Chapter – 4

DISCUSSION

THE RESERVOIR, an inland ecosystem provides scope for development of fisheries sector along with irrigation and water supply facilities. Large reservoirs do not provide easy conditions for the development of fisheries sector due to their size and water storage capacities. On the contrary the small irrigation tanks or water sheets provide favourable conditions for fisheries sector along with their primary goal. Capture fisheries as a traditional profession of fisherman community, is seen well established for all variety of surface water sheets.

Transition from lotic to lentic ecosystem due to the development of reservoir has impact on environmental condition, diversity and fishery potential of the reservoir (Jhingran, 1983). Sugunan (1997b) has embodied essential information on reservoir fisheries of India. The inland fish production has demonstrated significant positive trend. This feature has led fishery scientists to project target of fish production up to 4.5 million ton by 2000 AD. The current level of utilization of inland water sheet is around 25% (Sarma, 1990) and the estimated projection is up to 50%. Studies made in regards to status in potential of reservoir fishery in Gujarat indicate prospective future of this field (Sugunan, 1997b). If fishery management component is seriously attended then better inland fish production is definitely achievable. The physico-chemical and biological status, morpho-edaphic index (MEI) etc. indicates possible better fish yield from small to medium reservoirs of Gujarat.

Few essential physico-chemical characteristics of water quality and soil quality have direct relationship with organic productivity as well as fishery potential of the reservoir. In the tropical country like India, seasonal variation in the surface temperature acts as a limiting factor. Fluctuations in temperature have comparatively lesser impact on productivity of the small reservoir like Nyari – II. Survival of Indian major carps in water temperature range of $20^{\circ}C$ to $37^{\circ}C$ (Srivastava, 1999) is a positive feature for stocking of the fry and fingerlings of carps in small reservoir for their better exploitation. The water temperature has positive correlation with other environmental parameters, primary productivity and abundance of planktonic forms. Generally primary productivity increases in winter months and decrease in summer months due to variation in temperature (Korai, 2008). Different physical parameters of water quality play notable role in environmental condition of the reservoir as well as possible fish yield. Such few essential parameters have been analyzed from the water samples of reservoir Nyari – II for the year 2006 – 07 and 2007 – 08. Their monthly variations were recorded and the annual trend was determined using linear regression analysis and trend line equation has been derived (Table – 4.1 a and b).

Turbidity in 2006 – 07 (3.96 ± 1.00 NTU) is comparatively higher than following year; also higher values were observed during pre-monsoon period (Kumar et al., 2007) may be due to more siltation trend. Hujare and Mule (2007) have shown higher values of EC in the month of May and June which may be attributed to higher evaporation rate leading to more concentration of salts in water samples which were collected from the periphery of the reservoir.

The chemical nature of the water plays significant role in productivity, planktonic abundance, trophic status of reservoir ecosystem etc. Chemical characteristics of water are due to presence and variations in its pH, Dissolved gases, nutrients and salt of carbonates and bicarbonates. Welch (1952) has justified the importance of pH on aquatic life. The alkaline pH has been considered good for the growth of flora in the reservoirs. The pH is considered as an important ecological factor and is the result of interactions of various substances in the water (Tamlukar and Ambhore, 2006). Here in analysis pH has been recorded alkaline however marginal increased monthly variation was observed during year 2007 – 08. pH has positive relation with abundance of zooplankton (Bhandarkar and Gaupale, 2008). Annual average of Dissolved Oxygen is 7.19 mg/l and 6.66 mg/l recoded for year 2006 – 07 and 2007 – 08 respectively. This level of oxygen is ideal for fish production (Banerjee and Babulal, 1990). The Dissolved Oxygen is regulated primarily by free diffusion of oxygen from air to water and produce through photosynthesis etc. As observed by Munawar (1970) and Pawar et al., (2006) in different water sheets of Central India, here also we have observed low values of the dissolved oxygen during summer. Negative significance has been observed for Net Primary Productivity (NPP) with dissolved oxygen in Nyari – II reservoir. Free carbon dioxide; however do not show any significant relationship with other physico-chemical parameters, its absence is usual in unpolluted water body (Sharma et al., 1978). The higher concentration of free Carbon dioxide during April and May be attributed to variation in abundance of phytoplankton (Kumar and Kapoor, 2006).

