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Analysis Of Reservoir Water Variation In Gubi Dam Treatment Plant

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Abstract: - The seasonal variation of water in the reservoir level is generally due to variation of seasonal rainfall, temperature, evaporation and daily demand of consumers. During rainy season the reservoir level begin to increase up to a maximum value of 557.37m especially from the period of September to November, while at the period of December to around June draw down to minimum of 553m as a result of water required by the community and in addition most likely due to climatologically factors such as those mention above .The analysis of result was obtained by Least square method and trend analyses for the future monthly drawdown/rise up of water level in the reservoir and future monthly evaporation. In the analysis of result, the regression equation is obtained to be equal to Water level(Y) = 556 + 0.00228 Month(X) and that of monthly evaporation The trend line equation for mean monthly Evaporation = 0.00762708 -3.27022E-06 month h. In the trend analysis the equation was obtained as Yt = 555.774 + 2.43E-03*t with the graph plotted for the trend line. The seasonality was removed living behind the trend line equation as seen from the graph. These equations can be used to determine the reservoir water level at any time t (month). .

1.0 INTRODUCTION

With world population growing rapidly the water reservoir of the world are becoming one of the most important assets. Water is essential for human consumption and sanitation, for the production of many industrial goods and for the production of food and fibre. Water is an important means of transport in many part of the world and a significant factor in recreation. Water is unequally distributed about the earth and its availability at any place varies greatly with time. The total supplies of fresh water on earth far exceed human demand. Most of mankind lives in areas, which receives an abundance of annual rainfall. The provision of water to urban areas requires major capital investment in storage, treatment, and supply networks. Furthermore the per capita consumption of water has generally tended to increase rather than decrease, although this can be expected to be largely a function of life style and population density Jasem (2002). Hydrological analysis and designs require information on flow rate at any point of interest along a stream. However, in most cases, this information may not be available in sufficient quantity due to lack of (inadequate of stream gauging or non-availability of records. Faced with these difficulties, engineers and planners resort to the use of mathematical approaches such as synthesis and simulation as tools to generate artificial flow data for use in design for water supply, structures sizes flood control measures e.t.c. (Mustafa and Yusuf 1997).

1.1 THE STUDY AREA

Bauchi township is the study area and is located at 10^0 04' N and 9^0 09' E. It lies within the tropical climatic zone with marked wet and dry season. Fig.1 is the map of Bauchi State showing the study area.

1.2 THE GUBI DAM

The source of water in Gubi dam is mainly coming from three tributaries, namely Gubi River, Tagwaye river link with Shadawanka and Ran River. The function of the dam is to supply the state capital and its environs with potable water. A Temporary dam close to the site was constructed across one of the streams to provide water needed for the construction of the permanent dam. The embankment of the dam which has length of 3.86km and bottom earth-fill of 2,315, 000m^3 with a reservoir area of 590 hectares. The catchments area is 17,900 hectares with total storage capacity of 38.4 x 106m^3, the expected yield from the reservoir is 90,000m^3/d.(BSWB,1981) .The cross sectional dimensions of the dam is shown in Fig. 2 below The dam was started with temporary structures, which was constructed across one of the streams at the permanent dam site to provide water needed for the construction of the permanent dam. In this temporary dam about 500 million gallons of water which is equivalent to $2.27 \times 10^4 m^3$ be impounded, while the construction of the permanent dam was going on it was decided to make use of the temporary dam to supplement the water supply to the town

