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Assessment of Various Waste Water Treatment Technologies using Correlation, Multiple Regression and Sensitive analysis Techniques for different Sewerage Treatment Plants in Delhi, India

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Abstract—*Wastewater/Sewage effluent quality and its reutilization can also be assessed with the help of various multivariate tools. Nowadays multivariate tools have proved to be efficient method for the quality assessment and management of various wastewater treatment technologies. The present study focus on the Assessment of various waste water treatment technologies using multivariate techniques for different Sewerage Treatment Plants in Delhi. Three technologies namely Densadeck /BIOFOR, Extended Aeration and ASP technology have been taken into consideration and the various multivariate techniques like Correlation analysis, Multiple Regression Analysis and Sensitive Analysis are being applied on the effluents of these STP to assess their performance. Correlation analysis also shows the association of one parameter with other .As BOD is an potential pollution indicator parameter and also taken as an major parameter for assessment of performance hence the results obtained after regression analysis for each STP were subjected to sensitive analysis to see the impact of other evaluated parameters and their range influencing BOD. The results obtained after Multiple Regression and Sensitive analysis concluded Densadeck as the best and ASP as the least technology in terms of performance.*

Keywords*: Multivariate Techniques, Correlation Analysis, Multiple Regression, Sensitive Analysis, Principal Component Analysis (PCA),*

1. INTRODUCTION

Municipal Corporation usually takes care of the various sewerage treatment plants (STP's). In Delhi the same has been taken up by Delhi Pollution Control Board (DPCC) as well as Delhi Jal Board (DJB). Multivariate techniques have been utilised for the assessment of various wastewater/sewage treatment (Boyacioglu H.2006). Multivariate techniques are used worldwide as they are efficient in assessing the potential parameters affecting the Wastwater treatment technologies and further helping deciding the performance and management related to wastewater/sewage or water quality (Vega *et al.* 1998, Yerel et.al 2012, Wang ZM et.al Al.2014).

Many researchers have also worked on evaluating the efficiency of various STP's in Delhi (Priyanka Jamwal *et .al.* 2009, Colmenarejo *et al.* 2006), which primarily focussed on the calculating the integrated efficiency and comparing the same with the standard integrated efficiency to assess the performance of the selected STP's under their course of investigation. The application of Multivariate Techniques not only makes easy to assess the quality of Wastwater/sewage of water quality but along with that it also helps to how one variable can influence the other under defined circumstances/situations and what are the prime most variables affecting the performance or giving the optimum output as the function of input variables (Simeonova *et al.* 2003, Li X et. al 2014).

In the present study multivariate techniques used for the assessment of various waste water treatment technologies used in different Sewerage Treatment Plants in Delhi are Multiple Regression Analysis, Correlation Analysis, Sensitive Analysis and Principal Component analysis (PCA).Multiple Regression Analysis predicted the relation between the dependent and the independent variables, correlation analysis showed how the variables are associated with one another, sensitive analysis were performed using heat map to determine how different values of an independent variable impact a particular dependent variable under given set of assumptions.

Principal Component Analysis (PCA) in the final portion of the paper emphasis on the reduction of large set of variables into smaller one supporting the fact that the smaller set includes the maximum valuable information of the larger set of variables taken into account for the study (Helena *et. al.* 2000).

2. MATERIALS AND METHODS

2.1 Study Area

The present study was carried out on different sewerage treatment plants based upon different waste water treatment technologies in Delhi. The basic study was carried on the four Sewerage Treatment Plants using different Wastwater/sewage treatment technologies mainly ASP, Extended aeration and Densadeck. Hence the STP's based upon these technologies are being focussed in this study which were Okhla STP, Vasant Kunj STP and Dr. Sen Nursing Home STP respectively.

2.2 Sampling Points and Frequency

The sampling points for the above mentioned STP's in the study area was Outlet channel i.e. it focussed on the effluents of each selected STP's. Sampling were done every month from the year 2012-2017 (APHA 1998).

2.3 Parameters Analysed

The parameters considered for present study are pH, Total Suspended Solids (TSS), Biochemical Oxygen Demand (BOD), Chemical Oxygen Demand (COD), Oil and grease, Ammonical Nitrogen and phospahtes. All the parameters were tested as per (APHA 1998) standards.

