Strategic environmental assessment of Pushkar Lake, Ajmer (Rajasthan) with special reference to infiltration problem

Sunil Hotchandani[1]*, Ashit Dutta[1], Yogesh Jatav[2], Ajay Vardhan[3]
[1]Department of Civil Engineering (Environment Engineering), Bhagwant University, Ajmer (Raj)-305009, (INDIA)
[2]Department of Environment Science, MDS University, Ajmer (Raj)-305009, (INDIA)
[3]University Institute of Technology-RGPV, Bhopal (M.P.)-462036, (INDIA)
E-mail : sunil.hotchandani@gmail.com; hotchandani_sunil@rediffmail.com

ABSTRACT

Lakes are the most fertile, diverse, productive and interactive ecosystems in the world. The present work was conducted on the Pushkar Lake in the historic holy city of Pushkar, Ajmer. This Lake comes under the category of sacred lakes and is unique in terms of religious and ecological significance. This paper focuses on Strategic Environmental Assessment (SEA) of Pushkar Lake with special reference to infiltration problem which adversely affects its religious significance. This paper also considered the positive and negative effects of man-made canal constructed by Government of Rajasthan under National Lake Conservation Plan (NLCP) in order to make the water level of Pushkar Lake at the desired level. SEA proved to be an efficient tool to study all relevant parameters of Pushkar Lake and suggested various alternatives in order to make its religious significance forever.
© 2013 Trade Science Inc. - INDIA

INTRODUCTION

SEA is a systematic decision support process, aiming to ensure that environmental and possible other sustainability aspects are considered in policy, plan and programme making. SEA may be seen as:-

A structured, rigorous, participative, open and transparent environmental impact assessment (EIA) based process, applied particularly to plans and programmes, prepared by public planning authorities and at times private bodies,

A participative, open and transparent, possible non-EIA based process, applied in a more flexible manner to policies, prepared by public planning authorities and at times private bodies,

A flexible non-EIA based process, applied to legislative proposals and other policies, plans and programmes in political/cabinet decision-making.

SEA is an evidence-based instrument, aiming to add scientific rigor to PPP making by applying a range of assessment method and techniques.

SEA provides for a structured decision framework, aiming to support more effective and efficient decision making, sustainable development and improve governance by establishing a substantive focus. For example, in terms of issues and alternatives to be considered at

Current Research Paper

different systematic tiers and levels.

SEA has been applied in a wide range of different situation, including tread agreements, funding programmes, economic development plans, spatial/land-use and sectoral PPPs

STUDY AREA

The area under investigation, Pushkar is situated 12 Kms North-West of Ajmer, which is centrally situated city of Rajasthan. It is located at latitude 26º29'14" N and longitude 74º33'18" E, at an elevation of 530 m above mean sea level. Aravalli hillocks, sand dunes, agricultural fields, tourist facilities and fresh water bodies like Pushkar Lake and Buda Pushkar, represent diversity of the region. The total catchment of Pushkar Lake is 22 sq.Km. Map of the study area is shown below.

Pushkar Lake or Pushkar Sarovar is located in the town of Pushkar in Ajmer district of the Rajasthan state of western India. Pushkar Lake is a sacred lake of the Hindus.

There are various legends from Hindu epics Ramayana and Mahabharata and the Puranic scriptures which mention the Pushkar Lake and the town of Pushkar surrounding it.

METHODOLOGY

The methodology adopted for the study work included both practical and theoretical work which was carried out in Pushkar as well as in the research lab of department of environment studies. All the facilities including various apparatus, chemicals, reagents, indicators etc. were available in department. A schematic plan was prepared to find out the objectives.

NEED OF SEA

All construction and conservation projects must co-exist satisfactorily with surrounding environment so as to reduce the environmental impacts caused due to these activities.

To control the adverse impacts, a sound and safe environmental management plan has to be implemented by the project proponent which makes environmental protection as essential requirement for sustainable development.

