STUDIES ON THE MANAGEMENT OF FRESHWATER INFLOWS AND HYDROGRAPHIC VARIABLES IN THE VAIGAI RESERVOIR THENI DISTRICT, TAMILNADU DURING THE YEAR 2013

S. Nijam Ali Khan*

A. Mohamed Nazar*

Abstract: *The freshwater management of rivers reservoirs in most countries evolved as an independent program that operate with distinct mandates, authorities, policies and implementation. Study elements include hydrographic surveys, hydrodynamic modeling of circulation and salinity patterns, sediment analyses, nutrient analyses, freshwater inflow optimization modeling, and verification of needs. For determining the needs, statistical regression models are developed among freshwater inflows and water sediments. Results from the models and analyses are placed into the Vaigai dam along with information on salinity viability limits, nutrient budgets and inflow bounds. The need to better integrate river reservoir management by combining Integrated water resources management (IWRM). This approach recognizes the river and branches of them and nearby lands or water resources are all elements of freshwater inflow management (FWIFM). Long-term monitoring is recommended in order to verify that implementation of future water management strategies maintain ecological health of the Vaigai dam and to provide an early warning of needs for adaptive management strategies.*

Keywords: *Freshwater inflow; Vaigai dam; hydrographic variables.*

*Post Graduate & Research Department of Management Studies, Khadir Mohideen College, Adirampattinam, Tamilnadu, India

INTRODUCTION

Our earth is a blue planet. Water covers seven-tenths of its surface only 3% of earth's water is freshwater and most of this freshwater is inaccessible-frozen in glaciers. A mere 0.03% of our global water supply is both accessible and suitable for human use (Bhandari 2003) the scarcity of high quality of freshwater is increasingly producing sectoral and transboundary conflicts both within and among countries.

Water resources particularly freshwaters have been the most exploited natural system in the recent past. The water quality models have proved to be powerful means of testing, freshwater resources management since they incorporate the complexity of the relevant process in the water bodies such as rivers and reservoirs into a most way of utilizing those (Mathivanan *et al*. 2005).

Climate change will accentuate shortages of freshwater is many parts of the world during the next 20 years and make it seasonal availability is uncertain (Vorosmatry *et al*. 2000). The terrestrial water cycle has been significantly altered by the construction and operation of water engineering facilities. Reservoirs, in particular have fragmented and transformed the Worlds Rivers. The last century saw a rapid increase in large Reservoir building. By 1949, about 5000 large dams had been constructed worldwide three- quarters of them in industrialized countries. By the end of 20th century, there were 45,000 large dams in over 140 countries (World Commission on Dams, 2000; Vorosmarty and Sahagiann 2000; Postal and Richter 2003).

The freshwater inflows rely on various characteristics viz. rainfall, hydrography and sedimentation. In other words, the management studies on the freshwater inflows into any reservoir of India are based biogeochemical parameters. Knowledge on the management of freshwater inflow into reservoirs of southern districts of Tamilnadu is meager. Therefore, an attempt has been made on the management of freshwater inflows together with hydrographic variables during different months of the year 2013 in the Vaigai reservoir, Theni district, Tamilnadu, India.

MATERIALS AND METHODS

2.1. Study Area Description

Vaigai reservoir is located about 70 km from Madurai and 15km from Theni longitudes 9°30'and10°10' N and 77° 10' and 77° 40' E. It is a reservoir on Vaigai River constructed in

1955 and completed in 1958. The reservoir is eutrophic with diverse types of sedimentary bottom. The river Vaigai rises at an altitude of about 1524 m in the Western Ghats in the Gandamanaickanur in Theni District and flows in northern direction. Vaigai reservoir is a multipurpose reservoir. The water is used for irrigation in Dindigul, Madurai, Theni, Sivagangai and Ramanathapuram District in addition to hydro power use and drinking water supply to Madurai city.

