

**PLS RESPONSE (ZOOPLANKTON) TO PHYSICO-CHEMICAL PARAMETERS FROM  
THANE LAKES (MAHARASHTRA)**

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**Key words :** Lakes, Zooplankton, PLS. (Partial Least Square Regression).

**Abstract :**

*In four study lakes namely Ambeghosale, Rewale, Makhmali and Upavan; the zooplankton samples were collected through out the year. During the course of statistical analysis zooplankton analysis was done for the four study lakes in the Thane city. PLS response (zooplankton) to physico-chemical parameter were represented first time for Thane lakes. The study shows that calculated PLS response of zooplankton is very near to actual response of zooplankton in all the four lakes studied.*

**Introduction :**

Aquatic environment depicts ecological features that lead to the establishment of a very dynamic system in which the plankton communities play an important role (Sharma and Sarang, 2004). During the present study an attempt has been made to verify certain physico-chemical parameters in relation to zooplankton from the study lakes.

Regression means change in the measurements of a variable character, on the positive or negative side, beyond the mean. Regression coefficient is a measure of the change in dependent (y) character with one unit change in the independent character (x). Helsel and Hirsch (1992) represented simple Linear Regression between sedimentary concentration and stream discharge. Pierson *et al.*, (2003) reported Linear Regression between long and short term variation in suspended particulate material. Chakraborty (2005) gave least square line of La Jolla Ozone collected at the white mountain research center.

Partial Least Square Regression (PLS) reduce the number of predictors to a set of uncorrelated

components and performs least square regression on these components.

**Materials and Methods :**

The water samples from the study lakes Ambeghosale, Rewale, Upavan and Makhmali were collected monthly. The physicochemical analysis of water samples was performed as per the procedures described in the Standard Methods (APHA, 1981 and Trivedi and Goel, 1984) for the following parameters : Air temperature, water temperature, Light penetration, Total solids, Dissolved solids, Suspended solids, pH, conductivity, turbidity, salinity, Dissolved oxygen, Free carbon dioxide, Phenolphthaline alkalinity, Total alkalinity, Total hardness, Calcium hardness, Calcium, Magnesium, Silicates, Phosphates, Nitrates and Biological Oxygen Demand (BOD).

The samples for zooplankton were collected and preserved in 4% Lugol's Iodine for further analysis. The one year data of the physico-chemical parameters and zooplankton was subjected to statistical analysis, for which, software Mintab 14 was used. The PLS (Partial

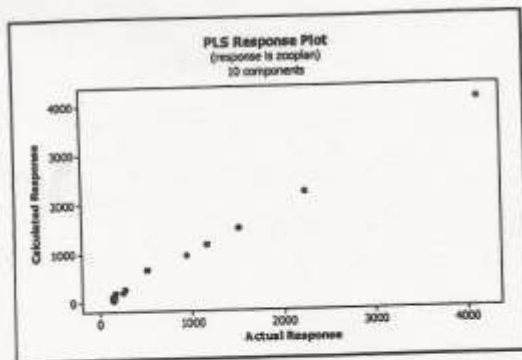
Least Square Regression) groups are drawn by using this statistical software.

**Result and Discussion :**

During the present study, the predictors (Physico-Chemical Parameters) were more than the number of observations and hence ordinary Regression Least Square fails. Hence Partial Least Square (PLS) method was used. Similarly in the present study, we have the response which are correlated to zooplankton. Response zooplankton (y) depends on Physico-Chemical Parameters (x).

In our data the number of observations were 12 but with 10 components we get better results. Hence 10 components were considered for Least Square. In PLS, standardized coefficient indicates the importance of each predictor in the model. The coefficients are used with the predictors to calculate the value of the response variable.