In order to assess the likely impacts arising out of the proposed project and the surrounding environment and evaluating means of alleviating the likely negative impacts and it helps us for preparing in eye report.
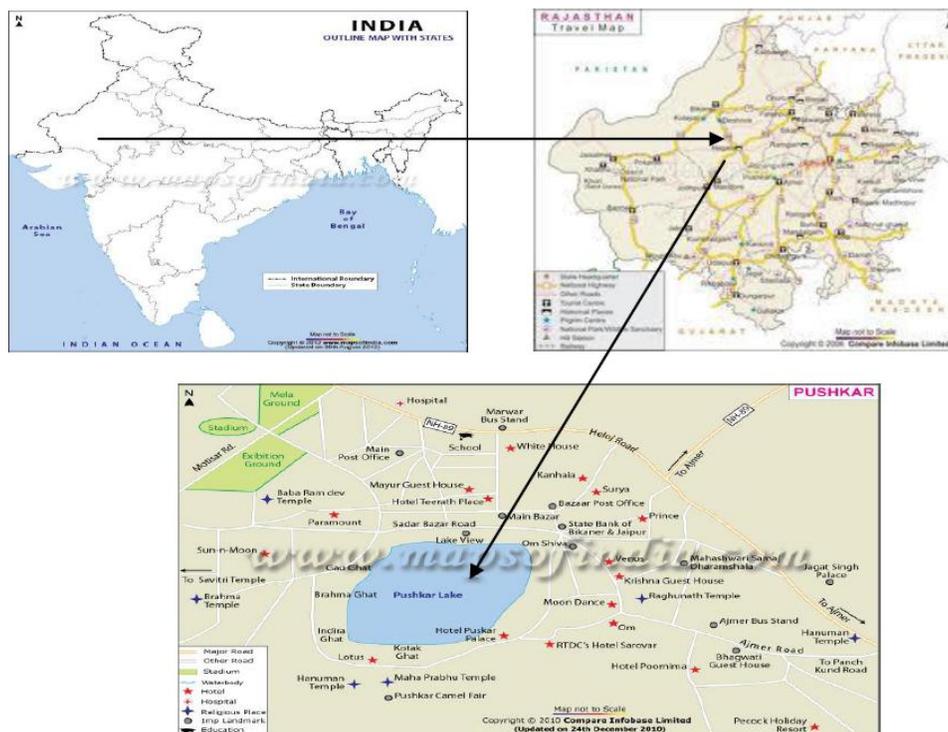

Figure 1 : Map of the area studied

Current Research Paper

ENVIRONMENTAL COMPONENTS

Water environment

Information on water resources in the study area was collected. The water in the study area mainly comprises lake water. The parameters of prime importance for water quality studies were selected under physical and chemical for analysis. Samples were collected at different location in the study area.

Land environment /soil sediment

Soil samples were collected from the project site not only at its immediate vicinity but also in the surrounding feeders and Canal Zone, physic-chemical properties of the soil were determined.

Eco system

Information on ecosystem within 10 Km radius was collected from the agricultural and forest departments of the state. The important flora species native to the area was enumerated.

Socio-economic status

Secondary data was collected for study area to establish socio-economic profile of the study area. The parameters selected under socio-economic component were demographic structure of the study area, provision of basic amenities, industries likely to come up in the study area, welfare facilities proposed by the project proponent, community and occupational health hazards. Relevant information was collected from selected areas and analyzed

OBSERVATION AND ANALYSIS

Environmental baseline studies

This chapter presents the existing environmental status of the project influence area of the project site. The database for all environmental components is collected from secondary sources as well as from primary sources from the site. Furthermore environmental monitoring system has been conducted at selected location to establish and assess the water, soil environment within the project influenced area.