Table 4.1 a: Linear regression analysis of water quality parameters for year 2006-07

Sr.No.	Parameters	Y	R^2	Annual Average	Standard Deviation
	Physical parameters				
1	Surface temperature	-0.496 X + 32.06	0.176	28.83	4.26046
2	Turbidity	0.170 X + 2.584	0.373	3.96	1.004045
3	Electrical Conductivity	0.023 X + 0.742	0.317	0.896	0.152037
4	TDS	-9.447 X + 581.9	0.147	520.5	88.7248
5	SS	10.21 X + 131.2	0.048	197.33	125.6641
6	TS	0.769 X + 713.1	0.000	718.17	233.9261
	Chemical Parameters				
7	pH	0.035 X + 7.530	0.062	7.76	0.510783
8	DO	-0.046 x + 7.085	0.007	7.19	1.936729
9	Free CO_2	1.061 X + 16.93	0.371	29.70	6.281189
10	Cl^- Chloride	4.318 X + 158.1	0.028	131.25	91.87751
11	BOD	0.208 X + 1.720	0.069	1.83	2.853902
12	COD	1.115 X + 13.66	0.280	21.75	7.597348
13	NO_3^- Nitrate	-0.012 X + 0.380	0.006	0.710	0.578907
14	PO_4^{-3} Phosphate	0.002 X + 0.117	0.007	0.205	0.12132
15	SO_4^{-2} Sulphate	-1.846 X + 80.5	0.051	67.50	29.44795
16	Total Hardness	9.580 X + 264.3	0.097	252.50	110.8917
17	Ca^{++} Hardness	6.713 X + 106.3	0.147	110.00	63.10165
18	Mg^{++} Hardness	2.867 X + 158.0	0.038	142.50	52.97226
19	Total Alkalinity	0.314 X + 178.7	0.000	122.50	65.42981
	Biological parameters				
20	Chlorophyll – a	0.660 X - 1.576	0.649	32.59	2.953625
21	Primary Productivity				
22	NPP	-15.60 X + 300.9	0.181	153.91	131.9722
23	GPP	24.93 X 630.6	0.091	746.10	297.5131
	Zoo plankton				
24	Protozoa	-1.318 X + 38.48	0.059	36.25	19.44437
25	Rotifer	-4.258 X + 161.3	0.058	144.75	63.38531
26	Total Arthropod	-13.49 X 292.5	0.215	233.50	106.9258
27	Copepod	-8.828 X + 207.8	0.201	169.00	70.88205
28	Cladocera	-4.667 X + 84.75	0.223	64.50	35.62802
29	Total Zooplankton	-19.15 X + 502.9	0.140	6.50	184.1987

Table 4.1 b: Linear regression analysis of water quality parameters for year 2007-08

Sr. No.	Parameters	Y	R^2	Annual Average	Standard Deviation
	Physical Parameters				
1	Surface temperature	-0.503 X +32.10	0.169	28.83	4.407294
2	Turbidity	0.299 X + 0.893	0.154	2.48	2.749036
3	Electrical Conductivity	-0.000 X + 1.013	7E-05	1.01	0.373748
4	TDS	-0.524 X + 648.7	6E-05	645.33	239.3534
5	SS	9.874 X + 151.8	0.032	216	197.4902
6	TS	9.244 X + 801.7	0.006	861.83	430.7397
	Chemical Parameters				
7	pH	-0.023 X + 8.345	0.020	8.19	0.596324
8	DO	0.088 X + 6.084	0.074	6.66	1.167227
9	Free CO_2	0.253 X + 22.73	0.018	32.45	6.663583
10	Cl^- Chloride	1.961 X +184.1	0.004	141.25	103.644
11	BOD	-0.108 x + 2.720	0.120	1.47	1.127656
12	COD	0.111 X + 19.60	0.003	21.75	6.610368
13	NO_3 – Nitrate	-0.108 X + 2.720	0.120	1.468	1.127656
14	PO_4^{-3} Phosphate	0.002 X + 0.325	0.020	0.353	0.073547
15	SO_4^{-2} Sulphate	-1.716 X +81.90	0.039	63.00	31.35754
16	Total Hardness	9.405 X + 256.3	0.108	260.00	102.879
17	Ca^{++} Hardness	6.503 X + 114.3	0.160	117.50	58.51703
18	Mg^{++} Hardness	2.902 X + 141.9	0.040	142.50	51.77896
19	Total Alkalinity	-2.517 X + 201.3	0.019	127.50	64.59665
	Biological Parameters				
20	Chlorophyll – a	0.612X – 0.672	0.728	6.11	2.588527
21	Primary Productivity				
22	NPP	-8.916 X + 327.2	0.070	246.88	120.9938
23	GPP	23.44 X 834.5	0.211	939.85	183.683
	Zoo plankton				
24	Protozoa	-0.164 X + 34.65	0.000	37.25	20.57562
25	Rotifer	-5.237 X + 164.0	0.082	141.75	65.90627
26	Total Arthropod	-12.65 X + 265.7	0.182	187.00	106.8299
27	Copepod	-8.244 X + 185.2	0.141	121.50	78.93304
28	Cladocera	-4.405 X + 80.47	0.204	65.50	35.13826
29	Total Zooplankton	-20.08 X + 483.7	0.150	7.00	186.8617