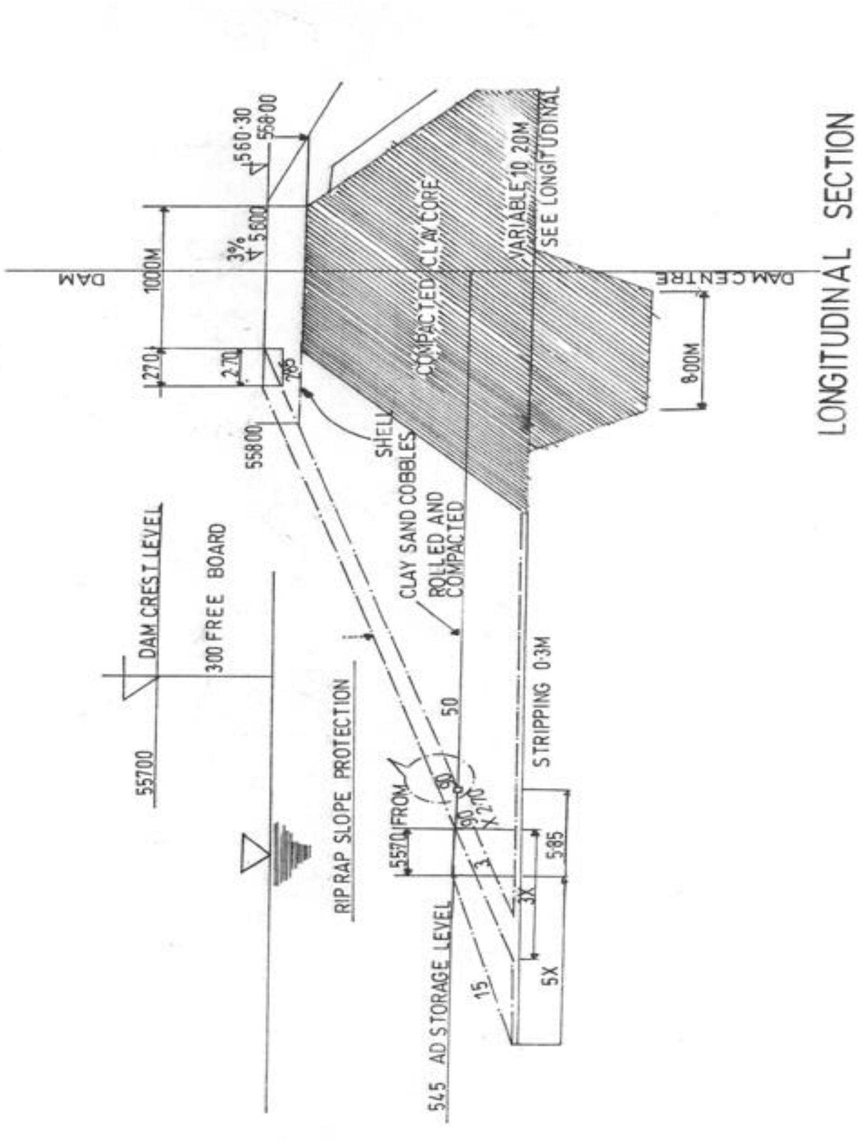


Figure 1. Cross-section of Gubi dam

Consequently in take arrangements were made, a treatment plant and pumping mains were provided. Thus the scheme with a capacity of 6,820m^3/day was put in operation on 30th may, 1980 by His Excellency the Governor of Bauchi, Late Alhaji Abubakar Tatari Ali.

The salient features of the scheme are:

(a) **The temporary dam:** this as mentioned earlier was only intended for construction purposes. The life span of the dam is only three years, but all the facilities provided can easily be removed to another dam when the main dam is ultimately commissioned.

(b) **Intake works and pumping Mains:** considering the nature of the temporary dam, the intake structure has been provided on pontoons. A total of five pumps have been installed. Four pumps working at a time discharging 340m^3/h and the fifth pump as a standby.

About three kilometer length of 300mm diameter AC raw water pumping main conveys the water to the treatment plants for purification with a 169KVA generating supplying power to the intake pumps.

(c) **Water treatment plant:** The raw water is purified in four units of the treatment plant with each unit designed to treat 85m^3/h. the raw water is mixed with chemical and then passed to a function chamber where sedimentation takes place. From this stage, the clear water is pumped for filtration. The filter media is sand of size 1.15mm thick and supported on a nozzle plate. The filtered water is disinfected with calcium hypo-chlorite solution and stored in a 1250m^3 capacity reservoir. The purified water is then pumped to the town to distribution. The power station of the treatment plant consist of two 653 KVA generator sets.

1.3 PUMPING MAIN TO TOWN

The pumps main comprise of 8.4K length of 300mm diameter DI pipeline and 200mm diameter AC pipeline one each to town centre through Ran Road and the G.R.A

1.4 THE PARMANENT GUBI DAM

After the construction of the permanent Gubi dam, it was commissioned in 1981. The permanent dam consist of the following features

(1) The embankments of the dam which has length of 3.86km and bottom earth-fill of 2,315, 000m^3 with a reservoir area of 590 hectares the catchments area is 179km^2 with total storage capacity of 38.4 x 106m^3, the expected yield from the reservoir is 90,000m^2/d.
(2) The clarifier: The treatment plant consist of three clarifiers, each clarifier contains sedimentation tank and flocculation tank
(3) The chemical Building
(4) The filters: The treatment consists of six different filters. The filters are rapid sand gravity types of filter.
(5) The chlorination building
(6) Elevated tank
(7) The pumping station