WATER ENVIRONMENT

Water environment consists of water resources such as lake, ponds, streams etc. The water quality forms the essential component of SEA that helps to identify and evaluate critical impacts/issues with a view to sug-

TABLE 1 : Gives various environmental attributes considered for formulating environmental baseline

S.no	Attribute	parameter	Spires of data
1.	Land/soil quality	Physic-chemical parameter (type)	Grab sample are collected for a season study at 3 location
2.	Water quality	Physic-chemical parameter (type)	Grab sample are collected for a season study at 3 location
3.	Ecology	Existing terrestrial flora & fauna within The 10 km radius of project influenced area	Secondary sources
4.	Socio-Economic aspect	Socioeconomic Characteristics of the affected area	Based on field survey and data collected from secondary sources

TABLE 2 : Give frequency and monitoring methodology for various environmental attribute

| Attributes | Squealing | | Measurement Method | Remark |
	network	frequency		
(a) Water Parameter for water quality:- PH, Temp Turbidity, Mg, Total Hardness , N, P, K, D.O., BOD, COD	Set of grab samples at request location for surface water	once	Samples for water quality collected and analyzed as per method for sapling and testing	
(b) Soil Texture, pH,	Requisite soil samples be collected as per specifications within project influenced area	once	Collected and analyzed as per soil analyses reference book S.K. maiti	

Current Research Paper

gest appropriate mitigation measures for implementation water quality of lake Water has been studied in order to assess various use of water such as during construction with respect to the proposed project.

WATER QUALITY

In order to assess the existing water quality, row water samples were collected from different locations within the project influenced area and analyzed as per the procedure specified in standard methods for examination of lake water. The result of physico-chemical analysis are summarized in the TABLE 3

TABLE 3 : Water quality in Pushkar Lake

S.no	Parameter	Unit	Site-a	Site-b	Site-c
1.	Temp	$0°C$	28	27	28
2	pH	-	8.2	7.9	8
3	TDS	Mg/lit	298	300	300
4	Total Hardness	Mg/lit	141	136	138
5	Turbidity	NTU	58	61	94
6	D.O.	Mg/lit	7.3	69	6.8
7	Chloride	Mg/lit	42.1	37.8	44.7
8	Nitrate	Mg/lit	21.65	29.04	24.86
9	Phosphate	Mg/lit	1.21	1.17	0.91
10	BOD	Mg/lit	6.1	6.5	6.8
11	COD	Mg/lit	33.2	33.9	35.8

LAND ENVIRONMENT

Land use

In Pushkar valley, about 30% of the area is occupied by shifting sand dunes and another 30% is under hill and streams, most of which are barren and degraded. Much of the remaining 40% of the area is under agricultural land.

Soil

Soil samples are collected from three different locations for the project influenced area. Samples were analyzed as per methodology define in S.K Maiti.

ECOLOGICAL ENVIRONMENT

There is one wild life park (deer park) in the 10 Km radius of the project site. No rare or endangered species have been recorded in the project influenced area.

TABLE 4 : Comparative analysis of various physico-chemical parameters at selected sites

Sr. No	parameters	unit	Location		
			Site-a	Site-b	Site-c
1	pH	-	7.19	7.07	6.96
2	Organic matter	%	1.814	2.5406	5.928
3	Potassium content	Meq/100gm	0.77	0.38	0.65
4	Calcium content	Meq/100gm	45.59	36.6	38.59
5	Magnesium content	Meq/100gm	4.56	4.51	4.40
6	Phosphate(as P_2O_5)	Kg/hectare	68.8	40.59	35.80
7	Nitrogen content	Kg/hectare	585.25	587.25	559.08