Vaigai reservoir has a maximum length of 315.468 m (1035 ft) Masonty Dam and 3225M Earthern Dam and width at top as roadway over reservoir 3.657m (012 ft and maximum depth of 71ft). The surface water spread area is 24.2015 sqkm while the water volume is 194.785mm^3 (6878 mcft). The reservoir is subjected to temporal fluctuation in water volume with high water volume in rainy season and less water in the dry season due to high evaporation. The water retention time is between September and December months in the rainy season (September-November) with an average precipitation 663mm, while the water residence time in the dry season (April-July) is between March and July months with an average rainfall of about 30mm in 2013 with a total rainfall in 2013 is 397.80mm only.

2.2. Vaigai River and Its Tributaries

The most important tributaries of Vaigai River are Survilar, Koltagudiaru (Theni aru) and Suthagangaiaru. Suruliaru rises at an attitude of 1830 (6000 ft) in the eastern side of Western Ghats and runs nearly parallel to Vaigai river. The Kottagudiaru originates at an attitude of about 1830m (6000 ft) in Western Ghats and joins with Suruliaru. The third tributary to the Vaigai River called Suthagangaiaru originates at an attitude of about 915 m (3000 ft) and joins Suruliaru.

2.3. Sampling Studies

Hydrographic variables of the water body selected as water quality parameters were studied from three stations between were studied from three stations between January 2013 and December 2013. Station I was at the reservoir axis where a lot of human activities such as washing, bathing and fish landing take place. It is the highest point of human and animal contact with the reservoir. Station II was at the mid-section of the reservoir which represented the area of surface (Standing) water. It is the transition zone between river in tributaries and surface waters. Station III was at the head water of the reservoir which represented the running water (freshwater inflow) of the reservoir.

RESULTS AND DISCUSSION

Results of the present study on hydrographic variables studied during the month of January 2013 to December 2013 are presented in Tables 1to3 and Figs.1 to 8. Data collected on the studies of hydrographic variables indicated that significant variations were correlated with seasons and freshwater inflows into Vaigai reservoir. These findings are in agreement with earlier studies by Dunne and Leopold (1978) and Warner (2005). Hydrological data referred to below and used in the analyses were compiled from U.S. Geological Survey (USGS) gagged flows measured at the last no tidally affected stream gagging station in each contributing river basin, ungagged flows of river and coastal drainage basins that contribute freshwater. Direct precipitation on and evaporation from the bay surface was also calculated and used in some aspects of the analysis, such as the salinity modeling and the estimation of atmospheric deposition of nitrogen.

Technological studies undertaken in the present investigation explain the relationship between various physico-chemical parameters and the amount of freshwater inflows into the Vaigai reservoir. The volume of flows is tied not only to the rate of nutrient input, but also to the rate of nutrient export through flushing and to the amount of time nutrients are exposed to biogeochemical cycling in the estuary (Dettmann 2001). The approach tried in Vaigai was to develop nutrient budgets for annual periods that link gains and losses to the internal pool to freshwater inflow volumes. Budgets of total nitrogen were developed using the method described in Brock (2001). There was insufficient data on the inflow relationship of a major loss term, denitrification, despite several studies that contributed valuable data (Zimmerman and Benner 1994; Joye and An 1999). This greatly hindered the effort to develop a nutrient constraint for direct inclusion in the optimization approach. Uncertainty in the budget components was also a limiting factor. This pre-development median stream flow loading is proposed as a minimal bay nitrogen requirement under current conditions. A nitrogen-based lower bound on required freshwater inflows can be calculated from this loading information.

Morphometric studies of Vaigai reservoir in the study (Table 4) reveal the architecture and its management by the authorities. Data mentioned in the morphometry were useful to assess the freshwater flow management. This idea has been favored by previous workers (Khalaf *et al*.1998). Working through the main components of the optimization approach described above has been the main effort in determination of inflow requirements. There has been considerable discussion among the participants over the suitability and use of mean versus median central tendency values for inflows, annual and monthly, in the analysis. Where inflows are episodic, as in the semi-arid regions of Vaigai, the median flow values, which are based on the frequency of occurrence, may differ by a factor of two or three from the mean values, which are based on the volume of flow occurring. Because upstream reservoirs can alter the duration and timing of flows on most Vaigai rivers, the decision about which statistic is most appropriate also includes consideration of the natural versus impacted hydrology of the contributing basins.