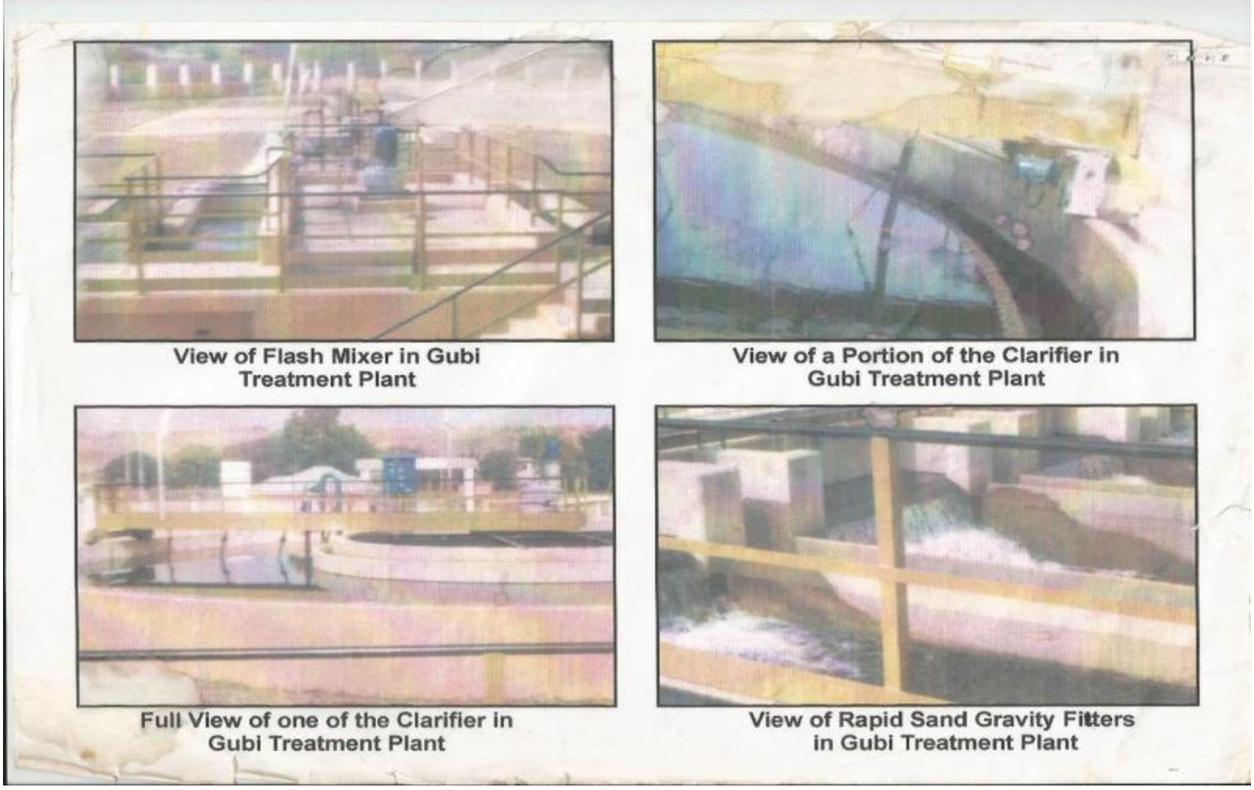


Figure2. View of Gubi dam Treatment Plant

2.0 LITERATURE

2.1 RESERVOIR

The basic purpose of impounding reservoir is to hold runoff during period of high runoff, and release it during period of low runoff; the specific functions of reservoir are hydroelectric flood control, irrigation, water supply and recreation. Many large reservoirs are multipurpose.

The use of reservoir for temporarily storing stream flow often results in a net loss of total stream flow due to evaporation and seepage. While these losses may not be desired the benefits derived from regulation of water supplies from flood water storage, from hydroelectric power and from any recreational activities at the reservoir site may offset the hydrologic losses and the cost of reservoir storage capacity can be divided among three(3) major uses:-

(i) The active storage used stream flow regulation and for water supply.
(ii) The dead storage required for sediment collection, recreational development hydropower production.
(iii) The flood storage capacity reservoir to reduce potential downstream flood damage in the design of storage reservoir to serve as a water supply system for any community, it has been further recommended that judgment be based on the equalizing or operating storage which can be read from a demand curve during 12 and 24 hours respectively. The total amount storage is desirably equal to the sum of the component requirement which include domestic, industrial and commercial, public uses fire demand losses e.t.c Augustine (1997).

2.3 EVAPORATION FOR WATER SURFACE

Evaporation from lakes more especially from impounded reservoirs, where it may reduce the yield from a catchments area by a considerable amount, the amount lost depend upon temperature of the air and water, wind, velocity, and atmospheric humidity. The high evaporation loss from reservoir in arid region has stimulated experiment in methods of reducing it by application of thin chemical film floating cover, or floating granular materials. None of these technique have prove to be practical in large-scale application but are useful on small reservoir Steel and Terence, (1972)

2.4 BASIC STORAGE EQUATION

The design of storage reservoir is given by an equation $I\text{-}O = \Delta s$………… (i) Where I = inflow 0= out flow and Δs = change in reservoir storage in a given time interest T. By neglecting both ground water portion of a predominantly on surface storage reservoir and the seepage out of it but including the evaporation from the reservoir and the sedimentation of it and using the continuous rates of flow, outflow evaporation and storage them

P-Q-E = ds/dt…………..(ii)

P= inflow discharge which is a stochastic variable, Q is the out flow discharge also a stochastic variable, E is the evaporation rate from the reservoir also a stochastic variable, variable because it is dependent on the climatic stochastic movement and the reservoir water surface and condition and ds/dt is the rate of change in the volume of stored water which is also a resulting stochastic variable. When the average annual evaporation from a reservoir is very small in comparison with the average annual inflow and outflow, E may be neglected. When the sediment inflow into a reservoir is also small in comparison with the storage capacity, then if these condition occur, the only remaining stochastic variable in above equation (ii) is inflow and outflow with volume of stored water, that is I-0= Δs as equation (i) before Yevjevich (1992)

3.0 METHODOLOGY AND ANALYSIS OFRESULT

Data collection has been carried out to observe seasonal variation of reservoir in Gubi treatment plant for Bauchi township water supply source. These include:

(1) Discharge record of Gubi dam.
(2) Data on important design features of the dam embankment and reservoir
(3) Map of Bauchi state
(4) Data of Evaporation records

3.1 DISCHARGE RECORDS OF GUBI DAM AND ANALYSIS OF RESERVOIR VARIATION

Daily water level recording from Gubi dam reservoir obtained from Bauchi state water board showed the level of water for the period of 1997 to 2003. According to the information, the dam was established and operated in 1981 and has been the main source of water supply to the people of Bauchi township but no record of daily reservoir level since then until 1997. Where records are been kept. The values of draw down and rise in the reservoir from Appendix1 were used to calculated the daily reservoir level , the expected value, calculated value and residual using MINI TAB R14 was obtained There is a rise in reservoir from period of May-Sept due to raining season observed during theses period.

