



Original Research Article

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## Water Chemistry and Trophic State of Seven Lakes of Mandya District, Karnataka, India

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### ABSTRACT

#### Keywords

Lakes, Physico-chemical parameter, WQI, Nygaard's Index and Trophic state

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Lakes supply water for irrigation, drinking, fisheries etc and thus have significant economic and recreational values in order to determine impact of human activities on fresh water Ecosystem. In the present study, 7 lakes of Mandya district classified based on the trophic state of Physico-Chemical and biological, chlorophyll 'a'. Nygaard's trophic state and water quality index (WQI). Each objects can be simplified by the correlation matrix and attempts to distinguish logical groupings, phosphate, chlorophyll 'a', and physico-chemical parameter. The correlation indicates that all lakes are Oligotrophic in nature and the most significant parameter was Chlorophyll 'a' and Phosphorus. Trophic state index based on Phosphorous in 6 lakes indicated that the category of oligotrophic lakes tending to become mesotrophic and one lake indicated that only oligotrophic. If the lakes were classified on the basis of Nygaard's trophic state index indicates that 6 lakes were in a state of oligotrophism and were fast tending become Eutrophic. The Water quality index (WQI) developed for rating of water are indicate 6 lakes were far from being pure and are unsustainable for drinking purpose except Thonnur lake. This study indicated that ideal means by which progress integrated water resources management can be monitored. Thus, the data of this findings can be used for the scientific management and restoring polluted lakes and its eutrophication.

### Introduction

The monitoring of water quality especially in the inland water bodies, aquifers, lakes reservoir is important as it helps the management of the Eutrophication and productivity of the water bodies, Carlson made early attempts to define an index, termed trophic state index (TSI) which could tell about the trophic states and nature of the

lake. Based on this trophic index, further classification of eutrophication of a lake into oligotrophic, mesotrophic and eutrophic were made. Because of water pollution and contamination of inland water bodies, it has become important to develop methods to determine index of eutrophication of lakes that provide better spatial and temporal coverage. During recent year large number of publications have been appeared on fresh

water regarding its suitability for domestic as well as non-domestic purpose, similar work done by Hosmani and Bharath (1980), Hosmani and Vasanthkumar (1996), Mahadev *et al.*, (2004). The present work was undertaken with the objective of elucidating lake water and establishing interrelationship between various Physio-chemical parameter including, Sakamoto index, EPA NEW trophic index, Carlsons trophic state index, Nygaards algal index and water quality index (WQI). Based on Physico-chemical parameter Chlorophyll 'a' and phosphorous of 7 lakes were studied. This study indicate that ideal means by which progress integrate water resource management can be monitored.

### **Materials and Methods**

A Mandya district is situated in the southern part of Karnataka state and lies between 76<sup>0</sup> 19' and 77<sup>0</sup> 22' east longitude and 12<sup>0</sup> 13' and 13<sup>0</sup> 04' north latitude. It receives an average annual rainfall of about 180 mm and most part of the land is irrigated by huge channels. The district also has several small and large reservoirs composite. Water samples were collected and analyzed from each of 7 lakes covering most part of the district for the period from March 2016 to February 2018. A brief description of these lakes are presented in Table 1. The methods followed for the determination of Physico-chemical parameter. APHA (2002), Trivedy and Goel (1986), Hosamani and Vasanthkumar (2002), Mahadev, *et al.*, (2004), The collection preservation and enumeration of phytoplanktons were all as described by Munnawar (1970), Hutchinson (1967), Patrick (1973), Prescott (1982), Jones *et al.*, (1993), Kaloo *et al.*, (1995) Seemajohori *et al.* (1990). In the present analysis Chlorophyll 'a' NO<sub>2</sub>-N phosphorus and SDD have been chosen as the potential candidates for estimating of TSI which can cover range concentration of each of three parameters and

applicable to any lake, Chlorophyll 'a' are representation of the optical scattering and absorption in the lake water. The light availability in the controls the general growth and health of microorganism, biomass, flora and nitrogen is one of the major nutrient components of the food chain of lakes. It lies at the base of food web and provide food for all living organism.