Technological studies undertaken in the present investigation explain the relationship between various physico-chemical parameters and the amount of freshwater inflows into the Vaigai reservoir. This view has been accepted by previous studies by Margalef (1976) Shurin and Havel (2002) and Hulyal Kaliwal (2007) and Mustapha (2010). Most of the reservoirs exhibit interplay of physical, chemical and hydrological features of water and sustainable fishery resources. Thus, any perturbations in these factors may affect their assemblage which could have a significant impact on water quality and fisheries of reservoirs. It is apparent from this work that there are many needs for freshwater flows, but none involve more land, water and wildlife needs of the Vaigai reservoir.

Table 1. Monthly variations of hydrographic at variables at station 1

(Each value represents the average values of five replicates of the samples)

Month of 2013	Surface Water Temp (ºC)	Salinity (%)	pH	D.O. (mg/l)	K (m^{-1})	NO_3 (µgat/l)	PO_4 (µgat/l)	SiO_3 (µgat/l)
Jan	24.1±0.04	2.71±1.12	8.15±0.9	4.94±0.9	5.01±0.01	13.83±0.7	2.60±0.1	98.60±0.2
Feb	26.3±0.06	3.07±1.10	8.27±0.8	5.03±0.8	4.94±0.07	12.75±0.7	2.15±0.2	101.57±0.2
Mar	29.8±0.05	4.85±1.17	8.20±0.9	5.23±0.9	4.86±0.02	11.99±0.5	2.82±0.2	79.43±0.3
Apr	31.5±0.07	5.16±0.90	8.28±0.7	5.38±0.9	4.11±0.12	11.00±0.4	1.68±0.1	65.28v0.5
May	31.2±0.01	6.10±0.98	8.29±0.9	4.97±0.7	4.01±0.15	10.68±0.4	1.53±0.1	62.60±0.1
June	32.8±0.01	7.07±0.95	8.30±0.9	5.08±0.6	3.90±0.07	8.95±0.5	1.08±0.2	59.23±0.2
July	31.6±0,09	3.49±0.96	8.00±0.8	5.67±0.7	5.87±0,08	11.81±0.2	3.07±0.5	116.42±0.2
Aug	30.7±0.08	0.18±0.15	8.01±0.7	5.49±0.7	5.93±0,07	10.73v0,1	2.85±0.4	109.21±0.3
Sep	31.5±0.07	0.04±0.12	8.00±0.8	5.96±0.8	9.87±0,05	13.97±0.2	2.97v0.5	119.50±0.2
Oct	30.9±0.06	0.89±0.21	8.02±0.8	4.85±0.8	7.01±0,04	12.92±0.2	1.86±0.7	97.42±0.2
Nov	29.0±0.07	1.97±0.14	8.07±0.8	5.65±0.9	5.30±0,12	12.49±0.8	2.17±0.6	88.66±0.2
Dec	25.3±0.07	4.28±0.97	8.10±0.9	5.82±0.5	5.82±0.14	3.86±0.9	2.89v0.1	117.08±0.2

Table 2. Monthly Variations of hydrographic variables at station II

(Each value represents the average values of five replicates of the samples)