Table:1

S/no	Yr/month	Y_Exp	Y_Exp calc	Y_Exp residual	Y_Exp residual ^2
	1997				
	Jan	555.642	556.2895349	0.64753486	0.419301395
	Feb	555.642	555.3337499	-0.308250063	0.095018101
	Mar	555.359	555.465697	0.106696956	0.01138424
	April	554.86	554.4396121	-0.420387916	0.176726
	May	554.702	555.0635019	0.361501914	0.130683634
	Jun	554.681	555.7253449	1.044344883	1.090656234
	Jul	554.826	556.1267382	1.300738179	1.691919811
	Aug	556.66	556.5573751	-0.102624929	0.010531876
	Sep	557.051	556.6618676	-0.389132431	0.151424049
	Oct	557.015	556.4149969	-0.600003073	0.360003688
	Nov	556.798	556.7405931	-0.057406883	0.00329555
	Dec	556.53	556.3649699	-0.165030067	0.027234923
	1998				
	Jan	556.132	556.0143747	-0.117625265	0.013835703
	Feb	555.814	555.7601973	-0.053802703	0.002894731
	Mar	555.7	555.5753422	-0.124657793	0.015539565
	April	555.344	554.9665871	-0.377412885	0.142440486
	May	554.63	554.2756543	-0.35434567	0.125560854
	Jun	554.836	554.9620336	0.126033571	0.015884461
	Jul	554.841	554.8150448	-0.025955159	0.00067367
	Aug	556.261	556.2710726	0.01007263	0.000101458
	Sep	557.259	556.4261909	-0.832809133	0.693571052
	Oct	557.07	556.7739289	-0.296071087	0.087658089

	Nov	556.738	556.4503922	-0.287607821	0.082718259
	Dec	556.445	555.7468872	-0.698112796	0.487361476
	1999				
	Jan	556.043	555.2866664	-0.756333632	0.572040563
	Feb	555.681	555.6450996	-	0.001288836
	Mar	555.285	555.6960082	0.411008151	0.1689277
	April	554.014	554.4255105	0.411510451	0.169340852
	May	554.771	554.9960354	0.225035394	0.050640929
	Jun	554.587	555.3818706	0.794870568	0.63181922
	Jul	555.439	555.8353894	0.396389401	0.157124557
	Aug	557.194	556.5071534	-0.686846645	0.471758314
	Sep	557.096	556.7690519	-0.326948101	0.106895061
	Oct	557.11	556.945095	-0.164905018	0.027193665
	Nov	556.814	557.0109204	0.196920369	0.038777632
	Dec	556.5	556.74166	0.241659994	0.058399553
	2000				
	Jan	556.146	556.3065029	0.160502856	0.025761167
	Feb	555.766	555.5715919	-0.194408096	0.037794508
	Mar	555.414	555.2764351	-0.13756485	0.018924088
	April	555.124	554.9874906	-0.136509358	0.018634805
	May	554.78	554.7109426	-0.069057408	0.004768926
	Jun	554.747	555.3998787	0.652878723	0.426250627
	Jul	555.004	555.9114169	0.907416905	0.823405439
	Aug	557.011	556.5209879	-0.490012146	0.240111903
	Sep	557.064	555.7990889	-1.264911108	1.600000111
	Oct	556.977	557.1957057	0.218705744	0.047832203
	Nov	556.745	556.7993577	0.054357665	0.002954756
	Dec	556.526	556.7804702	0.25447021	0.064755088
	2001				
	Jan	555.968	556.2103697	0.242369717	0.05874308
	Feb	555.728	556.3129099	0.58490988	0.342119568
	Mar	555.383	555.7194332	0.336433216	0.113187309
	April	554.992	555.6553805	0.663380539	0.440073739
	May	555.893	554.9289549	-0.964045118	0.929382989
	Jun	555.038	555.6877284	0.64972844	0.422147045
	Jul	556.204	556.1081941	-0.095805938	0.009178778
	Aug	557.277	556.42993	-0.847069956	0.71752751
	Sep	557.243	556.173695	-1.069305003	1.143413188
	Oct	556.938	556.2055756	-0.732424444	0.536445567
	Nov	556.635	556.1882084	-0.446791626	0.199622757
	Dec	556.348	556.0881191	-0.259880882	0.067538073
	2002				
	Jan	556.003	556.0725812	0.069581208	0.004841545
	Feb	555.527	555.5171383	-0.00986166	9.72523E-05
	Mar	555.089	555.091689	0.00268904	7.23093E-06
	April	554.639	554.3392761	-0.299723891	0.089834411
	May	554.231	554.3537437	0.122743741	0.015066026
	Jun	553.852	554.6708233	0.818823337	0.670471658
	Jul	554.742	555.8087986	1.066798617	1.13805929
	Aug	555.319	556.4958769	1.176876938	1.385039327
	Sep	556.968	556.818918	-0.149082046	0.022225456
	Oct	556.962	556.7285612	-0.233438848	0.054493696

	Nov	556.69	556.7175654	0.02756536	0.000759849
	Dec	556.363	556.4171261	0.054126111	0.002929636
	2003				
	Jan	556.136	556.6124806	0.476480641	0.227033801
	Feb	555.554	556.0654742	0.511474193	0.26160585
	Mar	555.281	555.1076957	-0.173304325	0.030034389
	April	555.048	554.2580385	-0.789961494	0.624039162
	May	554.9	554.9635269	0.063526882	0.004035665
	Jun	555.026	555.4457116	0.419711641	0.176157861
	Jul	555.867	555.7637916	-0.103208415	0.010651977
	Aug	555.891	556.4384272	0.547427236	0.299676579
	Sep	557.114	556.7336267	-0.380373279	0.144683831
	Oct	557.012	556.9005623	-0.11143771	0.012418363
	Nov	556.737	556.5792978	-0.157702176	0.024869976
	Dec	556.452	556.3927531	0.059246949	0.003510201

The estimation of trend can be achieved in one of the following ways:-

(1) **The method of least square:-** This can be used to find the equation of an trend curve.
(2) **Freehand method**:- This consist of fitting the trend line or curve by simply looking at the graph..
(3) **Moving average method**:- This is carry out by using average of appropriate order. Cyclical seasonal and irregular pattern may be eliminated. Thus, leaving only trend movement.
(4) **Method of semi average**:- This consist of separating the data into two parts (Preferable equal) and averaging the data in each part. This gives 2 parts that can be joined to give a trend line. Mustafa &Yusuf (1997)

