20.84	-10.00	-4.99	43.59	42.50	22.15	-68.33	30.34
High pulse count	54.38	-10.00	-30.92	-48.72	-15.56	16.11	8.58	26.32
High pulse duration	54.38	-10.00	76.44	-7.66	35.72	-32.14	10.85	32.46
Group #5								
Rise rate	-4.99	-22.86	-52.52	-38.46	-86.43	-45.71	-72.86	46.26
Fall rate	8.58	-48.57	-28.74	-13.85	-45.71	42.50	-40.62	32.65
Number of reversals	90.01	-55.00	-45.71	38.46	-45.71	-4.99	-72.86	50.39

*Note : The average values based on the absolute HA.

Group 1: Magnitude of Monthly Streamflow

The discharge is the magnitude of water flow through any location in unit time. The maximum and minimum magnitude of discharge can be varies with climate and watershed size. The month February and August are selected for discussion because they are most dry or wet month in the catchment. The analysis indicated that the median flow in the month of February which is consider as dry period decrease at Azad Pattan, Domel, Kohala and Palote by 8.47%, 12.3%, 9.63%, and 29% respectively with respect to the pre period with the hydrological alteration of -46%, -40%, -31%, and -76% respectively shown in figure().The median flow in the flood season of August in the whole catchment at the stations Azad Pattan, Domel, Gari Habibullah, Kohala, Kotli, Muzaffarabad and Palote decrease by 31.5%, 26.19%, 10%, 25.83%, 13.82%, 26.6% and 56.34% with respect to pre period with hydrological alternation of -46%, -70%, -5%, 38%,-59%, -46%, -46% respectively.