Statistical significant relationship between different physico-chemical parameters were tested for their individual inter relationship and represented in Table – 4.2 for year 2006 – 07 and 2007 – 08. In fresh water reservoirs availability of chloride has less significance still notable higher values of the same has been observed during summer months in our study. This may be due to high evaporation rate; marginal high values recorded here for chloride may be cited as an index of its animal origin (Munawar, 1970). Chloride has represented highly significant relationship with hardness and alkalinity in the water samples collected from Nyari – II reservoir. The deposition of organic wastes and sewage load contributes to the increase in chloride values. Various oxygen demands as chemical factors like Biological Oxygen Demand (BOD) and Chemical Oxygen Demand (COD) of the water samples collected from Nyari –II reservoir represent annual average as 3.08 mg/l and 2.02 mg/l for BOD and 19.00 mg/l and 20.33 mg/l for COD for the year 2006 – 07 and 2007 – 08 respectively. The Biological Oxygen Demand was reported high in September and May months where as Chemical Oxygen Demand was reported high in May for 2006 – 07 and in July for 2007 – 08. No significant statistical difference was observed for COD values during two years of study. Similar observation was made by Mustapha (2009). Nutrients in the form of Nitrate (NO_3^-), Phosphate (PO_4^{-3}) and Sulphate (SO_4^{-2}) exhibit marginal variations in their annual averages for both the years; monthly variation is more for both the year. Sulphate is statistically observed with high value of standard deviation. Kulkarni et al., (1995) has reported high value of Sulphate during summer season and attributed it to the high temperature and higher rate of evaporation, similar condition has been observed in present study for the month of April, May and June. The phosphate value changes probably due to influx through rain water (Munawar, 1970). The agricultural runoff may also play significant role in the influx of phosphate, the annual average values, as increased values observed for monsoon and post monsoon seasons coincide with the similar condition observed by other scientists. During year 2007 – 08 consistently higher values have been recorded for the phosphate in the sampled water. Remarkable concentration of phosphate represents high positive significance with total hardness during year 2007 – 08. This is the indication of some sort of pollution or higher sewage dumping as well as entry of fertilizers through agricultural runoff. If such conditions prevail for longer time duration, they may lead to imbalance in the organic load as well as alter trophic status of the reservoir. Total hardness and alkalinity are the parameters having direct positive interrelationship. The decline trend is observed for the total alkalinity from June to December months. Lower values of alkalinity during monsoon are obviously due to dilution of the reservoir water through new water entry (Mishra and Yadav, 1978). Moyle (1946) stated that water bodies having total alkalinity more than 200 mg/l are highly productive in nature. The desirable value of 100 mg/l of total alkalinity coincide with the observations made for both the years from the samples of Nyari – II reservoir, indicates that the water is productive and will have higher trophic status (Sarwar and Wazir, 1991).

Amount of chlorophyll – *a* represents considerable increase from month of December to April, this may be attributed to entry of new fresh water, watershed runoff and dilution in the concentration of various physico-chemical constituents in the water. During 2006 – 07 chlorophyll had shown significant relationship with turbidity and Electrical Conductivity but do not show such conditions in the year 2007 – 08. Chlorophyll represents non significant negative relationship with the surface water temperature. Saadoun et al., (2008) have observed Chlorophyll – *a* concentrations at higher value during September to February and marked decrease in summer months of May to August in Wadi–Al reservoir. Nearly similar observation is recorded for Nyari – II reservoir. Except the higher values were observed from December to April, that may have attribute to prevailing monsoon season in Indian tropical conditions. As Chlorophyll – *a* is the most abundant pigment in plants, appears to be closest factor to be correlated to primary production. Positive correlation was evident between chlorophyll – *a* and primary production (Saadoun et al., 2008). Even though physico-chemical characteristics of water have direct relationship with primary productivity, it was difficult to single out a parameter to correlate its significant relation with the productivity. This indicates that primary productivity of aquatic ecosystem is the function of multi-parametric conditions of water and soil quality.