Month of 2013	Surface Water Temp (ºC)	Salinity (%)	pH	D.O. (mg/l)	K (m^{-1})	NO_3 (µgat/l)	PO_4 (µgat/l)	SiO_3 (µgat/l)
Jan	24.9±1.2	16.21±0.5	8.25±0.9	5.89±0.6	5.11±0.5	12.66±0.9	1.75±0.5.	101.66±0.4
Feb	26.0±1.1	19.53±0.6	8.29±0.7	4.86±0.6	4.97±0.5	13.01±0.6	2.01±0,6	121.29±0.5
Mar	29.7±0.9	20.44±0.3	8.31±0.7	5.96±0.7	4.90±0.2	15.07±0.8	1.97±0.8	96.80±0.4
Apr	30.8±0,1	21.68±0.4	8.30±0.7	4.63±0.8	4.18±0.2	10.85±0.9	1.32±0.1	89.28±0.5
May	31.6±0.8	22.06±0.2	8.31±0.8	4.77±0.6	4.07±0.3	10.67±0.9	1.08±0.1	71.61±0.3
June	32.8±0.5	23.15±0.2	8.32±0.7	5.12±0.7	3.97±0.2	11.01±0.8	0.96±0.2	70.44±0.4
July	31.7±1.0	11.67±0.2	8.27±0.1	6.11±0.7	6.10±0.2	12.85±0.8	1.63±0.2	98.49±0.5
Aug	30.8±1.2	9.88±0.3	8.24±0.2	6.22±0.4	6.73±0.1	13.08±0.9	2.37±0.5	106.28±0.6
Sep	31.6±0.9	9.32±0.4	8.19±0.3	6.20±0.5	6.91±0.2	14.17±0.1	2.40±0.5	103.15±0.3
Oct	30.2±0.9	10.10±0.5	8.11±0.4	5.89±0.3	6.24±0.2	11.89±0.2	1.84±0.2	98.49±0.4
Nov	29.5±0.8	14.65±0.6	8.20±0.4	5.85±0.4	5.33±0.5	13.08±0.2	1.95±0.2	89.20±0/9
Dec	25.6±0.7	19.89±0.9	8.23±0.5	6.07±0.5	4.10±0.6	15.60±0.5	2.03±0.5	113.49±0.5

Table 3. Monthly Variations of hydrographic variables at station III

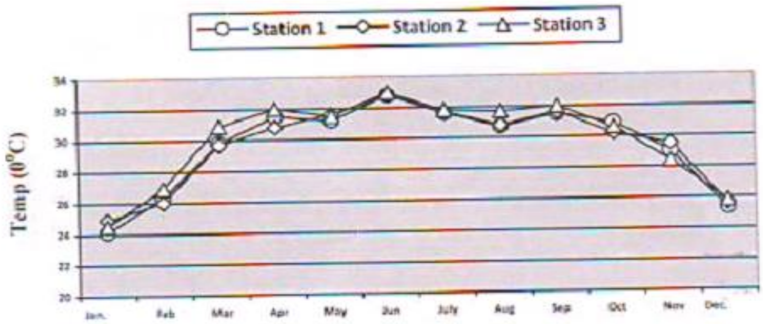
(Each value represents the average values of five replicates of the samples)

Month of 2013	Surface Water Temp (ºC)	Salinity (%)	pH	D.O. (mg/l)	(m^{-1})	NO_3 (µgat/l)	PO_4 (µgat/l)	SiO_3 (µgat/l)
Jan	24.5±0.6	22.6±0.2	8.30±0.3	5.12±0.1	4.36±0.9	12.66±0.2	1.67±0.9	133.76±0.6
Feb	26.9±0.7	24.3±0,1	8.32±0.2	5.73±0.2	4.24±0.8	11.87±0.2	1.45±0.8	121.09±0.5
Mar	30.9±1.6	25.9±0.2	8.33±0.2	5.69±0.6	4.50±0.8	9.32±0.2	1.08±0.7	96.50±0.9
Apr	32.0±0.1	28.4±0.2	8.33±0.5	5.27±0.7	3.97±0.8	8.10±0.2	0.78±0.8	89.97±0.8
May	31.5±0.9	29.7±0.1	8.34±0.5	5.15±0.8	3.89±0.8	8.06±0.1	0.69±0.4	88.66±0.9
June	33.0±0.8	31.0±0.1	8.34±0.9	6.01±0.1	3.77±0.8	7.13±0.4	0.57±0.3	73.09±0.8
July	31.8±0.1	25.1±0.5	8.32±0.8	6.32±0.8	5.45±0.1	9.11±0.6	1.33±0.7	137.68±0.8
Aug	31.7±0.8	19.4±0.5	8.30±0.8	6.81±0.9	5.78±0.2	12.20±0.4	2.01±0.9	119.87±0.5
Sep	32.0±0.9	15.7±0.9	8.30±0.9	6.83±0.7	7.24±0.2	14.13±0.9	2.26±0.8	133.67±0.9
Oct	30.6±0.9	21.2±0.9	8.31±0.2	6.28±0.9	6.26±0.1	13.85±0.8	1.98±0.9	141.02±0.9
Nov	28.4±0.7	21.7±0.8	8.32±0.9	5.20±0.7	4.38±0.2	12.98±0.7	1.91±0.9	112.98±0.8
Dec	25.8±0.7	29.6±0.5	8.33±0.9	5.67±0.9	3.79±0.2	15.29±0.9	2.07±0.9	147.89±0.5

