Impact Factor (SJIF): 4.542

International Journal of Advance Research in Engineering, Science & Technology

e-ISSN: 2393-9877, p-ISSN: 2394-2444

Volume 4, Issue 6, June-2017

Low stream flow Analysis for Damanganga basin, South Gujarat

Hitesh H. Ahir
M.E.Student
L.D.College of Engineering
Ahmedabad, India

Dr.N.P.Singh
Associate Professor
L.D.College of Engineering
Ahmedabad, India

Abstract: This study of Low stream flow intends to analyze the low-flow hydrology of River Damanganga at Valsad District, South Gujarat. Flood and Low Flow are two extreme hydrologic events. Low Flow Hydrology is a discipline which deals with minimum flow in a river during the dry period in summer season of the year. The discussion starts with the analysis of low-flow generating mechanisms operating in natural conditions and it is imperative for anthropogenic factors which directly or indirectly affect low flows, health of aquatic life, water supply and Waste water allocations. For Damanganga river basin, 172 days on an average there is no flow at all. 47% of times it remains in dry state. In this study, a statistical – probabilistic approach is utilized to predict the magnitudes of future low flow event. The Low flow 7Q (7th Minimum) design data statistic is generated by analyzing data manually and finding Seventh minimum low flow value 7Q (Mean discharge value from lowest flows for continuous seven days, a week) for each years for 30 years. The generated low flow discharge data is fit to various probability distribution functions i.e. Log Normal, Gumbel, Log Pearson Type III etc. and future low flow event is predicted. The most appropriate distribution function is then tested with Goodness of Fit test i.e. Chi-square test, Root Mean Square Error (RMSE) test manually. The parameters of the various probability distribution function is found out from statistic software EasyFit. Kolmogorov smirnov Test and Anderson Darling Test Goodness of fit Test carried out with use of EasyFit. This is followed by the generation of Flow duration curves (FDC) and determination of various flow characteristics (Low Flow Indices) and its practical significance is discussed. The study is largely based on the research results reported during the last thirty years. For this study, Last 30 years Discharge data (Year 1985 to 2014) of Damanganga Basin from NaniPalsan Gauge station is collected from Central Water Commission (CWC), India.

Keywords: Low Flow; Probability distribution; Damanganga river

---

1.0 INTRODUCTION

Low flow is the "flow of water in a stream during prolonged dry weather," according to the World Meteorological Organization. Many states use design flow statistics such as the 7Q10 (the lowest 7-day average flow that occurs on average once every 10 years) to define low flow for the purpose of setting permit discharge limits.

The critical-low-flow method insures that waste load allocations will maintain water quality criteria throughout the entire year when flows are higher than the critical flow, except in cases of significant non-point source pollution. Although, criteria may be exceeded when flows fall below the critical low flow, properly selecting the flow will minimize the frequency of excursions to the level specified by water quality standards.

Low flows typically increse the effects of water pollution. Dilution is the primary mechanism by which the concentrations of contaminants (e.g., copper, lead etc.) discharged from industrial areas and other point and some non-point sources are reduced. However, during a low flow event, there is less water available to dilute effluent loadings, resulting in higher in-stream concentration of the pollutants.

Such studies are particularly significant in connection with the planning, design and operation of reservoirs, irrigation, power and Water supply. Hydrological droughts are typically described by a reduction in reservoir storage, a decrease of stream flow discharge and a lowering of groundwater levels over large areas, over one year or continuously several consecutive years. During summer time the flow decreases and in some cases it may be zero for short period before beginning of water year (1st june to 31st May) .

2.0 LITERATURE REVIEW

Charles N. Kroll and Richard M. Vogel, 2002 predicted future low stream flow for gauged river sites. To estimate low streamflow statistics requires of annual n-day minimum streamflows for a variety of water resource applications. To select an appropriate probability distribution to describe annual low flows , and to estimate the parameters. Using L-moment diagrams, the ability of various probability distributions to describe low streamflow series was examined at 1,505 gauged river gauge sites in the United States. A weighted distance statistic was developed to compare the goodness-of-fit of different probability distribution functions for describing low stream flow series. An analytical experiment compared the observed shifts in L-moment ratios at intermittent sites with theoretical L-moment ratio shifts for a number of real- and log-spaced probability distributions. The experiments indicate that Pearson Type