SOCIO- ECONOMIC STUDIES

Any development activity will have impact on the socio-economic if the population in the region and thereby on the quality of life. Socio-economic impact assessment helps to get an idea of changes on social, economic and structural status baseline data for occupational status. SEA provides a flexible base to incorporate all relevant parameters which has direct or indirect relationship with socio-economic factors of Pushkar Lake and its immediate vicinity. Socio-economic factors play a major role in designing a firm and rigid planning schemes.
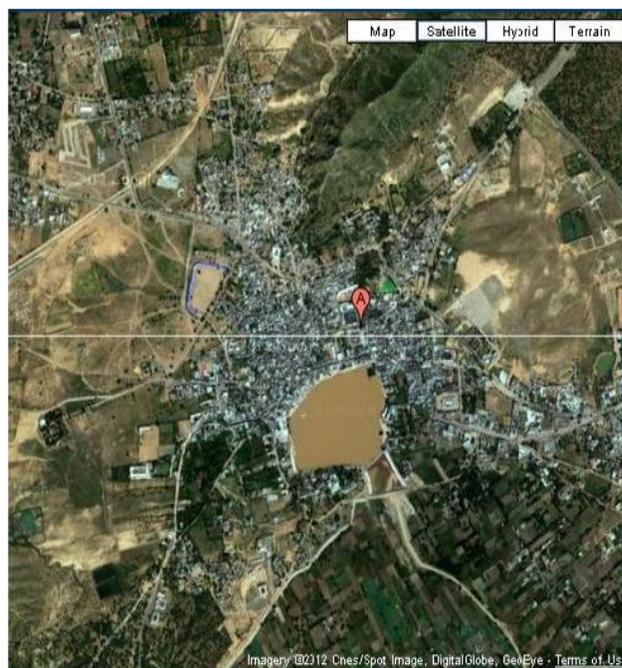
TABLE 5 : Comparative study based on satellite-data

S.NO	Categories	Area(sq km) 2005	Area(sq km 2008)
1	Agriculture Land	1.857	2.001
2	Forest	1.934	2.040
3	Gori River	1.024	1.702
4	Road	0.191	0.011
5	Mountain	11.234	11.125
6	Settlement	0.802	0.334
7	Water Body	0.944	2.511
8	Waste Land	4.425	5.580
9	Pushkar Lake	1.112	1.164
	Total	24.225	24.072

DRAINAGE PATTERN

Drainage constituted of network channels which flows higher reaches to lower levels often following the topography and slope of the terrain.

Following are the names of man-made canals in Pushkar-

- Pushkar Canal/Feeder
- Kharkheri Cana/Feeder
- Savitri Canal/Feeder
  Different types of Drainage pattern is following-
- Rectangular
- Dendritic
- Radial
- Centripetal

DRAINAGE PATTERN OF PUSHKAR (AJMER)

TIN MODEL OF PUSHKAR (AJMER)
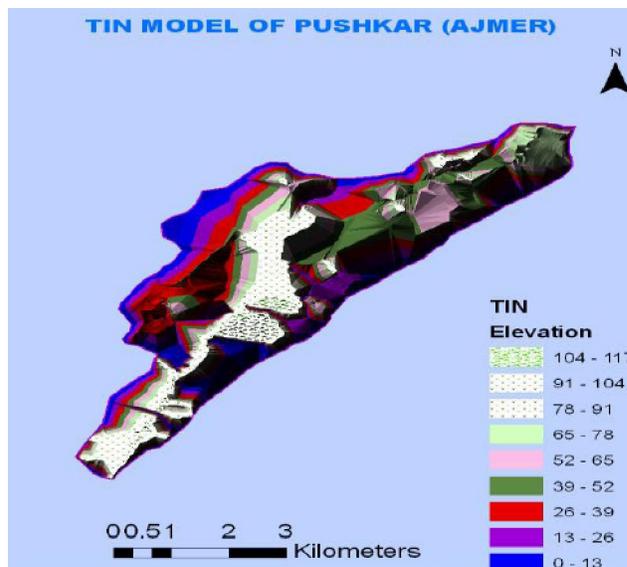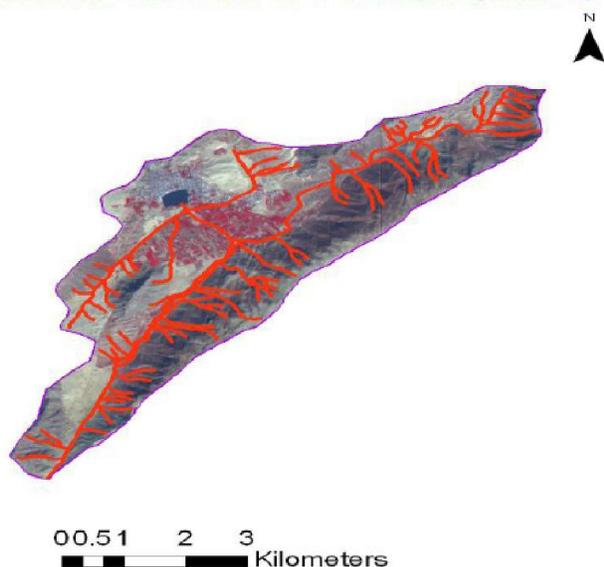
IDENTIFICATION OF IMPACTS