Energy generated in the form of Gross Productivity represents fluctuations in various months and seasons however, annual trend for both the year is positively increasing. The organic production is consumed by organisms at different trophic levels resulting into Net Primary Productivity (NPP). The trend here in our result indicates gradual decrease in NPP from June to May. In February month of 2007 – 08 NPP was recorded very high which may not have any significant reason and may be a chance.

Consistent increasing nature of Gross Primary Productivity (GPP) and higher values of NPP during months of monsoon could be due to reduction in the size of productive zone owing to rains, increasing water level, dilution of nutrient concentration and cloudy weather. Annual average of GPP is 746.1 mg/cm^3 and 939.85 mg/cm^3 respectively for the year 2006 – 07 and 2007 – 08. The Net and Gross production ratio was 4.84 (2006 – 07) and 3.80 (2007 – 08) recorded as average annual condition. Such lower values of NPP:GPP ratio may be attributed to the fact that when the wetland receives organic matter along with runoff from the catchment area, decomposition of these wastes demands more oxygen resulting in enhanced respiratory value which in turn gave a low value of NPP:GPP ratio. Similar findings were made by Qasim et al., (1969); Harikrishnan and Aziz Abdul, (2000) and Kumar and Singh, (2006). Ganpati and Sreenivasan (1970) observed higher productivity in smaller water bodies as compare to large reservoirs. Chemical and nutrient parameters have exhibited relationship with photosynthetic activity resulting in to productivity in water. The higher alkaline pH which is observed in the samples of Nyari – II reservoir may be associated with high rate of productivity. Similar observation was recorded by Goel and Chavan (1991). There is increasing evidence that the condition of reservoir bottom and the exchange of substances between soil and water strongly influence water quality (Boyd, 1995).

The organically rich bottom is favorable for the rapid growth of benthic organism community. The physico-chemical nature of bottom soil has become one of the essential components of study. Considering biology of aquatic organisms in general and ichthyofauna as specific the analysis of physico-chemical and biological status of water is required as routine scientific approach. The element of analytical status of soil when appended with hydrological condition results in to better decision making capacity for ecosystem and productivity of reservoirs. However, it is evident that role of soil for reservoir ecosystem is reported scantily; we have considered soil as important parameter and analyzed it thoroughly for its physico-chemical nature and its possible statistical correlations (Table – 4.3 and 4.4) in the reservoir ecosystem. For aquaculture practices in different inland conditions the soil management aspects were given importance due to the interrelationship between nature of bottom soil and overlying water, resulting in to leaching of nutrients from soil and generation of firm productive regime. Supplementation of soil as well as fertilizers is a regular practice in pond management during aquaculture practice. Physical property of soil is analyzed in the form of its texture. The texture is analyzed on the bases of the particle size. The functioning of soil depends on particle size. The physical nature of the soil of Nyari – II reservoir is Sandy Clay Loam where substantial clay amount is observed. An ideal pond soil should not be too sandy to allow leaching of the nutrient or should not be too clayey to keep all the nutrients absorbed in it (ICAR, 2006). Chemical properties of reservoir soil is required to be assessed in the context of its pH, Organic Carbon, Organic matter, available nutrients and micronutrients. The samples collected from the reservoir exhibit minor variation in the pH of soil which ranged from 7.8 to 8.3 with an average in near alkaline zone. However, Boyd (1995) considered best pH for fish ponds to be about neutral. Soil Organic matter concentration is difficult to assess because of its varied origins like decomposing plant matter and contribution from different micro organisms. Here in study the organic matter was estimated in percentage values. The annual average was 1.12% with August to December months having higher concentrations. The availability of Organic Carbon and nutrients like Nitrogen and Phosphorous play significant role in nutritional status of the reservoir. The Carbon to Nitrogen (C:N) ratio of soil influences the activity of soil microbe to a great extent. This in turn affects the rate of release of nutrients from decomposing organic matter (Goswami et. al., 2008). In general C:N ratio between 10 to 15 is considered favorable for aquaculture practices (ICAR, 2006).Here in present study 11.42 is the value derived for samples as annual average which is in turn expectable better range. Nutrients in the form of Nitrogen and Phosphorous as well as few essential micronutrients were estimated for the soil samples collected from the periphery of the Nyari – II reservoir. The soil strongly absorbs phosphorous. Similarly Nitrogen generated through aquatic inhabitants gets accumulated in the bottom soil (Boyd et. al., 2002).