### **Results and Discussion**

A data collected over two years during monsoon, summer and pre monsoon provided a basis of the results in the study during period March 2016 to February 2018. The data contains large variability. In the present study, 7 lakes of Mandya district classifying the trophic state based on Physio-Chemical, Chlorophylla, Phosphorus, Nygaars tropic state and water quality index (WQI) were represented in Table 2 to 5C.

### **Classification of Lakes**

The various methods have been adopted for classification of lake waters and to indicate their trophic status.

The value of Chlorophyll 'a' and Phosphate indicated that all lakes range from Oligotrophic to Mesotrophic nature According to sakamoto classification all 7 lakes fall under the categories of oligo trophic lake and tend to become mestrophic except Thonnur Lake was purely oligotrophic and Konanahallilake tend to became Mesotrophic to Eutrophic.

EPA and NEW trophic state index Guthalu lake, Sathanur Lake, Dodda Lake, Sullekere Lake indicated that oligotrophic to tend become mesotrophic, Thonnur lake (2.03) shows purely oligotrophic, Konanahalli lake (10.36) under categories of mesotrophic to eutrophic.

**Based on Carison (1977)**

According to this classification Chlorophyll 'a' and Phosphorous among in 7 lakes 6 lakes fall under the category of oligotrophic lakes

and tend to become mesotrophic except Thonnur lake purely become oligotrophic in throughout study period and Konanahalli lake is mesotrophic, tending to eutrophic

**Table.1** Physical feature of 7 lakes of Mandya District

Lakes	Location	Catchment area acre	Depth (Max)	Soil type	Micro phytes	Usage
1 Guthalu Lake	Longitude -76 <sup>0</sup> 50' E Latitude -12 <sup>0</sup> 30' N	60.00	7.0	RSL	a,b,c	Irrigation, agriculture, domestic
2 Konanahalli Lake	Longitude -76 <sup>0</sup> 45' E Latitude -12 <sup>0</sup> 30' N	36.00	10.00	RSL	a,c,d	Domestic, Agriculture
3 Thonnur Lake	Longitude -76 <sup>0</sup> 38' E Latitude -12 <sup>0</sup> 34' N	311.00	18.00	RSL	Nil	Agriculture, recreation
4 Sathanur Lake	Longitude -76 <sup>0</sup> 47' E Latitude -12 <sup>0</sup> 54' N	30.00	8.00	RSL	c,e	Agriculture, Domestic, Agriculture
5 Dodda Lake (Malavalli)	Longitude -77 <sup>0</sup> 20' E Latitude -13 <sup>0</sup> 45' N	10.00	6.00	RCL	c,e,f	Domestic Agriculture, Agriculture
6 Mangala Lake	Longitude-76 <sup>0</sup> 50' E Latitude -12 <sup>0</sup> 30' N	47.00	10.00	RSL	a,e,k	Domestic Agriculture, Agriculture
7 Sullekere Lake	Longitude -77 <sup>0</sup> 01' E Latitude -12 <sup>0</sup> 33' N	70.00	12.00	RSL	c,e,d	Irrigation Agriculture

a) *Eichornia crassipes* b) *Pistiastratirles* c) *Typhaangustala* d) *Jussiaacaadscondens* e) *Azolo*  
f) RSL: Redsoil and Loamy g) RCL: Red Clayey Loam

**Table.2** Based on the amount of Chlorophyll 'a' and Phosphate index

Trophic condition	Sakamoto	Academy Chlorophyll 'a' Mg/M <sup>3</sup>	Dibson
Oligotrophic	0.3-2.5	0-4	0.4.3
Mesotrophic	1-15	4-10	4.3-8.8
Eutrophic	5-140	>10	>8.8

**Table.2a** EPA NES trophic state index

Trophic state	Academy Chlorophyll Mg/M <sup>3</sup>	Total Phosphoron Mg/ M <sup>3</sup>
Oligotrophic	< 7	< 10
Mesotrophic	7-12	10-20
Eutrophic	> 12	> 20