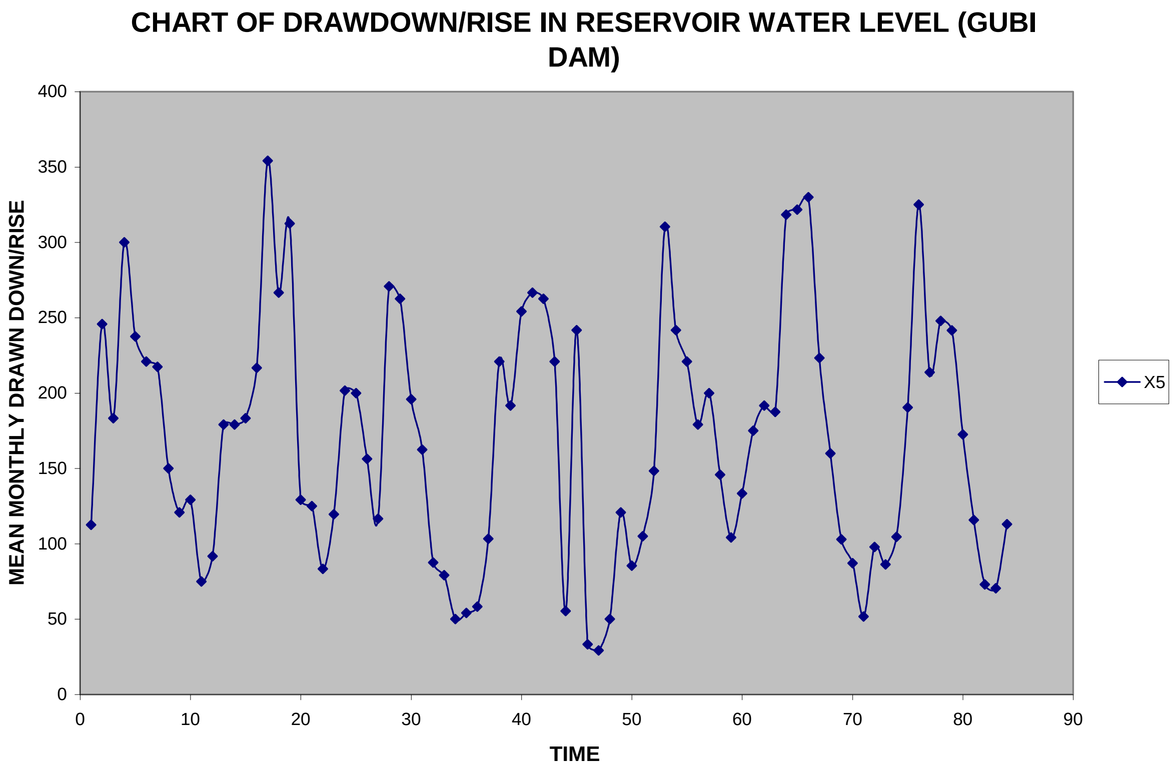


Figure 3 Local Characteristic of Draw Down / Rise from the period of 1997-2003

Figure3. Describe the local characteristic of the trend line for Draw down/ Rise in the reservoir water level (Gubi dam) for the period of 7 years that is 1997-2003. For over these periods a kind of irregular trend is observed due to rise and draw down of the water level in the reservoir as it can be seen from the figure (6). For the line going up above the line described the rise up of the water level in the reservoir and it is mostly seen

from the trend line to occur in the period of June to July for almost all the seventh years. The maximum observed year over the trend is the year 1998 which has highest rise up of the reservoir water level from Jun to Sept and also with the highest draw down of 0.083m in April as seen in the graph. For the line going down the graph described the drawdown of the water level in the reservoir. The behavior of the graph to be down is mostly seen within the period of Jan to April and October to Dec. This is due to the dry season and it is the peak time demand of water. Similarly the behavior of the graph to be above is due to the rain observed during the period of April to Sept and it is known as the raining season period. Table 2 below is the result of drawdown/rise against time for the trend line equation, the equation of the trend line can be used to predict the drawdown/rise of reservoir water level at any given month using the equation below.

Table 2

Linear Regression. Including a free parameter.		
	a1	**a0**
Coefficients	0.002431609	555.7743233
Std.dev.s	0.004120766	0.201629987
R2, SE (y)	0.004228413	0.915746909
95% conf. int.	0.008076701	0.395194775
Variance	0.838592402	
Sum of Squares	68.76457693	
Model	Draw_Down_Rise_Exp = a1 * Months + a0	

The trend line equation for drawdown/rise = 555.7743233+0.002431609 month.

It has been described earlier that the method of estimation of trend can be achieve in one of the four ways to remove the trend movement that is least square method, freehand method, moving average and method of semi average. This first method was adopted in other to find the trend line equation which is the method of least square. In this case the trend movement is removed living the trend line equation as shown in the figures. For trend line an equation is obtained.