2.4 Multivariate Analysis

The multivariate analysis involves the Multiple Regression Analysis, Correlation Analysis and Sensitive Analysis which was performed on the average effluent for each selected STP form the year 2012-2017.All the Multivariate analysis were carried out on excel 2013.

3. RESULTS AND DISCUSSIONS

Table 3.1: Correlation Analysis between the various tested physiochemical Parameters for Dr. Sen Nursing Home (Densadeck Technology)

Correlation Analysis

	BOD (Y)	*pH (X1)*	*TSS (X2)*	*COD (X3)*	*Oil & Grease (X4)*	*Ammonical Nitrogen*	*Phosphates (X6)*
BOD (Y)	1						
pH (X1)	0.767926553	1					
TSS (X2)	0.814571365	0.77208051	1				
COD (X3)	0.96154037	0.594637463	0.812941	1			
Oil & Grease (X4)	0.987387471	0.727679055	0.83996	0.97878172	1		
Phosphates (X6)	0.674959908	0.849640166	0.633523	0.531832623	0.669612306	0.124161653	1

Table 3.2: Correlation Analysis results interpretation for various tested physiochemical Parameters of Dr. Sen Nursing Home (Densadeck Technology)

Result Interpretation

1. **Weak Negative Correlation** is being observed between the following paramters: Ammonical Nitrogen & pH, Ammonical Nitrogen & TSS
2. **Strong Negative Correlation** is being depicted between the following paramters: Ammonical Nitrogen with BOD, COD and Oil & Grease
3. **Moderate Negative Correlation** isnot being depicted by any of the tested paramters
4. **Weak Positive Correaltion** is being observed between Phospahte & Ammonical
5. **Moderate Positive Correlation** is being observed between COD & pH
6. **Strong Positive Correlation** being observed between the following paramters: pH & BOD, TSS with pH & BOD, COD with TSS & BOD, Oil & Grease with BOD, pH, COD and TSS, Phosphates with pH,BOD,TSS and Oil & Grease

Table 3.3: Multiple Regression Analysis for various tested physiochemical Parameters of Dr. Sen Nursing Home (Densadeck Technology)

		Regression Analysis						
SUMMARY OUTPUT								
Regression Statistics								
Multiple R	1							
R Square	1							
Adjusted R Square	65535							
Standard Error	0							
Observations	5							
ANOVA								
	df	*SS*	*MS*	*F*	*Significance F*			
Regression	6	4.172	0.695333	#NUM!	#NUM!			
Residual	0	0	65535					
Total	6	4.172						
	Coefficients	*Standard Error*	*t Stat*	*P-value*	*Lower 95%*	*Upper 95%*	*Lower 95.0%*	*Upper 95.0%*
Intercept	9.702496639	0	65535	#NUM!	9.702496639	9.702496639	9.702496639	9.702496639
pH (X1)	0	0	65535	#NUM!	0	0	0	0
TSS (X2)	0.07352783	0	65535	#NUM!	0.07352783	0.07352783	0.07352783	0.07352783
COD (X3)	-0.053562786	0	65535	#NUM!	-0.05356279	-0.053562786	-0.053562786	-0.053562786
Oil & Grease (X4)	0	0	65535	#NUM!	0	0	0	0
Ammonical Nitroger	-0.821981716	0	65535	#NUM!	-0.82198172	-0.821981716	-0.821981716	-0.821981716
Phosphates (X6)	3.724173165	0	65535	#NUM!	3.724173165	3.724173165	3.724173165	3.724173165
Regression Equ	**Y = 9.7 + 0 X1+ 0.07 X2 - 0.05 X3 + 0X4 -0.82 X5 +3.72 X6**							
when we put the value of X1, X2, X3, X4, X5 & X6 in the above Regression Equation the final	**Y=9.7+0.07 X2-0.05 X3-0.82X5 +3.72X6 Y= 10.533**							

From table 3.3 it is observed that when we take BOD (Y) as a dependent variable and rest of the parameters as the independent variables (table 3.4 can be utilised to see the values) the regression equation obtained is Y=10.533 where X_1 i.e. pH and X_4 i.e. Oil & Grease have no significant impact on BOD (Y) as there value from the table indicated zero contributing towards no effect on the dependent variable.