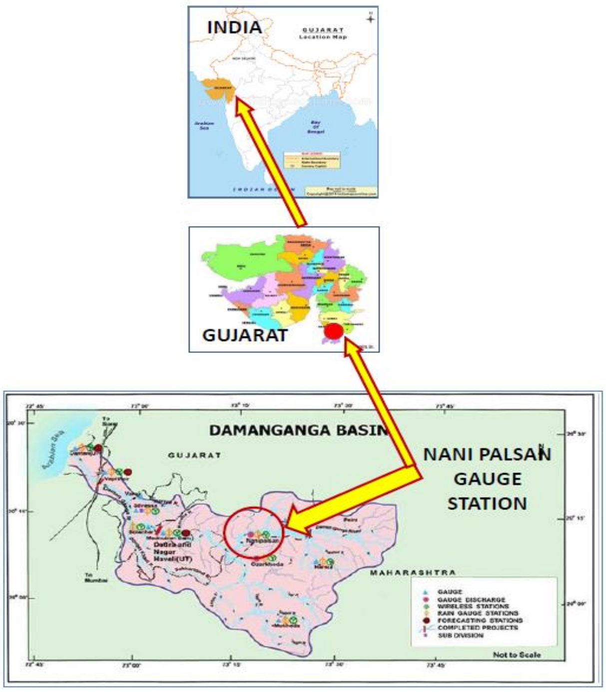
III and the 3-parameter log normal distribution function should be the recommended distributions for describing low streamflow statistics.

Hanadi S. Rifai, Suzanne M. Brock, Katherine B. Ensor and Philip B. Bedient, 2000,have used 7-day(7Q), 2-year low-flow (7Q2); and the 7-day, 10-year low-flow (7Q10) of ungauged streams of Texas using multiple regression analysis based on the meteorological and physiographic data of 63 gauged rivers. Harmonic mean, 7Q2, and 7Q10 values from the data range from 0.0001 to 1.6448 m3/s (0.004 to 58.12 cfs), 0 to 0.566 m3/s, (0 to 20 cfs), and 0 to0.425 m3/s (0 to 15 cfs), respectively. Gamma distribution function produced 7Q2 and 7Q10 estimates yielded more statistically reliable equations than either the log-Pearson Type III or mixed-log-Pearson Type III produced estimates. The river basin parameters considered include drainage area, length and slope of channel, basin shape factor, mean annual rainfall, hydrologic soil group, and the 2-year 24-h precipitation. The regression equation for the harmonic mean included channel slope, mean annual precipitation, and drainage area and had a higher adjusted R2 than the 7Q2 and 7Q10 equations. A regional regression analysis gave higher adjusted value of R2 for the harmonic mean than the statewide equation, implying that regional equations are more appropriate than statewide equations for Texas state.

V.K. Chandola1, Sunil Kumar Yadav, R.V. Galkate andPalakMehata, 2014 were conducted a study in the Bina River basin, a tributary of Betwa River, in drought prone region of Madhya Pradesh Bundelkhand, during 2011-12, to analyze the low flow events for assessment of drought conditions. The daily discharge data, recorded at Rahatgarh gauge discharge site of Bina River Basin, was studied for assessment of hydrological drought condition, it's frequency, duration, and severity of low flow using Flow Duration Curve (FDC) Technique. The dependable flow at 75% probability of exceedence was considered as truncation level to obtain deficiency volume and its severity for each event of low flow condition.

3.0 STUDY AREA AND METHOD

Damanganga River is a west flowing rivers from Tapi to Tadri in Gujarat state. It originates near the Sahyadri hills close to Ambegaon village in Dindoritaluka of Nasik district, Maharashtra. The river basin lies entirely on the western ghats, which has a total catchment area of 2,318 square kilometres (895 sq mi).



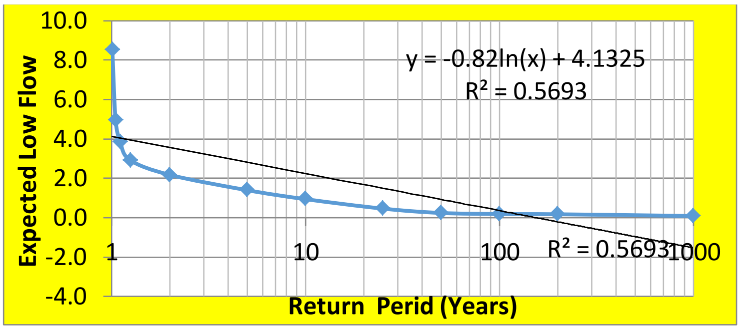
Discharge data is collected for 30 years from 1985 to 2014 which is recorded at Nani Palsan GD site (01 02 24 001), Daman.