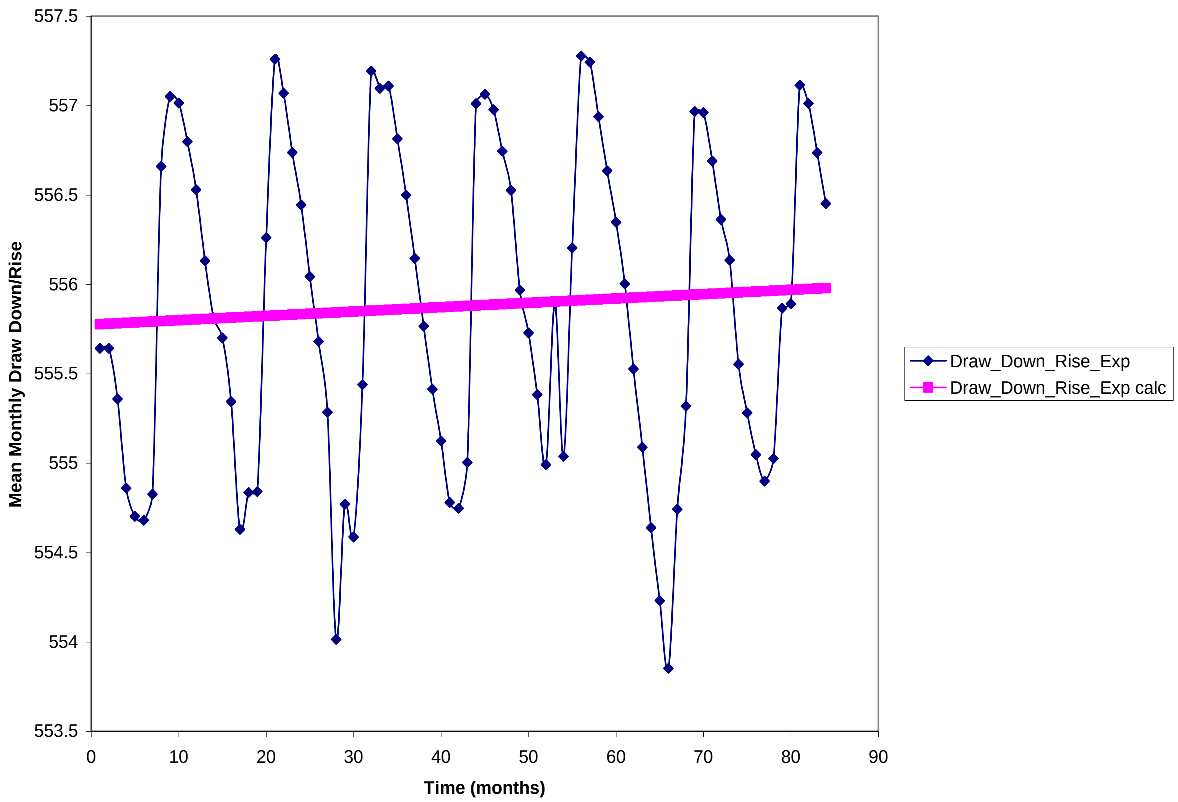


Figure 4. Mean monthly drawdown/rise against time

Figure 5 is the plot of trend line describing the variation of evaporation in Bauchi over the period of 7 years, which is from 1997 - 2003. The trend line appears to be having an irregular movement over the years. For values that appear to be at highest point is an indication of high evaporation which those at lower point is an indication. The peak valve of evaporation is mostly occur within the period of March to May and is the period of drought and high demand of water and it's may cause a draw down of the reservoir water level. The minimum valve of evaporation from the trend line in noticed in the month of July to Sept for all the trend lines.Since evaporation is very low within these period of July to Sept it in expected to have less evaporation and less water demand and this could lead to the increment of reservoir water level and it is the period of low demand of water.