**Lake Ambeghosale :**



**Graph 1. PLS response (Zooplankton) to physicochemical factor in lake Ambeghosale.**

Using PLS we got the final regression equation as : Zooplankton = 3608 + 4 AT - 123 WT - 20 LP - 0 TS + 2 DS - 2 SS - 536 pH + 497 COND + 23 TURB + 102677 SALI - 85 DO + 3 FCO<sub>2</sub> - 76 PA - 2 TA - 4 T HARD - 38 CA HARD - 94 CA + 2 MG + 0 SIL + 545 POSP + 670 NIT + 29 BOD.

	Regression Coefficient	Standardized Coefficient
Constant	3608	0.000000
AT	4	0.013643
WT	-123	-0.237982
LP	-20	-0.266396
TS	0	-0.055088
DS	2	0.0174333
SS	-2	-0.212957
pH	-536	-0.286446
COND	497	0.037469
TURB	23	0.370614
SALI	102677	0.931659
DO	-85	-0.155501
F CO2	3	0.045368
P ALK	-76	-0.506899
T ALK	-2	-0.060525
T HARD	-4	-0.151520
CA HARD	-38	-0.471442
CA	-94	-0.471208
MG	2	0.020175
SIL	0	0.005126
POSP	545	0.107867
NIT	617	0.055841
BOD	29	0.120091

**Table 1. Regression coefficient of Zoo-plankton in lake Ambeghosale.**

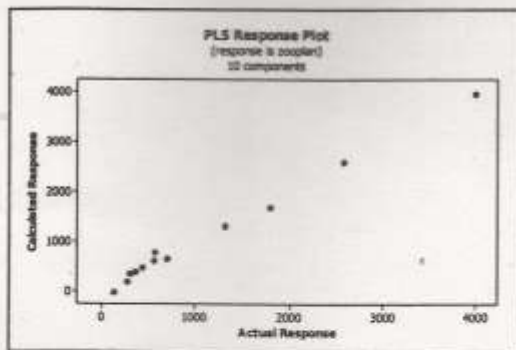
Using this equation we can obtain calculated value (expected value) of zooplankton, the actual values and calculated values are given in the following table.

Row	Observed values	Expected values
1	269.5	257.42
2	247.5	215.07
3	140.6	111.75
4	936.0	9.54
5	4125.0	4097.10
6	162.5	191.75
7	2227.5	2221.26
8	1160.0	1172.42
9	1501.5	1509.38
10	144.5	56.19
11	507.5	664.98
12	154.0	129.24

**Table 2. Observed and Expected values of Zooplankton in lake Ambeghosale.**

For zooplankton in lake Ambeghosale we observed maximum positive coefficient (hence positive covariance) for salinity (0.931659), while phenolphthaline alkalinity (-0.506899),  $Ca^{++}$  (-0.471442) and  $Ca^{++}$  hardness (-0.471208) has negative coefficient (hence negative covariance) where as coefficients of silicate (0.005126) are very close to 'zero'. Hence salinity has positive impact on zooplankton where as phenolphthaline alkalinity,  $Ca^{++}$  and  $Ca^{++}$  hardness have negative impact.

#### Lake Rewale :



Graph 2. PLS response (Zooplankton) to physico-chemical factor in lake Rewale.

Using PLS we got the final regression equation as : Zooplankton = -1068 - 2.2 AT + 4.5 WT + 1.7 LP + 1.6 TS + 3.4 DS - 1.4 SS + 69.8 pH + 87.4 COND - 7285.4 SALI + 319.7 DO - 8.7 FCO<sub>2</sub> - 14.6 PA + 17.1 TA - 3 T HARD - 5.1 CA HARD - 12.9 CA - 4.4 MG - 19.1 SIL + 608.3 POSP + 10942.9 NIT - 45.2 BOD - 7.1 TURB.