Table 3.4: Sensitive Analysis for various tested physiochemical Parameters of Dr. Sen Nursing Home (Densadeck Technology)

Dr. Sen Nursing Home Nalla (Capacity:- 2.2 MLD)								
S.No.	**Month/Year**	**BOD (Y)**	**pH (X1)**	**TSS (X2)**	**COD (X3)**	**Oil & Grease (X4)**	**Ammonical Nitrogen (X5)**	**Phosphates (X6)**
1	**Average Effluent in 2012**	10.4	7.5	13.7	52.2	2.6	0.6	0.8
2	**Average Effluent in 2013**	8.7	7.4	13.2	40	1.3	0.7	0.2
3	**Average Effluent in 2014**	9.3	7.5	14.6	44	2	2.1	0.7
4	**Average Effluent in 2015**	8.5	7.5	13	33	1.1	4.1	0.8
5	**Average Effluent in 2016 & 2017**	7.65	7.3	10.8	29.5	0.6	2.9	0.3
	Regression Equation =	**Y=9.7+0.07 X2-0.05 X3-0.82X5 +3.72X6**						
	Y=	**10.533**						

	Sensitivity Analysis				
When Varying Values of TSS (Row Input X2) & COD (Column Input X3)	**10.533**	**5%**	**10%**	**15%**	**20%**
	4%	12.1855	12.189	12.1925	12.196
	7%	12.184	12.1875	12.191	12.1945
	10%	12.1825	12.186	12.1895	12.193
	13%	12.181	12.1845	12.188	12.1915
When Varying Values of COD (Row Input X3) & Ammonical Nitrogen (Column Input X5)	**10.533**	**5%**	**10%**	**15%**	**20%**
	4%	13.5997	13.5972	13.5947	13.5922
	7%	13.5751	13.5726	13.5701	13.5676
	10%	13.5505	13.548	13.5455	13.543
	13%	13.5259	13.5234	13.5209	13.5184
When Varying Values of Ammonical Nitrogen (Row Input X5) & Phosphates(Column Input X6)	**10.533**	**5%**	**10%**	**15%**	**20%**
	4%	8.1568	8.1158	8.0748	8.0338
	7%	8.2684	8.2274	8.1864	8.1454
	10%	8.38	8.339	8.298	8.257
	13%	8.4916	8.4506	8.4096	8.3686
When Varying Values of TSS (Row Input X2) & Phosphates(Column Input X6)	**10.533**	**5%**	**10%**	**15%**	**20%**
	4%	6.7503	6.7538	6.7573	6.7608
	7%	6.8619	6.8654	6.8689	6.8724
	10%	6.9735	6.977	6.9805	6.984
	13%	7.0851	7.0886	7.0921	7.0956

From the regression Equation obtained in the multiple regression analysis the sensitive analysis is obtained by altering the percent contribution of X_2, X_3, X_5 and X_6shown in the table 3.4. The heat map using three colour (Red, White & Blue) shows the lowest, middle and the highest value obtained for the respective regression equation. From the table it is clear that when we alter the percent of TSS (X_2) and COD (X_3) the highest value obtained for the regression equation Y=10.533 will change to 12.196 when the TSS (X_2) and COD (X_3) percentage is 20% and 4% respectively. Similarly the lowest value obtained for the regression equation Y=10.533 will change to 12.181 when the TSS (X_2) and COD (X_3) percentage is 5% and 13% respectively.

Again altering the percent of COD (X_3) and Ammonical Nitrogen (X_5) highest value obtained for the regression equation Y=10.533 is 13.5997 and lowest value is 13.5184 instead of 10.533. When we change the percent of Ammonical Nitrogen (X_5) and Phospahtes (X_6) highest value obtained for Y is 8.4196 and lowest is 8.0338 instead of 10.533. Doing the alteration with the percent of TSS (X_2) and Phospahtes (X_6) highest value obtained for Y is 7.0956 and lowest is 6.7503 instead of 10.533.