Balanced ecosystem and better production state of the reservoir leads to flourish wide variety of biota. Three major groups viz., planktonic forms, aquatic weeds (Plate – 7) and aquatic fauna are the integral part of the reservoir ecosystem. Initiation of productivity depends on two major component i.e. phytoplankton and aquatic flora. The phytoplankton were represented by major groups like Bascillariophyceae, Chlorophyceae and Cyanophyceae. The zooplanktonic forms were represented in the phylum like Protozoa, Rotifera and Arthropoda, wherein Arthropoda was dominating two different sub classes of Arthropoda, i.e. Copepoda and Cladocera were abundantly present in the water of this reservoir. Correlation of physico-chemical properties with zooplankton abundance indicates positive relationship. All the types of zooplanktonic forms indicates marginal declined trend from June to May in 2006 – 07 and 2007 – 08. For both the years during month of September, October and November comparatively plankton density was high that coincides with the similar condition for nutrients as well as some physico-chemical property of water (Bhandarkar and Gaupale, 2008). In context of productivity, macrophytes also play significant role in the reservoir ecosystem. These macrophytes were grouped in to varieties according to their habitat. Submerged and emergent macrophytes provide protective covering to developing molluscan larvae as well as small fishes. Variety of aquatic plants has been identified by Leghari et al. (1999) from Chotiari reservoir. Most of all these varieties were found in Nyari – II reservoir also.

The biodiversity of such reservoir represented by two major groups i.e. Mollusca and fish fauna. The gastropods and pelecipod form molluscan shell fisheries. In general the diversity and fishery aspect of molluscans from the different reservoirs were studied extensively (Lohar and Borse, 2003). These molluscans play significant role in maintaining the aquatic ecosystem by recycling the nutrients. Kamble et al., (2009) suggested that the water of smaller reservoirs is suitable for development of macrophytes, molluscans and ichthyofauna. Family Thiaridae and Viviparidae were observed to be dominating to molluscan diversity from the reservoir of western zone of India (Kamble et al., 2009; Goswami et al., 2010). According to Rao (1989) molluscan population is highly necessary for overall maintenance and productivity of aquatic ecosystem.

The reservoir in-house several local and wild variety of fishes, mainly represented by family Cyprinidae. Total 15 different species have been identified from the reservoir Nyari – II. Along with these fishes Indian Major Carps (IMC) were also identified. Ichthyofauna represents variety of fishes of indigenous origin (Jhingran, 1983, Sugunan, 1997b). A reservoir fishery unfortunately was never an important issue in the development and execution of small to medium size impoundments. Fishing of native fishes of smaller size, less rich in nutrition and fewer in density is a non-organized trade executed by unskilled fisherman. In last decade consistently good fish catch has been recorded from Nyari – II reservoir. Since 2004 -05 significant increases in the fish catch has been registered from Nyari – II reservoir contributing considerably in the total inland fish catch of Rajkot district. Traditionally the hauled fish catch is transported to Rajkot city to attract fresh market (Plate – 8). Several varieties of smaller fishes as well as trace fishes were sundried in the open fields near reservoir itself (Plate – 9), such preserved fish stock is transported to North India. Along with traditional fishing activity for native fish fauna, stocking of commercially viable Indian Major Carps is carried out to get economic gain (Jhingran, 1983 and Sugunan, 1997b). In last decade except during year 2001 – 02 and 2002 – 03 average 5 lacks carp fingerlings were stocked in this reservoir (Plate -10). Remarkably substantial fish catch in the form of Indian Major Carps have been registered from this reservoir. Compare to miscellaneous fish catch in 660 kg of the year 2006 – 07 about 7500 kg catch of IMC have been recorded in the year 2007 – 08 were reservoir ecology was in its better state. Total fish catch was nearly 25000 kg out of which approximately 18000 kg was of Indian Major Carps like Catla, Rohu and Mrigal. This is the conversion of 2.5 lakh of fish seeds stocked in the previous year.