	Regression Coefficient	Standardized Coefficient
Constant	-1068	0.000000
AT	-2.2	-0.005987
WT	45	0.013598
LP	1.7	0.013594
TS	1.6	0.2025536
DS	3.4	0.384759
SS	-1.4	-0.147599
pH	-1.4	-0.037242
COND	87.4	0.009607
SALI	-7285	-0.082689

DO	319.7	0.516742
FCO <sub>2</sub>	-8.7	-0.97877
P ALK	-14.6	-0.038473
T ALK	17.1	0.420998
T HARD	-3.0	-0.104665
CA HARD	-5.1	-0.147265
CA	-12.9	-0.147561
MG	-4.4	-0.035524
SIL	-19.1	-0.420969
POSP	608.3	0.046215
NIT	10942.9	0.428594
BOD	-45.2	-0.241261
TURB	-7.1	-0.241261

Table 3. Regression coefficient of Zoo-plankton in lake Rewale.

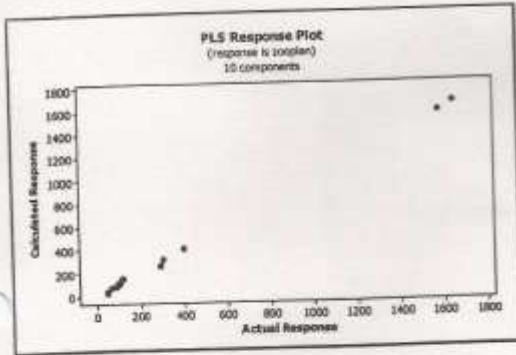
Using this equation we can obtain calculated value (expected value) of zooplankton, the actual values and calculated values are given in the following table.

Row	Observed values	Expected values
1	1316.00	1307.18
2	353.50	384.02
3	1790.25	1688.75
4	570.50	775.61
5	125.38	-21.89
6	299.00	352.36
7	3997.50	3978.06
8	2578.50	2603.47
9	267.75	192.95
10	432.00	466.03
11	558.00	612.16
12	702.00	652.67

Table 4. Observed and Expected values of Zoo-plankton in lake Rewale.

In lake Rewale maximum positive coefficient was observed with dissolved oxygen (0.516742), nitrate (0.428594) and total alkalinity (0.420998), while maximum negative coefficient was observed with silicates (-0.420969), where as coefficients of air temperature (-0.005987) are very close to 'zero'. Hence dissolved oxygen, nitrate and total alkalinity has positive impact on zooplankton where as silicates has negative impact.

Lake Makhamali :



Graph 3. PLS response (Zooplankton) to physicochemical factor in lake Makhamali.

	Regression Coefficient	Standardized Coefficient
Constant	-4975.61	0.000000
AT	20.59	0.149022
WT	5.19	0.044606
LP	-15.36	-0.203854
TS	0.08	0.013959
DS	0.79	0.165169
SS	-0.59	-0.136919
PH	491.92	0.692608
COND	1217.00	0.236962
TURB	7.92	0.348925
SALI	4294.71	0.191425
DO	-74.03	0.387403
F CO2	1.48	0.029658
P ALK	-5.41	-0.176796
T ALK	-0.62	-0.085540
T HARD	-8.04	0.283036
CA HARD	1.93	0.121216
CA	4.81	0.120834
MG	-16.95	-0.272683
SIL	5.29	0.128288
POSP	3005.81	0.506424
NIT	3005.81	0.506424
BOD	-9.35	0.073549

Table 5. Regression coefficient of Zoo-plankton in lake Makhamali.

Using PLS we got the final regression equation as : Zooplankton = -4975.61 + 20.59 AT + 5.19 WT - 15.36 LP + 0.08 TS + 0.79 DS - 0.59 SS + 491.92 pH + 1217.00 COND + 7.92 TURB +

$$4294.71 \text{ SALI} - 74.03 \text{ DO} + 1.48 \text{ FCO}_2 - 5.41 \text{ PA} - 0.62 \text{ TA} - 8.04 \text{ T HARD} + 1.93 \text{ CA HARD} + 41.8 \text{ CA} - 16.95 \text{ MG} + 5.29 \text{ SIL} + 3005.81 \text{ POSP} + 3005.81 \text{ NIT} - 9.35 \text{ BOD}.$$