Assessment of impacts depends on the nature and magnitude of the activity being undertaken and also on the type of pollution control measures that are envisages as part of the project proposal. As proposed project is a conservation of the Lake Project. The potential impacts from the proposed project area are identified and assessed based on the nature and magnitude of various activities associated with the project.

POTENTIAL IMPACTS

Water environment

- Impact on surface water quality.
- Loss of water in the lake.
- Infiltration problem in the lake.

Land environment

- Impacts on land use.
- Impacts on soil fertility
- Impacts on agriculture

Ecological impacts

- Impacts on tree/vegetation.
- Impacts on forest and wildlife.

Socio-economic impacts

- Impacts on other infrastructure.
- Impacts on tourism.

Current Research Paper

- Impacts on cultural resources.

IMPACT DUE TO PROJECT LOCATION

Change of land use

The development in the entire project area is as per the National Conservation of Lake Program (NLCP) of Pushkar and due to this land-use change is anticipated. The project site also forms part of the NLCP and is designated for public purpose.

Loss of trees

The proposed site is an open land earmarked for construction of feeders and Lake catchment area and possesses tree loss; hence cutting of trees is anticipated. Moreover all the activities related project shall confined to designated site so cutting of tree even in the project influenced area is envisaged.

IMPACTS ON LAND USE PATTERN

- The construction of the canal is the permanent drainage for the rain water goes to the Pushkar Lake, so no change will be in the course of drainage in near future.
- The elevation of the drainage at the place of canal is decreased at 1 to 3 metres.
- The velocity of the rain water will be high than simple sand drainage due to elevation decreases towards the lake, the water will not stay in the canal and after the rain, the canal seen as dry in the future.

RESULTS AND DISCUSSION

Results

The results of present study are presented under following headings:

1 Existing situation

Pushkar Lake is located in the heart of Pushkar town, 12 Km North-West from Ajmer city. The Lake has religious, holy and cultural importance. There are 52 Ghats around the lake. Earlier there were almost 500 temples in this holy town therefore Pushkar town was known as "Mandiron ki Nagri".

The town is surrounded by hills on three sides. The surrounding hills have rare vegetation and with the passage of time green cover is decreasing. Every year almost 10 Lakh visitors come to Pushkar for holy dip.

The information collected from various tests and sources revealed that the water quality is deteriorating gradually due to:

- Mass bathing.
- Flowing of sewer, waste water and solid waste in monsoon season.
- People offering flowers and ashes is one of the major causes.
- Siltation caused due to rain water flowing from the canal to the Pushkar Lake.
- Due to steep slope of hills the surface run off carries boulders and silt from eroded hills. Thus water capacity of the Lake decreases.
- Eutrophication.
- The Lake gives a stinking smell and poor ambience to the public visiting it.