ISSN: 2278-6236
Impact Factor: 4.400

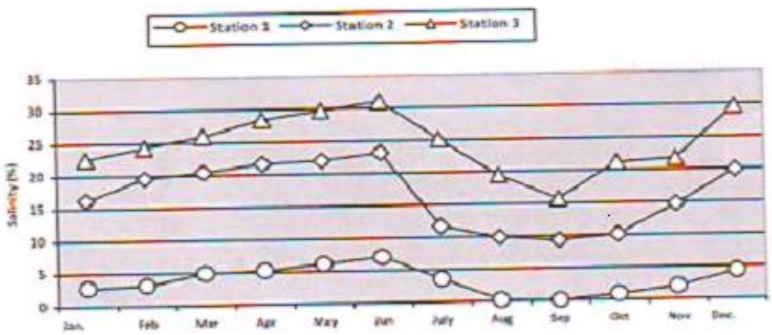
Table 4. Morphometric characteristics of Vaigai reservoir

S. No	Parameter	Particulars
1	Elevation (m)	279.197 m
2	Surface area(m^2)	24201000m^2
3	Volume (m^3)	1947850000 m^3
4	Mean depth (m)	18.00 m
5	Maximum depth (m)	21.641 m
6	Mean depth to maximum depth ratio	0.85:1
7	Hydraulic residence time (days)	Variable
8	Length of shoreline (km)	6.2 km
9	Shoreline development (Nature)	Mixed with gravel, sand and clay



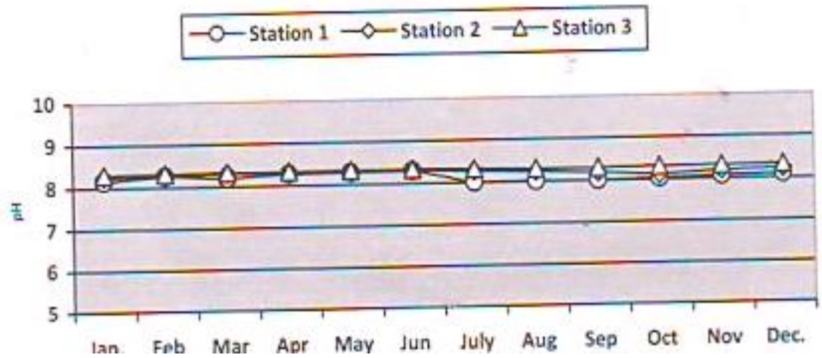
2013 2013

Fig. 1. Monthly mean variations in temperature of three samplings sites of Vaigai reservoir



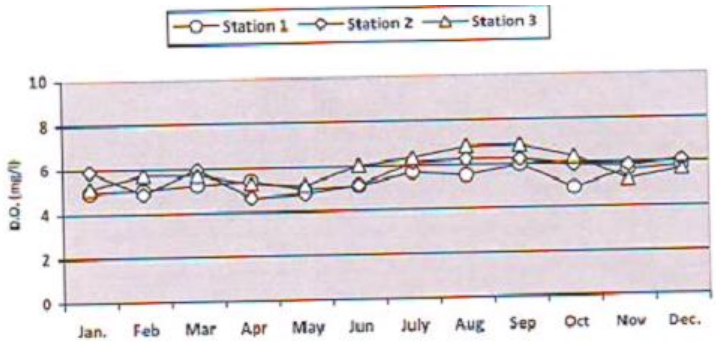
2013 2013

Fig. 2. Monthly mean variations in Salinity (x) of three samplings sites of Vaigai reservoir