Table 3.5: Correlation Analysis between the various tested physiochemical Parameters for Vasant Kunj STP (Extended Aeration Technology)

Correlation Analysis							
	BOD (Y)	*pH (X1)*	*TSS (X2)*	*COD (X3)*	*Oil & Grease (X4)*	*Ammonical Nitrogen (X5)*	*Phosphates (X6)*
BOD (Y)	1						
pH (X1)	-0.335729291	1					
TSS (X2)	0.56542627	0.168594787	1				
COD (X3)	0.863687204	-0.63597608	0.255606	1			
Oil & Grease (X4)	0.247217082	-0.199505969	0.269514	0.526740365	1		
Ammonical Nitrogen (X5)	-0.492711559	0.735471184	0.152306	-0.863018218	-0.6531718	1	
Phosphates (X6)	-0.468883903	0.416803706	0.453679	-0.618079472	0.037216146	0.637086249	1

Table 3.6: Correlation Analysis results interpretation for various tested physiochemical Parameters Vasant Kunj STP (Extended Aeration Technology)

Result Interpretation
1. **Weak Negative Correlation** is being observed between the following paramters: pH & BOD, Oil & Grease and pH, Ammonical Nitrogen & BOD, Phosphates & BOD
2. **Strong Negative Correlation** is being depicted between the following paramters: COD & pH, Ammonical Nitrogen with COD and Oil & Grease.
3. **Moderate Negative Correlation** is not being observed by any of the tested paramters.
4. **Weak Positive Correaltion** is being observed between the following paramters:TSS & pH, COD & TSS, Oil & Grease with BOD and TSS, Ammonical Nitrogen with TSS, Phosphates with pH TSS and Oil & Grease.
5. **Moderate Positive Correlation** is being observed between TSS & BOD, Oil & Grease with COD
6. **Strong Positive Correlation** being observed between the following paramters: COD & BOD,Ammonical Nitrogen & pH, Phosphates & Ammonical Nitrogen.

Table 3.7: Multiple Regression Analysis for various tested physiochemical Parameters of Vasant Kunj STP (Extended Aeration Technology)

	Regression Analysis							
SUMMARY OUTPUT								
Regression Statistics								
Multiple R	1							
R Square	1							
Adjusted R Square	65535							
Standard Error	0							
Observations	5							
ANOVA								
	df	*SS*	*MS*	*F*	*Significance F*			
Regression	6	35.488	5.914667	#NUM!	#NUM!			
Residual	0	0	65535					
Total	6	35.488						
	Coefficients	*Standard Error*	*t Stat*	*P-value*	*Lower 95%*	*Upper 95%*	*Lower 95.0%*	*Upper 95.0%*
Intercept	-5.449618615	0	65535	#NUM!	-5.449618615	-5.449618615	-5.449618615	-5.44962
pH (X1)	0	0	65535	#NUM!	0	0	0	0
TSS (X2)	-0.15941876	0	65535	#NUM!	-0.15941876	-0.15941876	-0.15941876	-0.15942
COD (X3)	0.333665945	0	65535	#NUM!	0.333665945	0.333665945	0.333665945	0.333666
Oil & Grease (X4)	0.646984183	0	65535	#NUM!	0.646984183	0.646984183	0.646984183	0.646984
Ammonical Nitrogen (X5)	1.69027973	0	65535	#NUM!	1.69027973	1.69027973	1.69027973	1.69028
Phosphates (X6)	0	0	65535	#NUM!	0	0	0	0
Regression Equation =	**Y = -5.44-0.15X2+0.33X3+0.64X4+1.69X5**							
when we put the value of X1, X2, X3, X4, X5 & X6 in the above Regression Equation the final Equation becomes i.e Y=	**Y= -5.44-0.15X2+0.33X3+0.64X4+1.69X5 Y= 21.94**							

From table 3.7 it is observed that when we take BOD (Y) as a dependent variable and rest of the parameters as the independent variables (table 3.8 can be utilised to see the values) the regression equation obtained is Y=21.94 where X_1 i.e. pH and X_6 i.e. Phospahtes no significant impact on BOD (Y) as there value from the table indicated zero contributing towards no effect on the dependent variable

Table 3.8: Sensitive Analysis for various tested physiochemical Parameters of Vasant Kunj STP (Extended Aeration Technology)