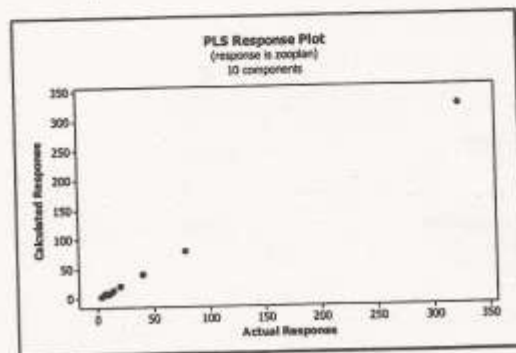
Using this equation we can obtain calculated value (expected value) of zooplankton, the actual values and calculated values are given in the following table.

Row	Observed values	Expected values
1	110.25	143.77
2	42.90	23.33
3	285.00	254.63
4	299.00	305.96
5	95.00	108.79
6	97.50	102.15
7	1575.50	1571.12
8	1645.00	1648.19
9	396.75	399.48
10	84.00	80.18
11	45.00	30.80
12	63.75	71.24

Table 6. Observed and Expected values of Zooplankton in lake Makhamali.

In lake Makhamali pH (0.692608), phosphate (0.506424), nitrate (0.506424) was showed positive response with zooplankton, while dissolved oxygen (-0.387403) is showing negative response with zooplankton.

Lake Upavan :



Graph 4. PLS response (Zooplankton) to physicochemical factor in lake Upavan.

	Regression Coefficient	Standardized Coefficient
Constant	36.365	0.000000
AT	-3.172	-0.117822
WT	1.228	0.121145
LP	0.304	0.094022
TS	0.011	0.014711
DS	0.008	0.007972
SS	0.021	0.015480
PH	11.176	0.042662
COND	-93.595	-0.088496
TURB	-0.340	-0.034556
SALI	-340.474	-0.056526
DO	16.357	0.237010
F CO <sub>2</sub>	9.683	0.629738
P ALK	-0.245	-0.012937
T ALK	-0.766	-0.158899
T HARD	0.320	0.140125
CA HARD	-0.220	-0.085833
CA	-0.549	-0.085811
MG	2.504	0.253563
SIL	-0.139	-0.023195
POSP	-19.929	-0.005476
NIT	-11.152	-0.006506
BOD	2.541	0.077635

Table 7. Regression coefficient of Zoo-plankton in lake Upavan.

Using PLS we got the final regression equation as : Zooplankton = 36.365 - 3.175 AT + 1.228 WT + 0.304 LP + 0.011 TS + 0.008 DS + 0.021 SS + 11.176 pH + 93.595 COND - 0.340 TURB - 340.74 SALI + 16.357 DO + 9.683 FCO<sub>2</sub> - 0.245 PA - 0.766 TA + 0.320 T HARD - 0.220 CA HARD - 0.549 CA + 2.054 MG - 0.139 SIL - 9.929 POSP - 11.152 NIT + 2.541 BOD.

Using this equation we can obtain calculated value (expected value) of zooplankton, the actual values and calculated values are given in the following table.

However in lake Upavan (non infested) free carbon dioxide (0.629738) is showing positive coefficient to zooplankton, while water temperature (-0.117822), total hardness (-0.158899) are the parameters showing

maximum negative coefficient. In this lake phosphate (-0.005476), nitrate (-0.006506) and are the parameters, which are near the 'zero'.

Row	Observed values	Expected values
1	14.00	13.694
2	40.25	40.014
3	6.60	9.194
4	9.00	6.702
5	10.50	8.750
6	6.80	6.812
7	40.05	40.645
8	20.30	20.074
9	3.15	2.751
10	324.00	323.904
11	6.00	7.880
12	78.75	78.977

Table 8. Observed and Expected values of Zooplankton in lake Upavan.

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