Depending upon the existing literature, execution strategies and exploiting methodologies, Indian reservoirs were utilized for irrigation and potable water supply. Only few large reservoirs were covered under the umbrella of scientific investigations leading to their ecological and economical status (Sugunan, 1997a and b). The concept of utilizing reservoir resources for fisheries purpose required to be enhanced. Most important aspect in this regards is to estimate fishery potential of the reservoir in the subject. Depending upon the limnological parameters especially pertaining to salt and solids related component, reservoir morphometry etc. requires to be taken in to account for the calculation of potential of fish yield for the reservoir. According to Ryder (1965), Morpho-Edaphic Index (MEI) represents most widely accepted method for estimation of potential yield from the reservoirs. Here in case of reservoir Nyari – II on the basis of Ryder's formula potential yield capacity was calculate as 35 kg/ha for year 2006 – 07 and 43 kg/ha for year 2007 – 08. If the conductivity value which is a function of total solids (TS) increases and low average depth of the reservoir is taken in to account than high potential yield can be projected (Henderson and Welcome, 1974). According to Jackson and Marmula (2001) the conductivity of water increases and depth decreases will lead to better fish production. This hypothesis was coined on the bases of African tropical shallow reservoirs. Similarly, Janjua et al., 2008) predicted a high fish production from the Shahpur Dam of Pakistan. Depending on the MEI Calculations based on Ryder, (1965) and other co-authors who have taken into account various physico-chemical properties to evaluate reservoir ecology and establish its relation with potential fish yield. In order to ensure the high potential fish yield, the reservoir should be managed effectively (Mustapha, 2009).

Table: 4.2 a: Significant relationship between various water quality parameters for year 2006-2007

2006-07	pH	Temp	Turb	E.C	TDS	SS	TS	DO	CO_2	Cl-	BOD	COD	NO_3-N	PO_4-P	SO_4	TH	CaH	MgH	TA	CHL-a	NPP	GPP
pH		-0.22	-0.10	0.06	-0.24	0.37	0.17	0.48	0.59	0.23	0.01	0.48	0.19	-0.02	0.24	0.21	0.26	0.12	0.066	0.06	-0.55	-0.006
TEMP			0.18	-0.40	0.32	0.01	0.13	-0.45	-0.48	0.04	0.11	-0.04	0.29	-0.77	0.47	-0.11	-0.21	0.01	0.03	-0.37	0.18	0.40
Turb				0.64	0.15	0.51	0.42	-0.44	0.22	0.56	0.25	0.41	0.06	-0.26	0.10	0.57	0.50	0.59	0.44	0.63	-0.12	0.14
E.C					0.34	0.69	0.62	-0.20	0.36	0.73	-0.02	0.27	-0.30	0.17	-0.002	0.81	0.86	0.67	0.69	0.77	0.02	-0.41
TDS						0.62	0.82	-0.58	-0.49	0.70	-0.15	-0.15	-0.32	-0.40	0.43	0.64	0.57	0.66	0.82	0.054	0.59	-0.422
SS							0.95	-0.27	0.15	0.98	0.14	0.51	-0.24	-0.29	0.43	0.95	0.91	0.90	0.86	0.40	-0.07	-0.37
TS								-0.42	-0.07	0.97	0.04	0.32	-0.29	-0.37	0.48	0.92	0.87	0.90	0.93	0.31	0.17	-0.43
DO									0.36	-0.35	0.005	-0.17	0.04	0.46	-0.31	-0.32	-0.25	-0.37	-0.35	-0.22	-0.41	-0.19
CO_2										0.08	-0.11	0.49	0.25	0.40	-0.07	0.09	0.17	-0.01	-0.21	0.27	-0.43	-0.17
Cl-											0.12	0.42	-0.24	-0.28	0.39	0.95	0.90	0.92	0.91	0.39	0.06	-0.43
BOD												0.37	-0.27	-0.27	-0.33	0.09	0.056	0.13	0.066	0.0023	-0.30	0.26
COD													0.07	-0.06	0.21	0.35	0.37	0.30	0.08	0.20	-0.65	0.10
NO_3-N														0.06	0.28	-0.35	-0.45	-0.20	-0.43	-0.32	-0.03	0.20
PO_4-P															-0.53	-0.24	-0.15	-0.32	-0.30	-0.03	-0.15	-0.44
SO_4																0.36	0.26	0.43	0.32	-0.04	0.07	-0.07
TH																	0.96	0.94	0.93	0.60	0.05	-0.39
CaH																		0.82	0.87	0.66	-0.02	-0.37
MgH																			0.90	0.46	0.14	-0.38
TA																				0.43	0.25	-0.43
CHL-a																					-0.13	0.12
NPP																						-0.33
GPP																						