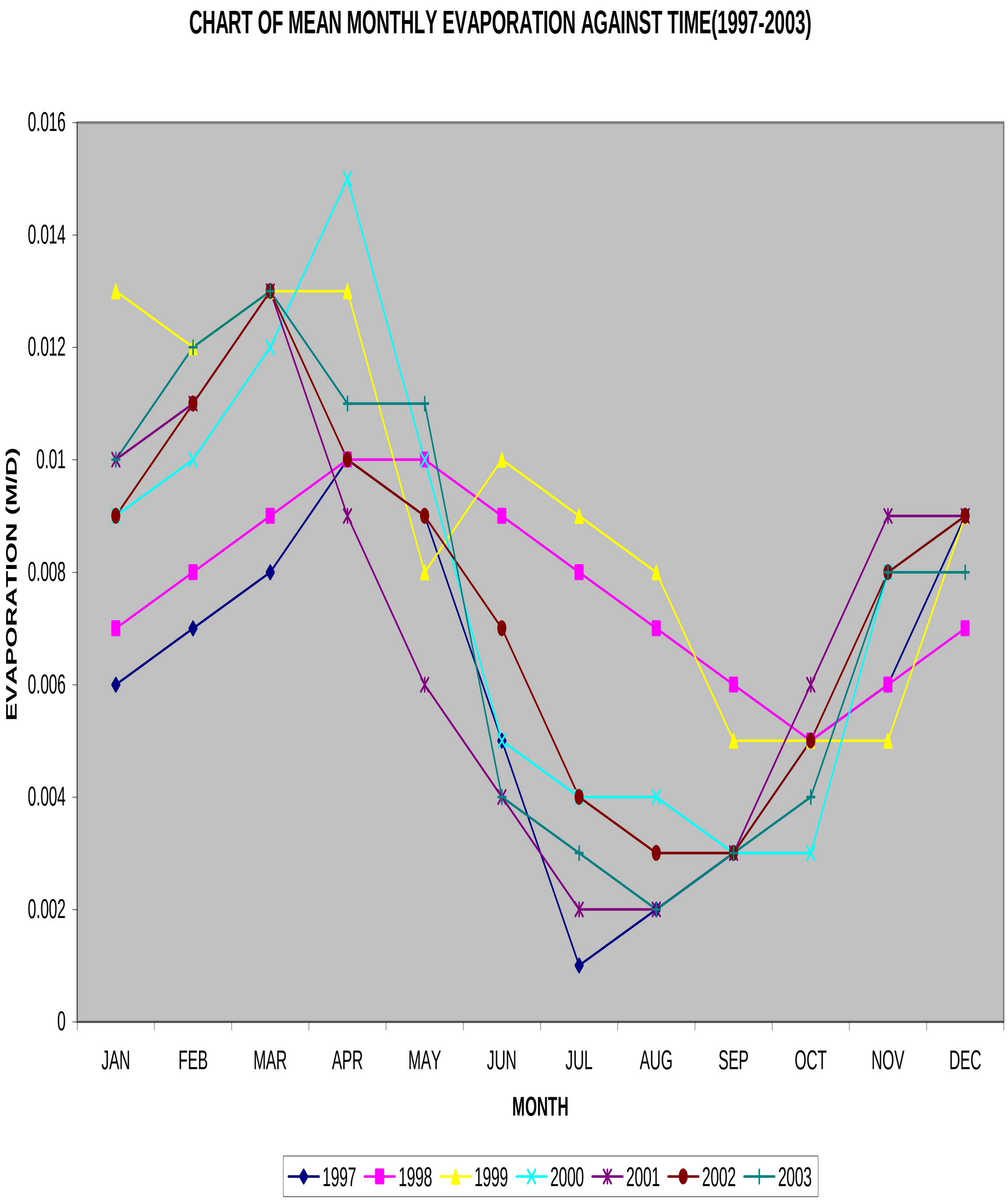
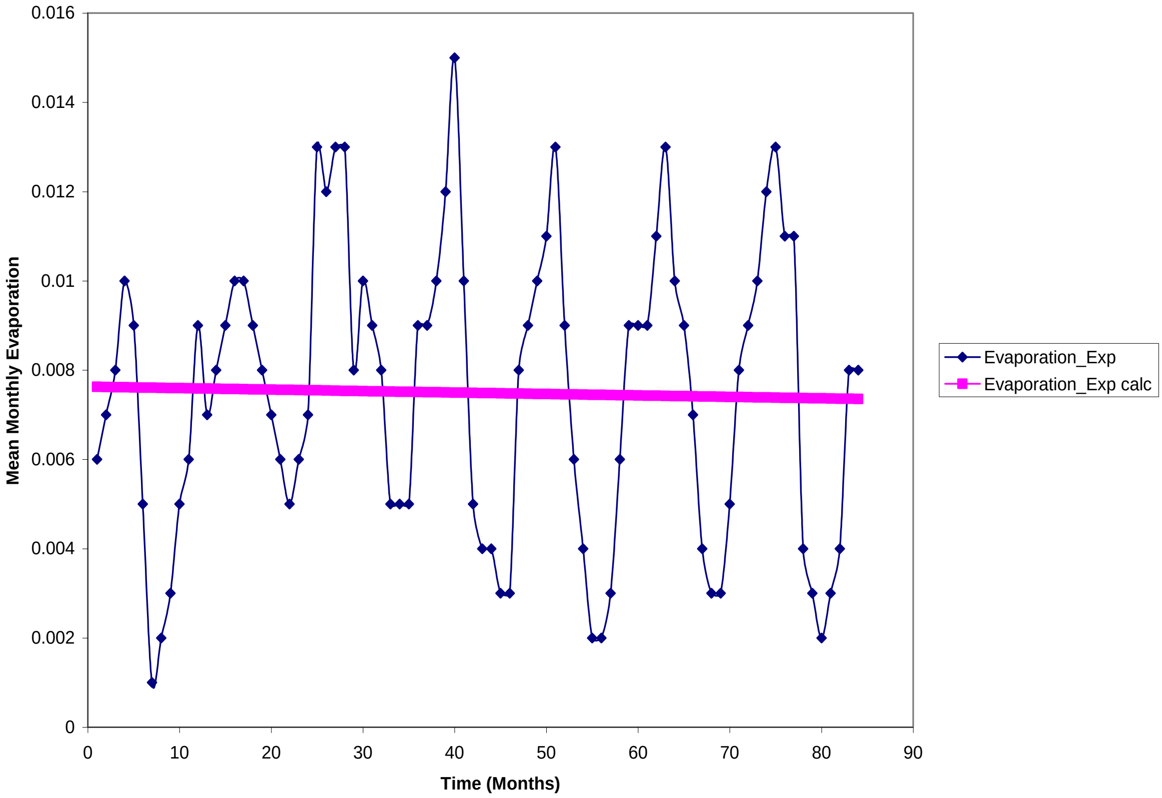


Figure 5: Local Characteristic of mean monthly evaporation from the period of 1997-2003

Linear Regression. Including a free parameter.		
	a1	**a0**
Coefficients	-3.27022E-06	0.00762708
Std.dev.s	1.49117E-05	0.000729634
R2, SE (y)	0.00058618	0.003313792
95% conf. int.	2.9227E-05	0.001430082
Variance	1.09812E-05	
Sum of Squares	0.00090046	
Model	Evaporation_Exp = a1 * Time + a0	

The trend line equation for mean monthly Evaporation = 0.00762708 -3.27022E-06 mont



Figs 6 mean monthly Evaporation against time

CONCLUSION

The water source in the dam varies in quantity and quality due to the seasonal variation over the catchments area. It is expected that during rainy season, that is, from the period of April to September, the quantity of water in the reservoir will increase due to the amount of the rain fall observed during these period. During dry season the level of water is reduced due to high demand and the effect of evaporation, The peak valve of evaporation is mostly occur within the period of March to May and is the period of drought and high demand of water and it's may cause a drawdown of the reservoir water level. The minimum valve of evaporation from the trend line is noticed in the month of July to Sept for all the trend lines the research work has established a mathematical model of the variation in reservoir and also establish a model for the evaporation..