**Table.2b** Trophic condition of Chlorophyll 'a' and Total Phosphorous in 7 lakes of Mandya

Lake	Academy Chlorophyll 'a' Mg/M <sup>3</sup>	Total Phosphorous Mg / M <sup>3</sup>
1 Guthalu Lake	6.39 (m)	0.72
2 Konanahalli Lake	10.36 (m)	2.24
3 Thonnur Lake	2.03 (O)	0.08
4 Sathanur Lake	6.83 (m)	0.68
5 Dodda Lake (Malavalli)	5.22 (m)	0.56
6 Mangala Lake	8.21 (m)	0.68
7 Sullekere Lake	6.88 (m)	0.59

(M-Mesotrophic , O-Oligotrophic (Dobson classification))

**Table.3** Carisons trophic state index in 7 lakes of Mandya

Sl. No.	Lakes	Chlorophyll Mg/M <sup>3</sup>	Phosphate Mg/ M <sup>3</sup>
1	Guthalu Lake	8.64	0.98
2	Konanahalli Lake	9.26	1.24
3	Thonnur Lake	2.16	0.08
4	Sathanur Lake	8.93	0.94
5	Dodda Lake (Malavalli)	6.81	0.45
6	Mangala Lake	9.22	0.65
7	Sullekere Lake	7.20	0.54

**Table.3(a)** Carison Trophic index in surface total phosphorus and total surface Chlorophylla 'a'

TSI	Carison trophic index	Summer surface total phosphorous Mg/M <sup>3</sup>	Summer surface total Chlorophyll 'a' Mg / M <sup>3</sup>
0	Oligotrophic	0.75	0.04
10	Oligotrophic	1.50	0.12
20	Oligotrophic	3.0	0.34
30	Oligotrophic	6.0	0.94
40	Oligotrophic	12.0	2.60
50	Mesotrophic	24.0	6.4
60	Eutrophic	48.0	20
70	Eutrophic	96.0	56
80	Eutrophic	192	154
90	Eutrophic	384	427
100	Eutrophic	768	1183

**Table.4** Nygarra’s Index for water of Mandya district

Index	Values	Oligotrophic	State
Myxophycean	1.2	-	Eutrophic
Chlorophycean	1.3	-	Eutrophic
Diatim	0.07	-	Oligotrophic
Euglenophycean	0.3	-	Oligotrophic
Compound Coefficient	3.4	-	Eutrophic

**Table.4(a)** Nygaar’s algal Index in 7 lakes of Mandya

Index	GL	KL	TL	SL	DL	ML	SL
Myxophycean	1.4	2.2	0.4	1.4	1.3	1.6	1.5
Chlorophycean	5.3	8.4	0.6	5.8	4.8	6.2	5.4
Diatoms	1.64	1.92	0.3	1.60	1.43	1.52	1.24
Euglenophycean	0.98	1.14	0.08	0.8	0.73	0.68	0.61
Compound coefficient	1.8	2.8	0.8	1.64	1.52	1.44	1.68

GL- Guthal Lake, KL-Konanahalli Lake, TL- Thonnur Lake, SL-Sathanur Lake, DL-Dodda Lake, ML-Mangala Lake, SL- Sullekere Lake

**Table.4(b)** Nygaards algal index

Index	Calculation	Oligtrophic	Eutrophic
Myxophycean	Myxophycean / desimidacea	0.0-0.4	0.1-3.0
Chlorophycean	Chlorococcales / desimidacea	0.0-0.7	0.2-9.0
Diatoms	Centric diatom / Pennate diatom	0.0-0.3	0.0-1.75
Euglenophycean	Euglenophyta / Myxophycean + Chlorphycea	0.0-0.2	0.0-1.0
Compound coefficient	Myxiphycean + Chlorococcaly + Centric diatom + Englenophycea / desimid	0.01-1.0	1.2-2.4

**Table.5** Physico-chemical parameter and Water Quality Index (WQI) Horton 1965

Lakes	pH	TDS	Total alkanyity	Total Hardness	Chloride	DO	BOD	Sulphate
GL	8.3	520.00	243.00	380.00	256.00	3.8	3.2	64.00
KL	9.0	680.00	350.00	320.00	286.00	2.4	3.4	86.00
TL	7.14	175.00	115.00	176.00	62.00	6.2	8.4	0.00
SL	8.14	512.00	215.00	326.00	216.00	4.3	4.8	58.00
DL	7.98	531.00	220.00	308.00	244.00	4.2	4.8	64.00
ML	8.13	543.00	208.00	326.00	250.00	3.9	4.9	49.00
SL	8.15	560.00	214.00	316.00	254.00	4.0	4.8	52.00

(All parameters were Mg/L except pH)

GL- Guthal Lake, KL-Konanahalli Lake, TL- Thonnur Lake, SL-Sathanur Lake, DL-Dodda Lake, ML-Mangala Lake, SL- Sullekere Lake.