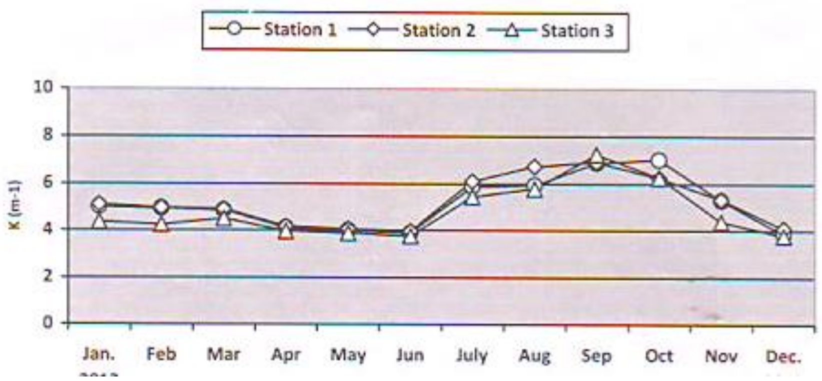
2013 2013

Fig.3. Monthly mean variations in pH of three samplings sites of Vaigai reservoir



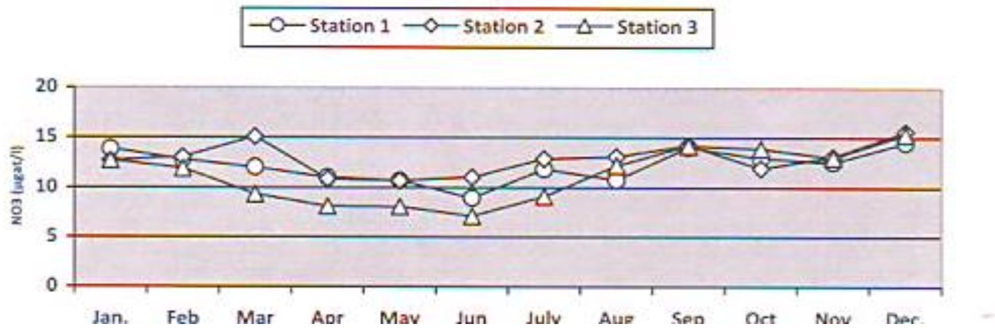
2013 2013

Fig.4. Monthly mean variations in D.O. (mgl) of three samplings sites of Vaigai reservoir



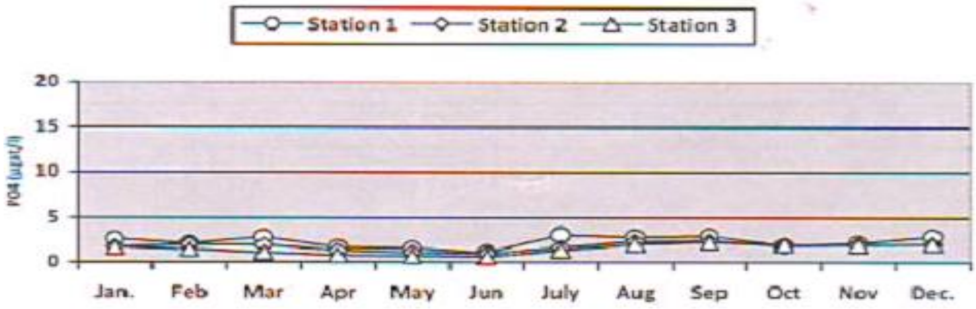
2013 2013

Fig.5. Monthly mean variations in K (m-1) of three samplings sites of Vaigai reservoir