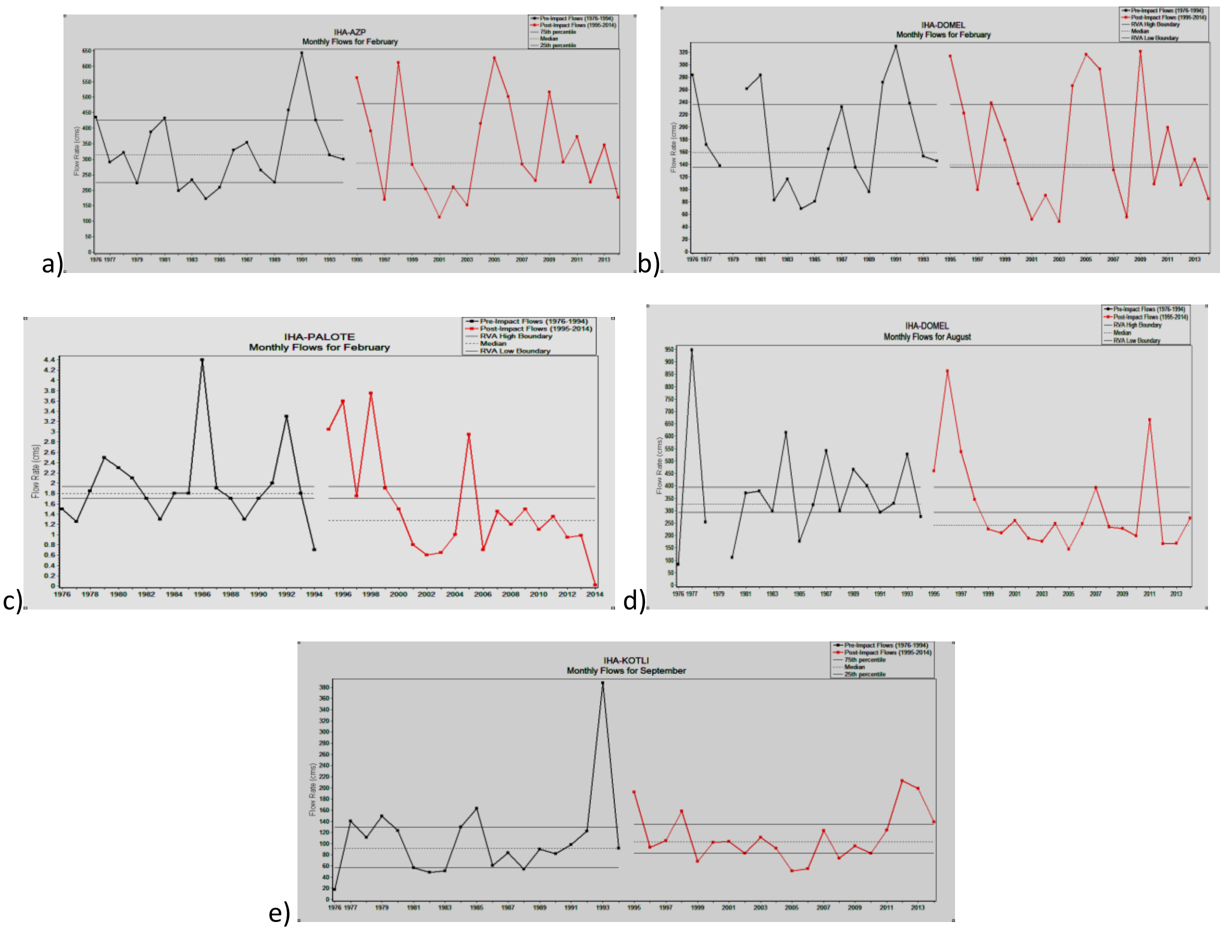


Figure 1: Monthly flow of (a) February at Azad Patten (b) February at Domel (c) February at Palote (d) August at Domel (e) September at Kotli.

Group 2: Magnitude and Duration of Annual Extreme Conditions:

The function of river, flood plains and estuaries are effected by extreme hydrological events. The hydrological event of high intensity with low frequency is effects on the function of lotic ecosystem and on the human use of rivers (spark, Spink 1998).The one day minimum medium alteration of -46%, -53%, -59% and -53% are observed at Azad Pattan, Gari Habibullah, Muzaffarabad and Palote while low hydrological alteration is found at Domel, Kohala and Kotli. The median flow of 1 day minimum is decrease by 1.7%, 5.26%, 19.23% and 19.81% at Azad Pattan, Gari Habibullah, Kotli and Muzaffarabad but the medium flow increase by 11.76%, 0.63% and 50% at Palote.The medium alteration of 1 day maximum flow found by -54%, -59% and -46% at Kohala, Muzaffarabad and Palote respectively as well as the median flow also decrease by 6.7%, 12.21%, 2.16%, 18.33%, 28%, 24.71% and 41.35% at Azad Pattan, Domel, Gari Habibullah, Kohala, Kotli, Muzaffarabad and Palote respectively as shown in figure().