**Table.5(a)** Water quality rating (qn) in 7 lakes of Mandya District

Sl. No	Lakes	pH	TDS	Total alkalinity	Total hardness	Chloride	DO	BOD	Sulphate	Total
1	Guthalu Lake	96.8	48.14	246.00	108.40	86.80	134.24	80.2	0.64	801.22
2	Konanahalli Lake	98.4	102.28	356.40	158.54	68.10	120.40	108	0.86	1098.02
3	Thonnur Lake	26.88	20.18	104.40	58.00	24.00	48.5	20.00	00	301.96
4	Sathanur Lake	94.22	86.24	204.00	96.32	78.20	138.2	90.60	00	787.46
5	Dodda Lake (Malavalli)	86.66	40.54	181.42	88.4	53.96	94.05	64.00	0.30	609.37
6	Mangala Lake	73.40	52.00	164.20	98.30	76.40	108.00	96.00	0.40	668.70
7	Sullekere Lake	58.64	68.60	244.16	67.43	38.40	102.45	78.90	0.30	658.83

**Table.(5b)** Drinking Water standard recommending agency Mg/L

Parameter	Standard	Recommending Agency
pH	7.0 + 8.5	ICMR
TDS	500	WHO
Total Alkalinity	120	ICMR
Total Hardness	300	ICMR
Chloride	250	ICMR
Sulphate	250	WHO
Dissolved Oxygen	5.0	ICMR
BoD	5.0	ICMR

**Table.(5c)** Status of Water quality based on WQI

WQI	Status
0-25	Excellent
26-50	Good
51-75	Poor
76-100	Very Poor
100 & above	Unsuitable for drinking

### Nygaar’s algal Index

Nygaarrad (1949) proposed 5 indices to evaluate the organic pollution of water body on the basis of occurrence of algal groups and designated them as Myxophyceae Index, Chlorophyceae Index, diatom Index, Euglenophyceae Index, Based on algal count indices 6 lakes are Eutrophic one lake still oligotrophic states. The physico-chemical parameters found to be high in Konanahalli lake and Sullekere lake compared to other lakes. All the physico-chemical parameters are within the

permissible limit and is suitable for domestic purpose. An excellent test based on 7 parameters indicated that 6 lakes were far from being pure and were not suitable for drinking purpose. Based on 7 parameters indicated that in Thonnur lake all the parameters were within permissible limits and was suitable for drinking purpose.

### Shannon and Weaver Index 1949

Species diversity Index: The order of pollution among lakes range as follows.

Thonnur Lake had high species diversity index and was less polluted, while Konanahalli lake had least species diversity index and was highly polluted whereas rest of the lakes were moderately polluted.

In conclusion the trophic state index of 5 lakes indicated that they range from oligotrophic to mesotrophic and Konanahalli lake, has mesotrophic to eutrophic and Thonnur lake purely oligotrophic lake. Among 7 lakes 6 lakes indicated that was not suitable for drinking. Based on most significant parameters viz., Chlorophyll 'a' and Phosphorous, among the 7 lakes, 6 lakes indicated that the categories of oligotrophic lake tending to become mesotrophic. The Nygaars trophic state index indicates that all the lakes are in a state of oligotrophic fast tending become eutrophic except Thonnur lakes. Water Quality Index indicates that among 7 lakes, 6 lakes not suitable for drinking purpose. Shannon and Weaver index indicate that Thonnurlake had high species diversity and less pollution. While Konanahalli lake had least species diversity and was highly polluted. Whereas, rest of the lakes were moderately polluted. The data of the findings can be used for scientific management and restoring the polluted and eutrophic status of the lake.

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