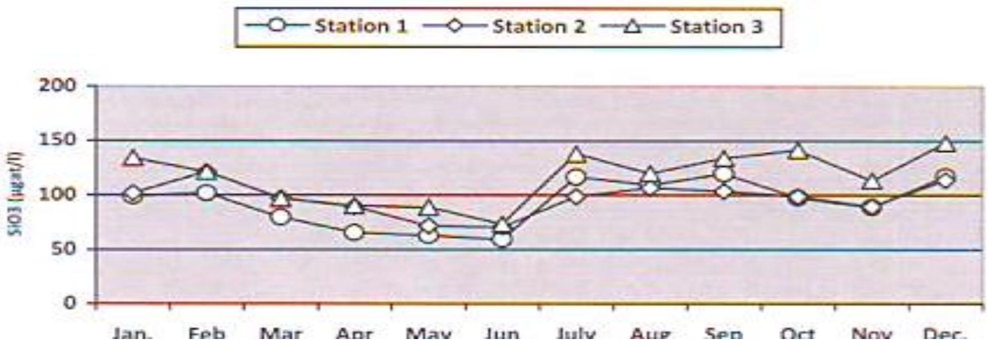
2013 2013

Fig.6. Monthly mean variations in NO_3 of three samplings sites of Vaigai reservoir



2013 2013

Fig.7. Monthly mean variations in PO_4 of three samplings sites of Vaigai reservoir



2013 2013

Fig.8. Monthly mean variations in Sio3 of three samplings sites of Vaigai reservoir

ACKNOWLEDGEMENT

I am highly thankful to Dr. S. Raveendran Associate Professor, P.G. and Research Department of Zoology, Khadir Mohideen College, Adirampattinam for providing necessary literature and for his valuable suggestions offered in the pursuit of this study.

REFERENCES

1. Bhandari B.B., (2003). What is happening in our freshwater resources. Retrieved Oct27,2005 frohjtp:/www.iges.on.jp/en/phase 2/ee/pdf/ report7.pdf

2. Brock D. A., (2001). Nitrogen budget for low and high freshwater inflows, Nueces estuary, Texas. Estuaries 24:509–521.
3. Dettmann E. H., (2001). Effect of water residence time on annual export and denitrification of nitrogen in estuaries: A model analysis. Estuaries 24:481–490.
4. Durine T and Leopold LB., (1978). Water in Environ planning and Management San Francisco CA : W.H.Freeman & co.,
5. Joye,S.B. and S. An. (1999). Denitrification in Galveston Bay. Final Report to Texas Water Development Board. Texas A&M University, College Station, Texas.
6. Khalaf, E.A. Galal M.and Aithman, M. (1998). Assessment of hydrographic parameters and their effect of freshwater flows into reservoirs Journal of Environmental Science, 21 (2) 229-236
7. Mangled R (1976) Limnology of Spanish reservoirs Publication No.123 centra de studios hydrographic, Madrud, Spain PP460.
8. Mathivanan V.,Vijayan P., and selvi Sabhanayagam (2005) Pollution studies on River cauvery in Mettur, Tamilnadu, India. J. Exp. Zool. India. 8(2) : 321 – 325
9. Mustapha M.K. (2010). Seasonal variations of limnological variables on freshwater inflows in African Oyun Reservoir. J.Exp.Biol Sci 1(1) 60-79.
10. Postal S., Richter B.D., and John R.W., (2003) Rivers for life : Managing water for people and Nature. Island Press Washington D.C.
11. Vorosmatry C.J., and Sahagian D., (2000). Anthropogenic disturbance of terrestrial water cycle. Bioscience, 50(9):753-765.
12. Vorosmatry C.J., Green P., Sahsbury J., and Lammers R., (2000) Global water resources vulnerability from climate change and population growth. Science 289 (5477) : 284-288.
13. Warner A., (2005) : Yuna River hydrologic charaterization, University Press, PA : The Nature conservancy.
14. World commission on Dams (2000) Dams and development : A new framework for decision making. The report of the world commission on Dams. Earthscan Publications Ltd., London.
15. Shurin J.B and Havel J.E (2002) Hydrologic connections and freshwater inflows in Guarapiranga reservoir Sao Paulo state, Brazil. Hydrology 424:51-60.
16. Zimmerman,A.R. and R. Benner. (1994). Denitrification, nutrientregeneration and carbon mineralization in sediments of Galveston Bay, Texas, USA. Marine Ecology Progress Series 114:275–288.