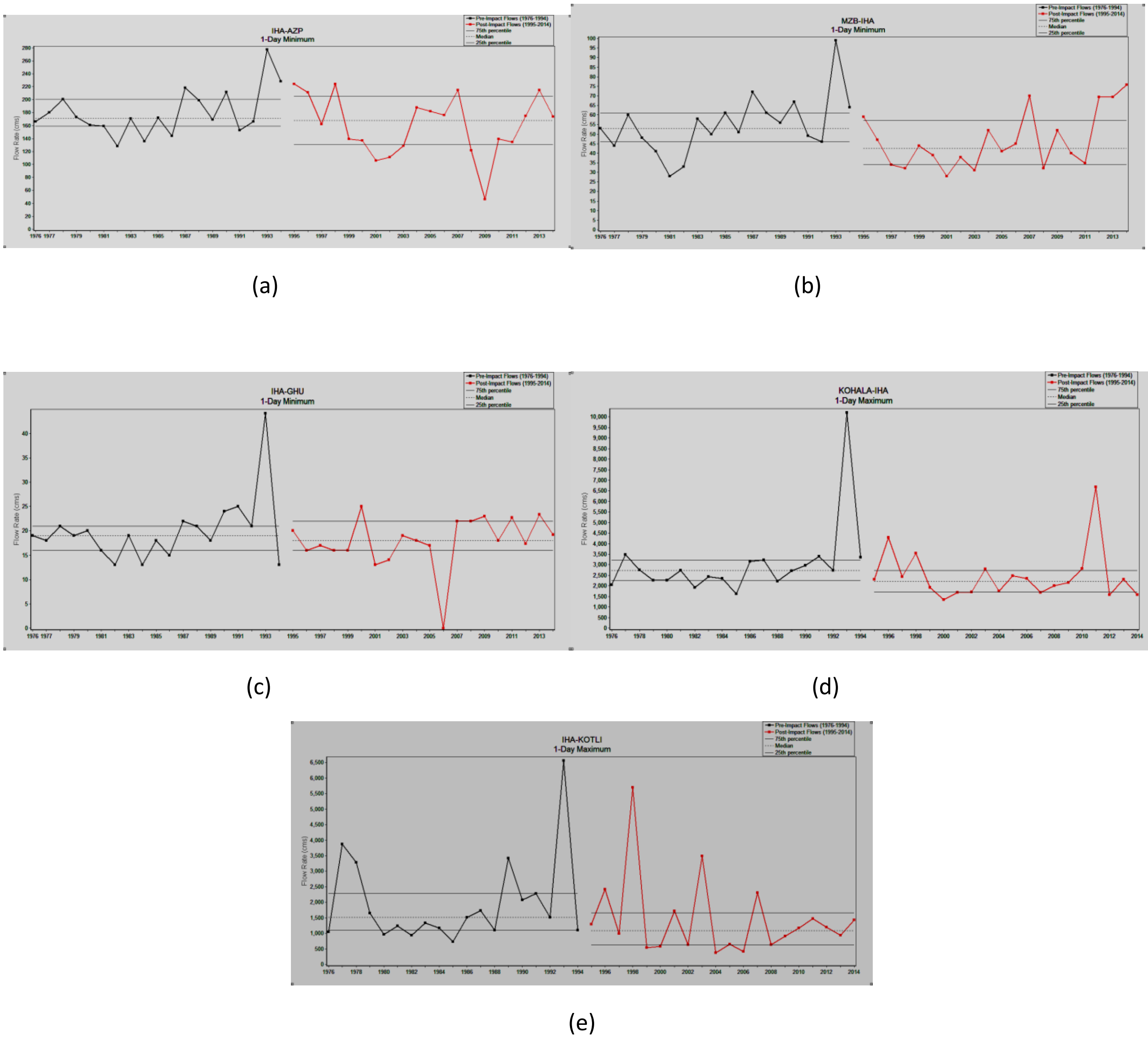
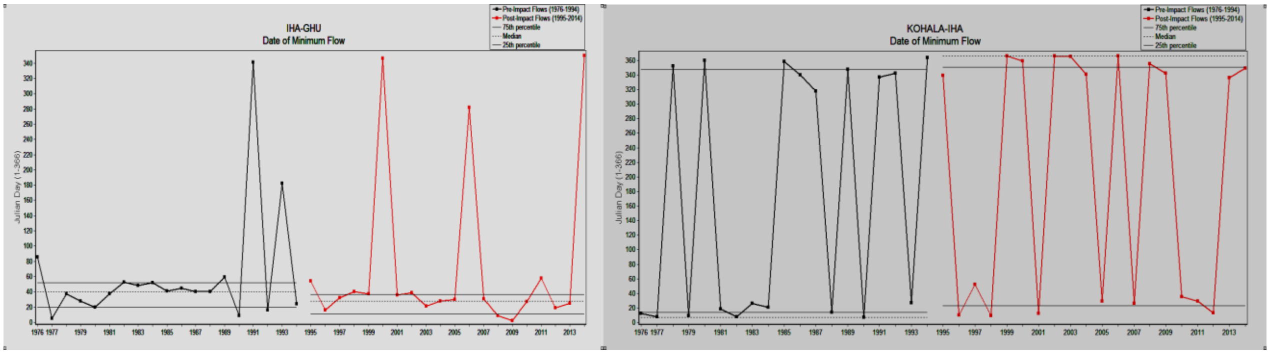


Figure 2: Monthly flow of (a) February at Azad Patten (b) February at Domel (c) February at Palote (d) August at Domel (e) September at Kotli.

Group 3: Timing of Annual Extreme Water Conditions

The time of the Julian date of 1-day annual minimum flow having negative alternation except at Domel and MZB. The medium hydrological alternation of 34.99% , -45.71 and-38.76 were observed at Domel, GHU and Kohala respectively while the high hydrological alternation were observed by -72.86% at Palote. The Julian date of 1-day minimum flow were earlier at station of AZP,Domel, Kohala and MZB than the pre-period while on the other station 1-day minimum flow were later than pre-period.The timing of the Julian date of 1-day annual maximum flow were also having negative hydrological alternation at most of the station except Domel , Kotli and Palote . The medium hydrological alternation of -48%,-62%,-59% and 38% were observed at Domel,GHU,Kohala and MZB respectively while the other station having low hydrological alternation as shown in the figure 3. The 1-day annual maximum flow at the station of kotli, MZB and Palote than pre period as shown in figure 3. The 1-day maximum flow was 30 days earlier than that of pre- period in figure 3.