Vasant Kunj Phase - I (Capacity:- 2.2 MLD)								
S.No.	Month/Year	BOD (Y)	pH (X1)	TSS (X2)	COD (X3)	Oil & Grease (X4)	Ammonical Nitrogen (X5)	Phosphates (X6)
1	Average Effluent in 2012	22	7.6	28.2	83.5	3.7	1	1.2
2	Average Effluent in 2013	25.8	7.8	27.7	94.8	3.1	1.2	0.5
3	Average Effluent in 2014	24.6	7.4	24.6	93.3	2.3	0.8	0.5
4	Average Effluent in 2015	18.5	7.9	23	49	2	5.9	1.1
5	Average Effluent in 2016	25	7.8	34	76	2.4	5.3	1.3
	Regression Equation =	Y = -5.44-0.15X2+0.33X3+0.64X4+1.69X5						
	Y=	21.943						

	Sensitivity Analysis				
When Varying Values of TSS (Row Input X2) & COD (Column Input X3)	21.943	5%	10%	15%	20%
	4%	-1.3763	-1.3838	-1.3913	-1.3988
	7%	-1.3664	-1.3739	-1.3814	-1.3889
	10%	-1.3565	-1.364	-1.3715	-1.379
	13%	-1.3466	-1.3541	-1.3616	-1.3691
When Varying Values of COD (Row Input X3) & Ammonical Nitrogen (Column Input X5)	21.943	5%	10%	15%	20%
	4%	-7.2179	-7.2014	-7.1849	-7.1684
	7%	-7.1672	-7.1507	-7.1342	-7.1177
	10%	-7.1165	-7.1	-7.0835	-7.067
	13%	-7.0658	-7.0493	-7.0328	-7.0163
When Varying Values of Ammonical Nitrogen (Row Input X5) & TSS(Column Input X2)	21.943	5%	10%	15%	20%
	4%	24.5615	24.646	24.7305	24.815
	7%	24.557	24.6415	24.726	24.8105
	10%	24.5525	24.637	24.7215	24.806
	13%	24.548	24.6325	24.717	24.8015
When Varying Values of TSS (Row Input X2) and Oil & Grease (Column Input X4)	21.943	5%	10%	15%	20%
	4%	23.8231	23.8156	23.8081	23.8006
	7%	23.8423	23.8348	23.8273	23.8198
	10%	*23.8615*	*23.854*	*23.8465*	*23.839*
	13%	23.8807	23.8732	23.8657	23.8582

From the regression Equation obtained in the multiple regression analysis the sensitive analysis is obtained by altering the percent contribution of X_2, X_3, X_4 and X_5 shown in the table 3.8. The heat map using three colour (Red, White & Blue) shows the lowest, middle and the highest value obtained for the respective regression equation. From the table it is clear that when we alter the percent of TSS (X_2) and COD (X_3) the highest value obtained for the regression equation Y=21.943 will change to -1.3466 when the TSS (X_2) and COD (X_3) percentage is 5% and 13% respectively. Similarly the lowest value obtained for the regression equation Y=21.943 will change to -1.3988 when the TSS (X_2) and COD (X_3) percentage is 20% and 4% respectively.

Again altering the percent of COD (X_3) and Ammonical Nitrogen (X_5) highest value obtained for the regression equation Y=21.943 is -7.0163 and lowest value is -7.2179 instead of 21.943. When we change the percent of Ammonical Nitrogen (X_5) and TSS (X_2) highest value obtained for Y is 24.815 and lowest is 24.548 instead of 21.943. Doing the alteration with the percent of TSS (X_2) and Oil & Grease (X_4) highest value obtained for Y is 23.8807 and lowest is 23.8006 instead of 21.943.