Table: 4.2 a: Significant relationship between various water quality parameters for year 2007-2008

	pH	Temp	Turb	E.C	TDS	SS	TS	DO	CO_2	CHL	BOD	COD	No3-N	PO4-P	So4	TH	CaH	MgH	TA	CHL-a	NPP	GPP
pH		-0.15	0.05	0.27	0.27	0.17	0.22	0.16	0.06	0.22	0.23	0.84	0.23	0.32	0.40	0.17	0.08	0.24	0.22	0.16	0.16	0.00
TEMP			0.36	0.85	0.08	0.06	0.07	0.21	0.44	0.10	0.31	-0.24	0.31	0.07	0.43	0.10	-0.12	0.01	0.22	-0.5	-0.31	-0.34
Turb				0.45	0.45	0.60	0.53	0.46	-0.04	0.54	-0.23	-0.11	-0.23	0.03	0.22	0.48	0.37	0.53	0.35	0.12	-0.33	0.41
E.C					0.99	0.94	0.99	0.12	-0.07	0.98	-0.31	-0.31	-0.31	0.06	0.60	0.92	0.83	0.89	0.93	0.20	-0.06	0.03
TDS						0.94	0.98	0.12	-0.07	0.98	-0.31	-0.31	-0.31	0.06	0.60	0.92	0.83	0.89	0.93	0.20	-0.06	0.03
SS							0.98	0.32	0.00	0.98	-0.43	-0.43	-0.43	0.03	0.59	0.93	0.83	0.92	0.84	0.26	-0.11	0.18
TS								0.21	-0.04	0.99	-0.37	-0.37	-0.37	0.05	0.60	0.94	0.84	0.91	0.90	0.23	-0.08	0.10
DO									0.36	0.24	-0.12	-0.62	-0.12	-0.02	0.11	0.19	0.18	0.16	0.02	0.03	-0.70	-0.02
Co2										-0.05	-0.48	0.08	-0.48	0.03	-0.07	-0.06	-0.12	0.01	-0.36	0.06	-0.32	-0.23
CHL											-0.35	-0.38	-0.35	0.02	0.59	0.95	0.83	0.91	0.91	0.21	-0.10	0.08
BOD												0.11	1	0.34	-0.37	-0.43	-0.28	-0.54	-0.09	-0.33	-0.04	-0.08
COD													0.11	0.12	-0.36	-0.32	-0.35	-0.24	-0.35	0.03	0.23	-0.01
No3-N														0.34	-0.37	-0.43	-0.28	-0.54	-0.09	-0.33	-0.04	-0.08
Po4-P															0.10	0.94	0.09	0.07	0.00	0.14	-0.28	0.01
So4																0.54	0.40	0.40	0.58	0.56	-0.08	-0.27
TH																	0.94	0.92	0.85	0.51	-0.11	0.20
CaH																		0.73	0.79	0.64	-0.12	0.24
MgH																			0.79	0.28	-0.08	0.13
TA																				0.11	0.00	0.04
CHL																					-0.19	0.30
NPP																						0.41
GPP																						