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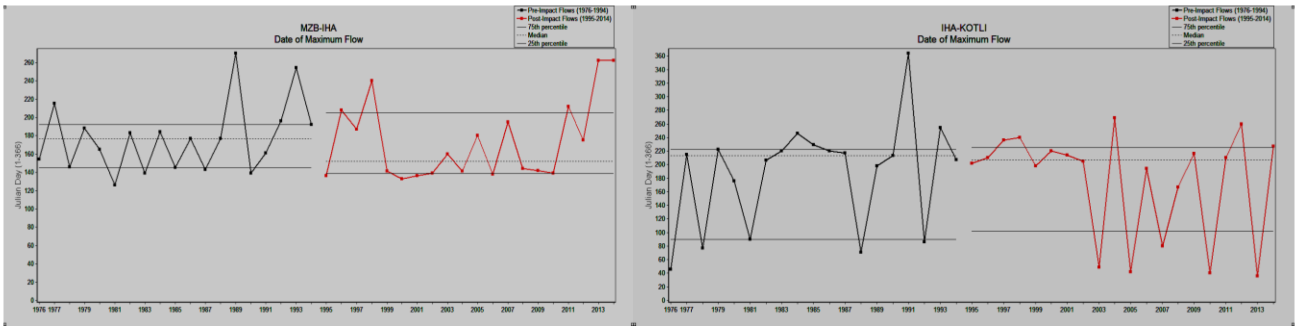
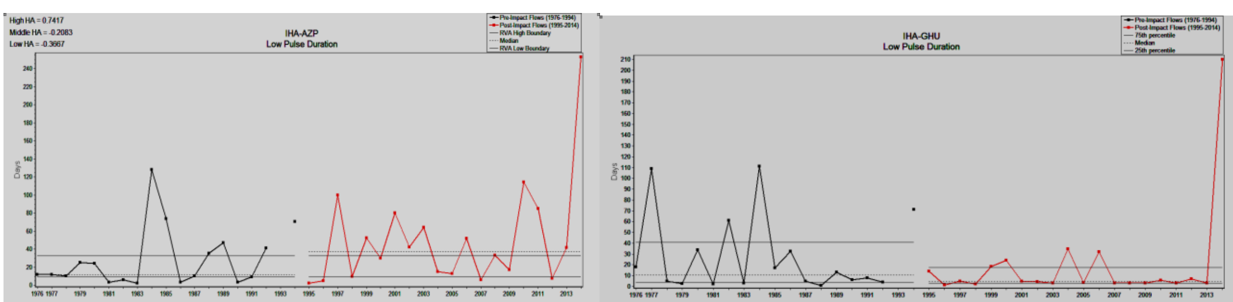


c) d)

Figure 3: (a) Date of Minimum flow at GHU (b)) Date of Minimum flow at Kohala (c) Date of Maximum flow at MZB (d) Date of Maximum flow at Kotli.

Group 4: Frequency and Duration of High and Low Pulses:

The frequency of high pulse count changed more than of low pulse count at most 0f the station of Watershed except at Domel, MZB and Palote . The medium hydrological alternation of 54.38% in the frequency of low pulse were observed at Kotli while in the frequency of high pulse count having medium alternation of 54.38% and -48.72% at AZP and Kohala . The duration of the Low pulse were having medium alternation of 43.59% and 42.50% at Kohala and Kotli. And the hight alternation of -68.33% were observed at Palote as shown in figure 4. The alternation in the duration of high pulse were medium at AZP,GHU and MZB while the other station having Low alternation as shown in figure 4.