Sr No	LF	Year	Sr No	LF	Year	Sr No	LF	Year
1	0.03	2006	11	0.20	2000	21	0.57	2012
2	0.06	1996	12	0.21	1998	22	0.66	2002
3	0.11	1991	13	0.39	2005	23	0.71	2009
4	0.12	1995	14	0.44	2001	24	0.89	1986
5	0.14	1994	15	0.45	2007	25	0.97	1989
6	0.16	1997	16	0.47	1990	26	0.99	2003
7	0.17	1999	17	0.50	2004	27	1.13	1985
8	0.19	2011	18	0.52	1988	28	1.21	2014
9	0.19	2010	19	0.53	2008	29	2.03	1993
10	0.19	1992	20	0.53	2013	30	2.56	1987

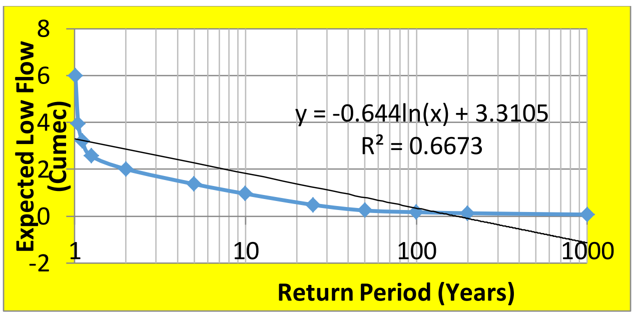
The Low flow (LF) 7day Minimum design data statistic is generated by analyzing data manually and finding Seventh minimum low flow value 7Q (Mean discharge value from lowest flows for continuous seven days, a week) for each years for 30 years. Various distribution functions are used to fit data i.e. Log Normal, Log Pearson type-III, GEV etc and prediction is done. Appropriate distribution is selected by caarying out goodness of fit tests i.e. Kolmogorov Smirnov (KS) and Root Mean Square Error (RMSE)

4.0 RESULTS AND DISCUSSION

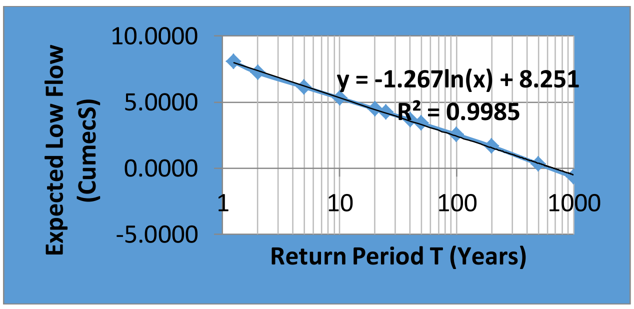
Log - Pearson Type III Distribution:



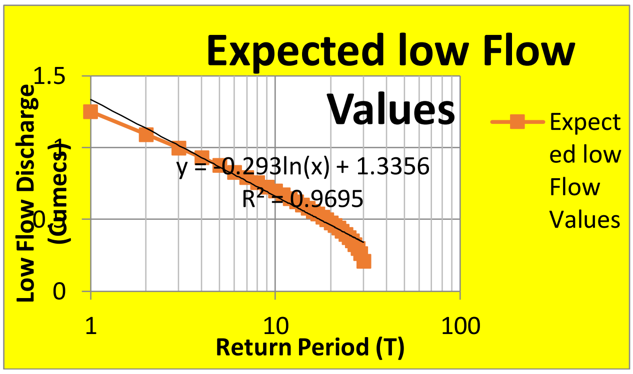
Log-Normal Distribution:



GEV1 Distribution:



Gumbel Distribution:



Goodness of Fit Test:

1. kolmogorov Smirnov

The kolmogorov Smirnov is based on empirical continuous distribution density function (ECDF).For n numbers of data y1,y2,y3,….,yn it is defined as,

$$Ei = \frac{ni}{N}$$

Where, ni is the nos. of data which is less than yi
yi is arranged in increasing order

Sr No	**Distribution Function**	**Kolmogorov Smirnov**	
		Statistic	**Rank**
1	Gumbel	0.11701	01
2	LP III	0.13432	02
3	Log Normal	0.21915	03
4	GEV I	0.42295	04