Table 4.3: Linear regression analysis of soil quality parameters

Sr. No.	Parameter 2007 – 08 soil	Y	R^2	Annual Average	Standard Deviation
(A)	Physical parameters				
1	Bulk Density (Db)	0.0015x + 1.3705	0.0039	1.38	0.0869977
2	Particle Density (Dp)	0.0051x + 2.404	0.0038	2.37	0.2945780
3	Porosity/Pore Space %	0.0201 x + 40.225	0.0001	40.36	6.54632063
4	Max.Water Holdind Capasity %	0.7432 x + 51.025	0.1488	46.19	6.9460213
5	Electrical Conductivity	-0.0269 X + 0.8431	0.2499	0.835	0.196255
(B)	Chemical parameters				
6	pH	-0.0079 X + 7.9877	0.0281	8.04	0.1693442
7	Organic Carbon	-0.0106 X + 0.7091	0.0393	0.64	0.193344
8	Organic Matter	-0.0129 X + 1.2041	0.0207	1.12	0.324093
9	Available K	- 6.5263 X + 238.24	0.2427	195.82	47.766
10	Available P	-2.3236 X + 41.395	0.0626	26.29	33.491062
11	Available Nitrogen	-1.9567 X + 140.75	0.0879	128.00	23.7933
12	Total Nitrogen	-0.0011 X + 0.0635	0.0451	0.05633 3	0.0187584
(C)	Mechanical parameter				
13	C.S. % (Coarse Sand)	2.9287 X + 14.488	0.4633	33.5246	15.512997
14	F.S. % (Fine Sand)	0.8432 X + 13.447	0.1477	18.9281	7.9113671
15	Total Sand % (C.S.+F.S.)	3.773 X + 27.956	0.4674	52.4805	19.8972
16	Clay %	- 3.2 X +50.676	0.519	29.8765	16.0149
17	Silt %	- 5729 X + 21.364	0.1482	17.6402	5.365345
(D)	Micronutrient				
18	Copper (Cu)	-0.2372 X + 5.0971	0.4772	3.5553	1.2380638
19	Zinc (Zn)	0.0346 X + 0.8164	0.0877	1.0414	0.4213965
20	Iron (Fe)	1.6779 X + 1.7856	0.741	12.6922	7.0280689

Table – 4.4: **Significant relationship between various soil quality parameters for year 2007-2008**

	Db	Dp	Por	WH	EC	pH	OC	OM	Ak	AP	AN	TN	CS	FS	CLy	Silt	Cu	Zn	Fe
Db		0.24	-0.20	-0.76	-0.43	0.14	-0.25	-0.26	-0.55	0.06	-0.08	-0.21	0.39	0.14	-0.29	-0.45	-0.01	-0.44	-0.10
Dp			0.84	-0.48	0.22	0.09	-0.58	-0.58	-0.12	-0.55	0.15	-0.49	0.08	0.56	-0.33	-0.06	-0.15	-0.02	-0.02
Por				-0.14	0.37	0.02	0.41	-0.39	0.10	-0.56	0.23	-0.35	0.03	0.43	-0.30	0.16	-0.21	0.32	0.16
WH					0.60	-0.50	0.70	0.71	0.68	0.38	-0.01	0.64	-0.70	-0.67	0.77	0.72	0.49	0.34	-0.17
EC						-0.76	0.42	0.45	0.80	0.13	-0.05	0.39	-0.67	-0.45	0.65	0.65	0.62	0.51	-0.09
pH							-0.70	-0.75	-0.65	-0.56	0.37	-0.67	0.56	0.60	-0.63	-0.65	-0.72	-0.60	-0.17
OC								0.98	0.49	0.75	-0.32	0.96	-0.59	-0.75	0.75	0.58	0.57	0.31	0.06
OM									0.51	0.77	-0.31	0.95	-0.53	-0.80	0.72	0.55	0.55	0.38	0.11
AK										0.30	-0.15	0.50	-0.69	-0.47	0.70	0.60	0.61	0.56	-0.15
AP											-0.69	0.78	-0.29	-0.64	0.55	0.16	0.49	0.11	-0.01
AN												-0.31	0.06	0.07	-0.12	0.08	-0.15	-0.21	-0.31
TN													-0.60	-0.68	0.74	0.52	0.54	0.24	0.01
CS														0.37	-0.89	-0.78	-0.76	-0.08	0.43
FS															-0.71	-0.44	-0.60	-0.23	0.20
CLy																0.64	0.83	0.02	-0.50
Silt																	0.62	0.48	-0.06
Cu																		0.10	-0.46
Zn																			0.65
Fe																			

Plate – 7: Aquatic weeds

Hydrilla

Vallisneria

Plate – 8: Post harvest fisheries activities at Nyari – II Reservoir

Plate – 9: Sun drying of hauled fishes at Nyari - II Reservoir

Plate – 10: Stocking of fish seeds at Nyari – II Reservoir