2 Issues

The emerging issues with respect to conservation of lakes in Pushkar are discussed below:

The main problem of Pushkar Lake is its acute silting in rainy season. Rain water falling on the hill slopes runs down and head towards the lake in the form of three main feeders/canals. The movement of the water erodes the soil, carries the silt in the Pushkar Lake or Sarovar. The deposition can be seen most predominantly near the foot bridge which forms the southern edge of the main part of the water body, where the bottom of the lake has risen above the water over the years.

As a result, Pushkar Lake is continuously shrinking in size and hence the storage capacity of the Lake has been reduced. The reduction of the Lake water, apart from the high silting, is also due to leaching of lake water due to significant reduction of ground water level. It is observed that to increase the water storage capacity of Pushkar Lake, desilting work has to be done in the lake area of 225000 cubic meters under NLCP. Some 40 gavian structure has been constructed in Nag Pahar or Savitri Pahar for controlling the shifting of sand and silt with inflow of rain water in the lake water from the surrounding hills.

3 Developmental objectives

Our development objectives are as follows:
- Lake water quality improvement.
- Increasing water level in the lake and in and around Pushkar.
- Conservation and preservation of natural environment in and around Pushkar.
- Conservation of Pushkar Sarovar and renovation of Ghats.
- Preventive measures to avoid further siltation of the Sarovar.
- Maintaining religious significane of Pushkar Lake forever.
- Tourism industry has to be maintained in a proper and efficient manner.
- Sustainable development strategies have to be designed and executed.
- Government Policies and Programmes have to be improved in order to their proper execution.
- Global exposure in terms of Research and Development has to be given.

TABLE 6 : Gives the overview of potential impacts due to project location, construction and operation of the proposed project

S.No	Impact	Negative		Positive		No Impacts
		Short	Long	Short	Long	
A	Project sitting					
	1. Loss of trees /vegetation	√				
	2. Impact on archaeological Property	√				
	3. Change of land use		√		√	
B	Construction Phase					
	1. Pressure on local infrastructure	√			√	
	2. Contamination of soil	√				
	3. Impact on water quality		√			
	4. Impact on air quality including dust generation	√	√			
	5.Staving and disposal of construction material					
	6. Social impact		√			
C	Operation Phase					
	1. Quality of lake		√			

Major proposals

- Reforestation of barren hills.
- Checking of soil erosion.
- Construction of check dams.
- Lining of main feeder.
- De-silting of the sarovar.
- Water treatment plant.
- Public Awareness.

CONCLUSION

Pushkar Lake popularly called as "Tirtha Raj" is a sacred Lake for Hindus.

According to National Lake Conservation Plan (NLCP), desilting should be done but condition become unfavourable due to inappropriate process of desilting. Instead of removing layer by layer, heavy machinery was employed and the area was duged deeply resulting in removal of impermeable layer of soil. This in turn led to infiltration of water into soil.

By studying various environmental aspects at Pushkar, we can conclude that the plans were not properly decided and also resulted in an unscientific manner.

The Strategic Environment Assessment (SEA) led to a more systematic consideration of wider environmental impacts and their alternatives.

If plans were taken systematically that there would have been more accurate execution.

Thus before any project recreation, Strategic Environment Assessment is recommended.

The silt is cleared from the canals and particular care should be taken in rainy season. Large part of the feeder beds are being cultivated, this should stop forthwith to prevent the consequent increase in siltation of Lake. Tilling of feeder's beds loosens the soil.

The present study was done because the popular-

Current Research Paper

ity of Pushkar as tourist centre is increasing every year. Therefore better tourist facilities need to be provided in the town and its religious sanctity should be improved which has been degraded due to mishandling of resources by people, mostly by tourists,

Coordinated efforts should be done at local as well as government level for the management of environment of Pushkar. Stress should be laid on "Lake Conservation". Certain guidelines should be given by Central Pollution Control Board (CPCB) and State Pollution Control Board (SPCB) for the benefit of local authorities to formulate accurate plans.