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APENDIX 1
MONTHLY DRAW DOWN AND RISE
IN RESERVOR LEVEL (GUBI DAM)

Year /Month	**Reservoir water level (Gubi) masl**	**Monthly Draw down (m)**	**Monthly Rise up (m)**	**Mean Monthly Draw Down (m)**	**Mean Monthly rise (m)**
1997					
Jan					
Feb	555.648				
Mar	555.642				
Apr	555.359				
May	554.860				
Jun	554.702				
Jul	554.681				
Aug	554.826				
Sep	556.660		0.413	0.021	0.021
Oct	557.051	0.992		0.052	
Nov	557.015	0.201		0.007	
Dec	556.798	0.413		0.021	
	556.530				
1998					
Jan		0.247		0.021	
Feb	556.132	0.033		0.033	
Mar	555.814	0.062		0.009	
Apr	555.700	0.998		0.083	
May	555.344		0.098		0.014
Jun	554.530	0.048		0.007	
Jul	554.836		1.036		0.148
Aug	554.841		2.800		0.257
Sep	556.231	0.040		0.006	
Oct	557.259	0.370		0.046	
Nov	557.070	0.037		0.037	
Dec	556.738	0.322		0.022	
	556.445				

APPENDIX 1 (CONT)
MONTHLY DRANN DOWN AND RISE
IN RESERVOIR LEVEL (GUBI DAM)

Year/Month	**Reservoir water level (Gubi) masl**	**Monthly Draw Down (m)**	**Monthly Rive up (m)**	**Mean month Draw Down (m)**	**Mean Monthly Rise up (m)**
1999					
				0.035	
Jan	556.043	0.588		0.021	
Feb	555.681	0.396		0.015	
Mar	555.285	0.212		0.018	
Apr	554.014	0.274		0.012	
May	554.776	0.211		0.012	
Jun	554.587	0.243			
Jul	555.439		2.597		0.130
Aug	557.194	0.319		0.032	
Sept	557.096	0.030		0.002	
Oct	557.110	0.420		0.030	
Nov	556.814	0.286		0.014	
Dec	556.500	0.336		0.015	
2000					
Jan	556.146	0.280		0.018	
Feb	555.766	0.432		0.022	
Mar	555.414	0.496		0.025	
Apr	555.124	0.226		0.013	
May	554.780	0.333		0.017	
Jun	554.747		0.175		0.012
Jul	555.004		1.348		0.135
Aug	557.011		0.860		0.043
Sept	557.064		0.080		0.004
Oct	556.977	0.239		0.011	
Nov	556.745	0.247		0.012	
Dec	556.526	0.172		0.016	

APPENDIX 1(CONT)

Year/Month	Reservoir water level (Gubi) masl	Monthly Draw Down	Monthly Rise up (m)	Mean Monthly Draw Down (m)	Mean Monthly Rise up
2001					
Jan	555.968	0.218			
Feb	555.728	0.283		0.010	
Mar	555.383	0.372		0.018	
Apr	554.992	0.347		0.019	
May	554893			0.019	
Jun	555.038		0.004		0.002
Jul	556.204		0.870		0.046
Aug	557.277		1.286		0.061
Sept	557.243	0.250	0.145		0.006
Oct	556.938	0.210			
Nov	556.635	0.355		0.022	
Dec	556.348	0.223		0.010	
				0.017	
2002				0.014	
Jan	556003				
Feb	555.527	0.442			
Mar	555.089	0.459			
Apr	554.639	0.385		0.021	
May	554.231	0.476		0.024	
Jun	553.852	0.322		0.021	
Jul	554.742	0.319		0.024	
Aug	555.319			0.017	
Sept	556.968		0.762	0.020	0.035
Oct	556.962	0.206	1.591		0.072
Nov	556.690	0.234	0.572		0.027
Dec	556.363	0.382			
				0.009	
2003				0.012	
Jan	556.136	0.335		0.021	
Feb	555.554	0.370		0.019	
Mar	555.281	0.144		0.018	
Apr	555.048	0.121			
May	554.900		0.605		
Jun	555.026	0.162			
Jul	555.867	0.242			
Aug	555.891	0.365			
Sept	557.114		0.788	0.007	0.039
Oct	557.012		0.274	0.008	0.016
Nov	556.737		0.036	0.014	0.002
Dec	556.452		0.040	0.018	0.002

APPENDIX 2

DEPARTMENT OF METEO ROLOGICAL SERVIE BAUCHI AIRPORT

MEAN MONTHLY EVAPORATION (METRES)							
MONTH	**1997**	**1998**	**1999**	**2000**	**2001**	**2002**	**2003**
JAN	0.006	0.007	0.013	0.009	0.010	0.009	0.010
FEB	0.007	0.008	0.012	0.010	0.011	0.011	0.012
MAR	0.008	0.009	0.013	0.012	0.013	0.013	0.013
APR	0.01	0.010	0.013	0.015	0.009	0.010	0.011
MAY	0.009	0.010	0.008	0.010	0.006	0.009	0.011
JUN	0.005	0.009	0.010	0.005	0.004	0.007	0.004
JUL	0.001	0.008	0.009	0.004	0.002	0.004	0.003
AUG	0.002	0.007	0.008	0.004	0.002	0.003	0.002
SEP	0.003	0.006	0.005	0.003	0.003	0.003	0.003
OCT	0.005	0.005	0.005	0.003	0.006	0.005	0.004
NOV	0.006	0.006	0.005	0.008	0.009	0.008	0.008
DEC	0.009	0.007	0.009	0.009	0.009	0.009	0.008