Table 3.9: Correlation Analysis between the various tested physiochemical Parameters for Okhla STP (Activated Sludge Process, ASP) Technology

Correlation Analysis

	BOD (Y)	pH (X1)	TSS (X2)	COD (X3)	Oil & Grease (X4)	Ammonical Nitrogen (X5)	Phosphates (X6)
BOD (Y)	1						
pH (X1)	0.541670392	1					
TSS (X2)	-0.386137973	-0.625338274	1				
COD (X3)	0.259694553	0.660705203	-0.47283	1			
Oil & Grease (X4)	0.24775336	-0.102654024	-0.29249	0.399879956	1		
Ammonical Nitrogen (X5)	-0.222266138	-0.344222276	0.343473	-0.902772946	-0.726044174	1	
Phosphates (X6)	0.680570608	0.353553391	0.019281	-0.225893645	-0.504955522	0.431842091	1

Table 3.10: Correlation Analysis results interpretation for various tested physiochemical Parameters Okhla STP (Activated Sludge Process, ASP) Technology

Result Interpretation

1. **Weak Negative Correlation** is being observed between the following paramters: TSS & BOD, COD &TSS, Oil & Grease with pH & TSS, Ammonical Nitrogen & BOD, Ammonical Nitrogen & pH, Phospahtes & COD
2. **Strong Negative Correlation** is being depicted between the following paramters: Ammonical Nitrogen & COD, Ammonical Nitrogen with Oil & Grease.
3. **Moderate Negative Correlation** is being depicted between Phosphate and Oil & Grease
4. **Weak Positive Correaltion** is being observed between the following paramters: COD & BOD, BOD and Oil & Grease, Oil & Grese and COD, Ammonical Nitrogen & TSS, Ammonical Nitrogen & Phospahtes, Phospahtes with TSS & pH
5. **Moderate Positive Correlation** is being observed between pH & BOD
6. **Strong Positive Correlation** being observed between the following paramters: COD & pH, Phosphates & BOD,

Table 3.11: Multiple Regression Analysis for various tested physiochemical Parameters of Okhla STP (Activated Sludge Process, ASP) Technology

	Regression Analysis							
SUMMARY OUTPUT								
Regression Statistics								
Multiple R	1							
R Square	1							
Adjusted R Square	65535							
Standard Error	0							
Observations	5							
ANOVA								
	df	*SS*	*MS*	*F*	*Significance F*			
Regression	6	5.728	0.954667	#NUM!	#NUM!			
Residual	0	0	65535					
Total	6	5.728						
	Coefficients	*Standard Error*	*t Stat*	*P-value*	*Lower 95%*	*Upper 95%*	*Lower 95.0%*	*Upper 95.0%*
Intercept	34.31256567	0	65535	#NUM!	34.31256567	34.31256567	34.31256567	34.31256567
pH (X1)	0	0	65535	#NUM!	0	0	0	0
TSS (X2)	-0.159107256	0	65535	#NUM!	-0.159107256	-0.159107256	-0.15910726	-0.159107256
COD (X3)	-0.16067868	0	65535	#NUM!	-0.16067868	-0.16067868	-0.16067868	-0.16067868
Oil & Grease (X4)	0	0	65535	#NUM!	0	0	0	0
Ammonical Nitrogen (X5)	-0.597091032	0	65535	#NUM!	-0.597091032	-0.597091032	-0.59709103	-0.597091032
Phosphates (X6)	5.981556372	0	65535	#NUM!	5.981556372	5.981556372	5.981556372	5.981556372
Regression Equation =	**Y = 34.31-0.15X2-0.16X3-0.59X5+5.98X6**							
when we put the value of X1, X2, X3, X4, X5 & X6 in the above Regression Equation the final Equation becomes i.e Y=	**Y=34.31-0.15X2-0.16X3-0.59X5+5.98X6 Y= 22.76**							

From table 3.11 it is observed that when we take BOD (Y) as a dependent variable and rest of the parameters as the independent variables (table 3.12 can be utilised to see the values) the regression equation obtained is Y=22.76 where X_1 i.e. pH and X_4 i.e. Oil & Grease have no significant impact on BOD (Y) as there value from the table indicated zero contributing towards no effect on the dependent variable.