REFERENCES

[1] S.K.Agarwal; Limnology, A.P.H.Publishing Corporation. New Delhi, **(1999)**.

[2] APHA; Standard methods for the examination of water and waste water A.M.Publ.Hith.Assoc. New York, **(1992)**.

[3] S.C.Bhargava; Ecology and productivity of salt lakes of Rajasthan desert and culturing bring shrimp, Artemia for Aquaculture. MAB Project, Dept. of Environment, N.Delhi, **(1983)**.

[4] L.R.Bhatt, P.Cacoul; Physico-chemical characteristic and phytoplankton of Taudaha lake, Katmandu, **(1999)**.

[5] D.K.Billore; Ecological studies on Phichola Lake, Udaipur. Ph.D.thesis, MSC University, Udaipur (Raj.), **(1981)**.

[6] R.P.S.Chouhan; Causes of deterioration and suggested remedial measures for revival of Anasagar lake, Ajmer (Rajasthan). Dissertation work, M.D.S.University, Ajmer, **(2001)**.

[7] B.Gopal; Conservation of Inland waters in India: an overview. In proceedings of International Association of Theoritical and Applied Limnology. Stuttgart, **25(4)**, 2492-2497 **(1994)**.

[8] J.Kalff; Limnology: Inland water ecosystems, Prentice-Hall, Inc, **(2003)**.

[9] R.Kiran, T.V.Ramchandra; Status of wetlands in Bangalore and its conservationaspects. ENVIS Journal of Human Settlements, March 1999, 16-24 **(1999)**.

[10] A.Kumar; The limnological profile of a tropical fish farming pond at Dumka (Santhal Pargana), Bihar.Journal of Ecobiology., **8**, 117-122 **(1996)**.

[11] S.K.Maiti; Handbook of Methods in Environmental Studies. Water and Waste Water Analysis. ABD Publishers, Jaipur, INDIA, **1**, **(2001)**

[12] S.N.Prasad, T.V.Ramachandra, N.Ahalya, T.Sengupta, A.Kumar, A.K.Tiwari, V.S.Vijayan, L.Vijayan; Conservation of wetlands of India-a review. Tropical Ecology., **43(1)**, 173-186 **(2002)**.

[13] D.W.Schindler, F.A.J.Armstrong, S.K.Holmgren, G.J.Brunskill; Eutrophication of lake 227, Experimental lakes area, Northwestern Ontario, by addition of phosphate and nitrate. J.Fish.Res.Bd.Can., **28**, 1763-1782 **(1971)**.

[14] K.C.Sharma, Renu.Sharma; Algal Diversity in the littoral zones of a polluted shallow lake at Ajmer, Rajasthan. Int.J.of Eco. and Env.Sci., **18**, 139-146 **(1992)**.

[15] R.Sharma, K.C.Sharma; A note on trophic state of Anasagar lake, Ajmer. Geobios New Report., **10**, 158-159 **(1993)**.

[16] M.Sondergaard, K.S.Jensen; Physico-chemical environment, phytoplankton biomass and production in oligotrophic, soft water lake Kalgaard, Denmark, Hydrobiologia, 63 **(1979)**.

[17] E.Stockdale; Freshwater wetlands, urban storm water and non point source pollution control: A literature review and annotated bibliography. Olympia, WA: Washington Department of Ecology, **(1991)**.

[18] R.O.Sylvester; Nutrient content of drainage water from forested urban and agricultural areas. Algae and metropolitan Wastes, U.S. Public Health Service, SEC, TR W, **61-3**, 80-87 **(1961)**.

[19] R.K.Trivedi, P.K.Goel, C.L.Trisal; Practical methods in Ecology and Environmental Sciences, Enviromedia Publications, Karad, India, **(1998)**.

[20] L.N.Vyas; Studies in phytoplankton ecology of Picchola lake, Udaipur. Proc.Symp.Recent.Adv. Trop.Ecol., 334-337 **(1968)**.