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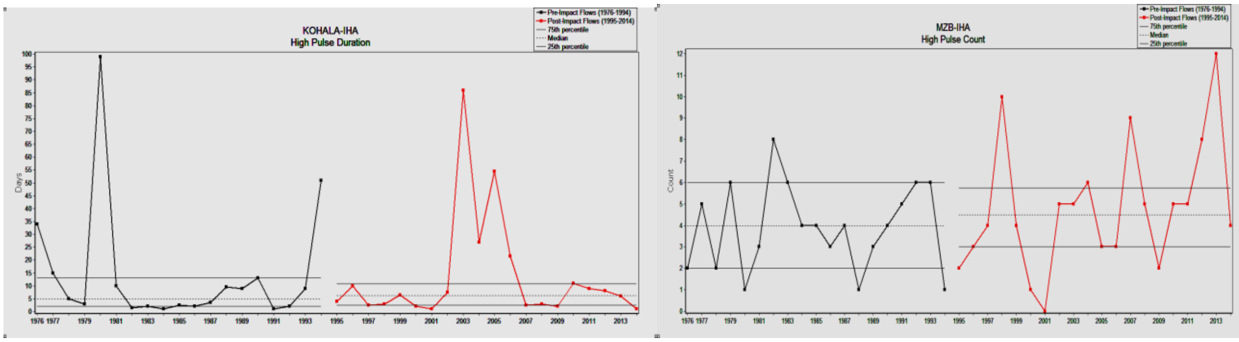
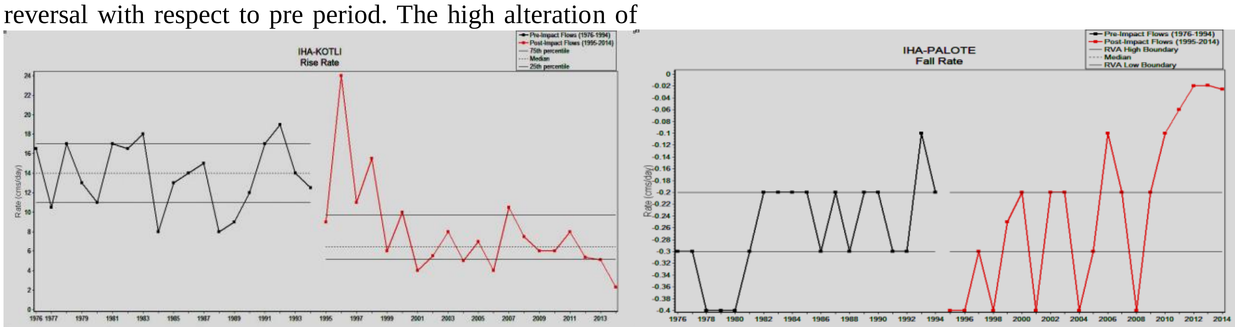


c) d)

Figure 4: (a) Low Pulse duration at AZP (b)) Low Pulse duration at GHU (c) HIgh Pulse duration at Kohala (d) Low Pulse duration at MZB.

Group 5: Rate and Frequency of Water Condition Changes

The parameters of this group mostly categorize as high or moderate, particularly palote having high alteration rise rate and number of reverse and moderate alterations of fall rate as shown in figure5.The high alteration of about 90.01 % is observed at Azad Pattan (AZP) in the number of reversal with respect to pre period. The high alteration of about -86.43 % observed at the Kotli at the median value of rise rate decreases by 54 % cms/day as shown in figure. The Gari Habibullah(GHU) shows the moderate alterations for all parameters of this group as shown in figure5.



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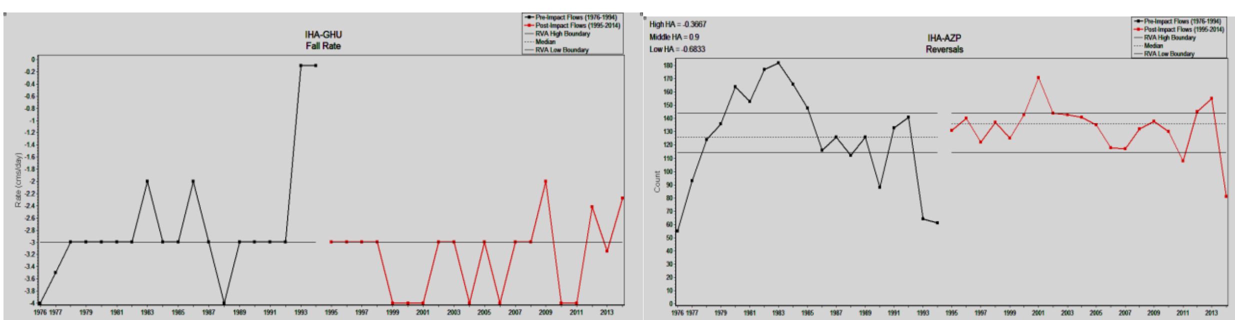

c) d)

Figure 5: (a) Rise rate at Kotli (b)) Fall rate at Palote (c) Fall rate at GHU (d) Number of Reversal at AZP.

4. CONCLUSION:

The results indicate that hydrological alterations in the Mangla watershed are medium alter on the all gauging stations of watershed due to global climate and environmental changes. The Absolute value of the hydrological alterations in the parameters of Group-1 is medium at all station of Mangle water shed. The parameters of Group-2 such as 1-day, 3-day, 7- day and 90-days maximum flow and base flow having medium alternation on average at station of watershed. Therefore on the basis of the parameters of each group the method is proposed to couple the hydrological and environmental approach to assess ecosystem of the Mangla watershed the hydrological alternation in the watershed indicate the changes of climate and environment and also land use change in the Mangla watershed. The important drivers of ecosystems may indicate the present and expected alterations in the existing biota, and thus it should be monitored, controlled and maintained in an appropriate range.

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