Table 3.12: Sensitive Analysis for various tested physiochemical Parameters of Okhla STP (Activated Sludge Process, ASP) Technology

Okhla Phase - V (Capacity:- 16 MLD)								
S.No.	Month/Year	BOD (Y)	pH (X1)	TSS (X2)	COD (X3)	Oil & Grease (X4)	Ammonical Nitrogen (X5)	Phosphates (X6)
1	Average Effluent in 2012	22.5	7.4	24.6	71.5	2.9	1	0.7
2	Average Effluent in 2013	19.7	7.4	22.5	75	2.4	1.3	0.3
3	Average Effluent in 2014	22	7.8	23.3	80	1.6	1.9	0.9
4	Average	21.7	7.5	22	59	1.6	8.4	0.9
5	Average Effluent in 2016 & 2017	20.25	7.25	28.2	61.5	1.5	6.5	0.7
	Regression Equation =	Y = 34.31-0.15X2-0.16X3-0.59X5+5.98X6						
	Y=	22.776						

	Sensitivity Analysis				
When Varying Values of TSS (Row Input X2) & COD (Column Input X3)					
	22.776	5%	10%	15%	25%
	2%	37.895	37.888	37.880	37.865
	4%	37.892	37.885	37.877	37.862
	6%	37.889	37.881	37.874	37.859
	8%	37.886	37.878	37.871	37.856
When Varying Values of COD (Row Input X3) & Ammonical Nitrogen (Column Input X5)	22.776	2%	4%	6%	8%
	5%	34.7733	34.7701	34.7669	34.7637
	10%	34.7438	34.7406	34.7374	34.7342
	15%	34.7143	34.7111	34.7079	34.7047
	25%	34.6553	34.6521	34.6489	34.6457
When Varying Values of Phosphates (Row Input X6) & Ammonical Nitrogen (Column Input X5)	22.776	1%	3%	5%	7%
	0%	19.2398	19.3594	19.479	19.5986
	1%	19.2339	19.3535	19.4731	19.5927
	2%	19.228	19.3476	19.4672	19.5868
	3%	19.2221	19.3417	19.4613	19.5809
When Varying Values of TSS (Row Input X2) & Phosphates(Column Input X6)	22.776	5%	10%	15%	25%
	1%	22.3323	22.3248	22.3173	22.3023
	3%	22.4519	22.4444	22.4369	22.4219
	5%	22.5715	22.564	22.5565	22.5415
	7%	22.6911	22.6836	22.6761	22.6611

From the regression Equation obtained in the multiple regression analysis the sensitive analysis is obtained by altering the percent contribution of X_2, X_3, X_5 and X_6 shown in the table 3.11. The heat map using three colour (Green,Yellow, Red) shows the highest, middle and the lowest value obtained for the respective regression equation. From the table it is clear that when we alter the percent of TSS (X_2) and COD (X_3) the highest value obtained for the regression equation Y=22.776 will change to 37.895 when the TSS (X_2) and COD (X_3) percentage is 5% and 2% respectively. Similarly the lowest value obtained for thregression equation Y=22.776 will change to 37.856 when the TSS (X_2) and COD (X_3) percentage is 25% and 8% respectively.

Again altering the percent of COD (X_3) and Ammonical Nitrogen (X_5) highest value obtained for the regression equation Y=22.776is 34.7733 and lowest value is 34.6457 instead of 22.776.When we change the percent of Ammonical Nitrogen (X_5) and Phosphate (X_6) highest value obtained for Y is 19.5986 and lowest is 19.222 instead of 22.776. Doing the alteration with the percent of TSS (X_2) and Phosphates (X_6) highest value obtained for Y is 22.6911and lowest is 22.3023 instead of 22.776

4. CONCLUSION

The present study was carried on three waste water treatment technologies namely Densadeck, Extended Aeration. Correlation, Multiple Regression and Sensitive analysis was performed on the effluents of these technologies. As BOD is an potential pollution indicator parameter and also taken as an major parameter for assessment of performance hence the results obtained after regression analysis for each STP were subjected to sensitive analysis to see the impact of other evaluated parameters and their range influencing BOD. Correlation analysis also shows the association of one parameter with other. Among the regression equation (Y) obtained for all the three STP's least variation are observed in case of Densadeck/BIOFOR used in Dr. Sen Nursing home STP i.e. the values from sensitive analysis shows the range between 6.7503- 13.599 for the regression equation (Y) = 10.533. The Extended Aeration technology utilised in the Vasant Kunj STP shows the variation in terms of negative values for the regression equation (Y) = 21.943. The Activated Sludge technology (ASP) utilised in the Okhla STP shows the maximum deviation 37.895 i.e. values reached upto in terms of for the regression equation (Y) = 22.766 hence contributing towards least performance.

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