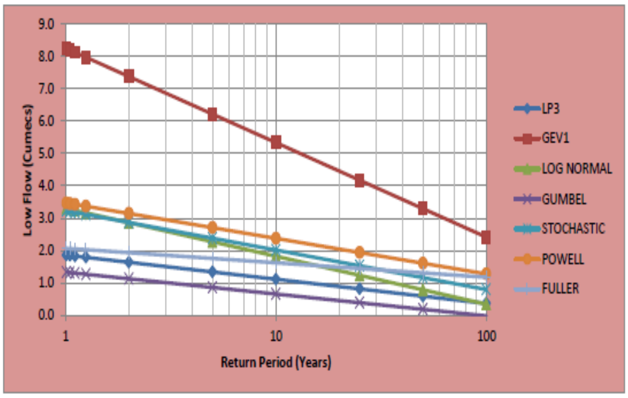
2. RMSE

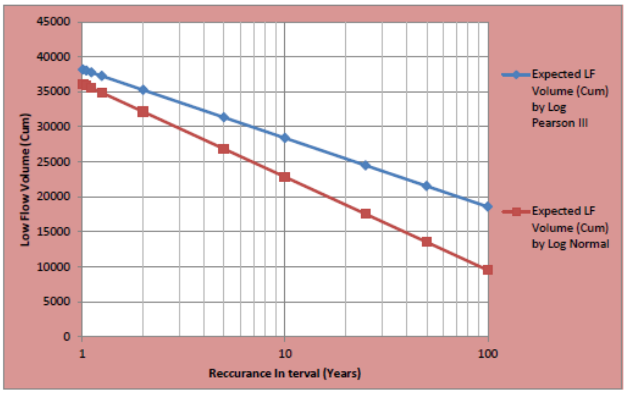
RMSE	Distribution	Rank
1.03	Log Normal	01
1.08	Log Pearson type 3	02
6.57	GEV	03

Parameters of Distributions :

Sr No	**Distribution function**	**Parameters of Function**
1	Generalized Extreme Value 1	k=0.43544 σ=11.41 μ=7.5222
2	Gumbel	σ=5.499 μ=25.802
3	Log Pearson III	α=0.69841 β=-0.55778 γ=3.4295
4	Log normal	σ=0.46614 μ=3.0399

Comparison of Different distributions :





Low Flow Estimation using best fit distributions:

Reccurance Interval (Years)	Expected Low Flow Volume (Cum)	
	Log Pearson type III	Log Normal
1.01	38159	36093
1.05	37993	35869
1.11	37756	35547
1.25	37250	34860
2	35246	32142
5	31340	26842
10	28385	22833
25	24479	17533
50	21524	13524
100	18569	9515

5. CONCLUSION

7Q Low flow data is fitted to various Probability distribution functions i.e. Gumbel, Log normal, Log Pearson type III, GEV, Fuller and Powell manually. From Goodness of Fit Test i.e. RMSE and koglomorov Smirnov, log Normal and Log pearson type III found most appropriate distribution function.

1. Various flow characteristics are obtained from flow duration curve significant from hydrological and Environmental aspects. None of the method found appropriate however LP III and Log normal found to be most appropriate to predict Low flow values.
2. Low flow indices are calculated and found as Q50 = 0.42, Q20/Q90 = 40%, Q50/Q90 = 16%.
3. The river selected for analysis is non perennial river. The of zero flow days have ranged from 96 to 276 days in 30 years of data studied.

ACKNOWLEDGEMENT

I am glad to confer gratefulness to Shri Dr. N.P.Singh for his guidance and support every now and then. I also would like to thank Shri Dr.Prof. G.P.vadodariya, Principal, L.D.College of Engineering to provide us resources and facilities to bring our project work up to this level successfully.

I would like to appreciate very good support from other staaf, colleagues and friends of L.D.College of Engineering as well as of governnment polytechnic, Ahmedabad.

REFERENCES

[1] Charles N. Kroll,Richard M.Vogel, Journal of Hydrologic Engineering April 2002
[2] Hanadi S. Rifai, Journal of Water Resources Planning and Management, Oct 2000
[3] V.K.Chandola, SunilKumar Yadav , R.V.Galkate, Palak Mehta, International Journal of Engineering Research, Dec 2014
[4] Richard M.Vogel, Charles N. Kroll, Journal of Water Resources Planning and Management, May 1989
[5] Review Low flow hydrology: a review V.U. Smakhtin CSIR, Environmentek, P.O. Box 395, Pretoria, South Africa, September 2000, Journal of Hydrology
[6] 19th,2 Days International Conference on "Hydraulics, Water Resources, Coastal and Environmental Engineering(HYDRO 2014 International)" Organized byDepartment of Civil Engineering, MANIT Bhopal, December 18-20, 2014
[7] Manual on Low Flow Estimation and Prediction, Oerational Hydrology report n0.50, World Meteorological organization,2009

AUTHORS BIOGRAPHY

Mr. Ahir, Hitesh had obtained his UG degrees from Gujarat university. His area of specialization is Water resource management. He is a Lecturer at Government Polytechnic, Ahmedabad.

Dr. Singh, N.P. obtained PG in Water resources from REMI, M.S. University, Baroda and doctoral degrees from IIT, Kharagpur. His area of specialization is Water Reources Engineering and Sediment Transport.