Study of Some Physicochemical Water Quality Parameters of Karola River, West Bengal - An Attempt to Estimate Pollution Status

Himangshu Shekhar Mandal[1], Amrita Das[2], Ashis Kumar Nanda[3]

[1]Sitalpur Mobarakpur High School, Malda, West Bengal, India

[2]Prasannadeb Women's College, Jalpaiguri, West Bengal, India

[3]University of North Bengal, Darjeeling, West Bengal, India

[1]hmandal10@gmail.com

[2]amritapdwc@yahoo.co.in

[3]asishnanda@hotmail.com

Abstract- **Levels of physicochemical parameters (pH, phosphate, chloride, TKN, turbidity, conductivity, alkalinity, total dissolved solids, chemical oxygen demand, biochemical oxygen demand, temperature, total hardness and total solid) were determined in the water samples collected from River Karola. The results of physicochemical analysis showed that phosphate and TKN were present in the water samples during dry season. Some of the physicochemical parameter values fall within WHO standard limits, some are not. Therefore, source protection is proposed for these bodies of water for the benefit of mankind because they were not safe for human consumption.**

Key Words- River Karola; Pollution Status; Physicochemical Parameters; Water quality

I. INTRODUCTION

The River Karola is mainly a rain fed river and a tributary of the River Teesta. It is originated at the Terrain slopes of the Teesta catchments area (Lat. about 25^0 N and Long.85^0 E) in Baikunthapur forest. The river flows almost parallel to the River Teesta for about 45 Km and meets to Teesta at Jalpaiguri town (Near Old Ferry Ghat).

After the great flood in 1968, a barrage is constructed at the confluence of the rivers so that the water of the River Karola can be drained to Teesta at downstream. This was necessary because in each rainy season the water from Teesta back flowed along the Karola and flooded the town areas. A small tributary River Dhardhara carries only rainwater of its small catchments area. It meets to Karola at Jalpaiguri old Dolona Pool (Near Jalpaiguri Hospital). The River Karola divides the Jalpaiguri town into two halves; so long it and its tributary Dhardhara collected the sewages from the town area and drained them to Teesta at downstream. The River Karola carries direct sewage from Cremation Ghat at Maskalai Bari, from District Hospital and from Dinbazar area.

II. EXPERIMENTAL

A. Materials:

All chemicals used in this study were of analytical grade. Deionised double distilled water was used for analysis and reagent preparation. Amber glass bottles with polypropylene cap were used for collection of water from each sample sites.

B. Methods:

Water samples were collected separately from each of three sampling stations of the river, spanning a period from February to June. Temperature, conductivity, pH, TDS and DO were measured at the collection sites by Water Analyzer Kit, ELICO, India. Calcium hardness indicator tablets (BDH) were used for the estimation of Ca-hardness. Spectrophotometric estimations were done using UV-160A SHIMADZU spectrophotometer. The samples were preserved and analyzed for other parameters in accordance with the Standard Methods [1] and [2].

C. Sampling Sites:

The three sample collection sites were: i) Maskalai Bari side (Sample site A, Upstream), ii) Sadar Girls School side (Sample site B, Midstream) and, iii) Min-Bhaban side (Sample site C, Downstream) of River Karola at Jalpaiguri town. The basis of selection of the sites was to assess the effect of different anthropogenic activities leading to deterioration and influencing the river water quality.

III. RESULT AND DISCUSSION

A. Temperature:

Temperature is a measure of how much heat present in the water. Cold water holds more oxygen than warm water. Wastes often raise water temperatures. This leads to lower oxygen levels and weakens many insects and fish. In the summer, the sun heats up sidewalks, parking lots and streets. Rain falls on these areas, warms up, and runs into the river. Factories and stations that generate electricity to cool their processes also use water. Warm water enters the river, raises the temperature of the downstream area and changes oxygen levels. These are forms of thermal pollution. Thermal pollution is one of the most serious ways humans affect rivers. Cutting down trees along the bank of a river or pond also raises water temperature. Trees help shade the river from the sun. When they are cut down, the sun shines directly on the water and warms it up. Cutting down trees also leads to erosion. When soil from the riverbank washes into the river the water becomes muddy (turbid). The darker, turbid water captures more heat from the sun than clear water does. Even murky green water with lots of algae will be warmer than clear water [3]. The area studied shows that the downstream water temperature is greater than the two other streams (Table 1).

Table 1 CONCENTRATION OF DIFFERENT WATER QUALITY PARAMETERS AT 3 SAMPLE SITES IN 5 MONTHS

SL.No.	Parameters	Sampling	February	March	April	May	June	Min.	Max.
		A-E	21.5	24.5	27	26.5	31		
1.	Water Temp.	A-M	21.5	24.5	27	26.5	31		
	in ^{o} C	A-W	21.5	24.5	27	26.5	31		
		B-E	21.5	24.5	27	27	31	21.5	31.5
		B-M	21.5	24.5	27	27	31		
		B-W	21.5	24.5	27	27	31		
		C-E	24	26	27.5	27	31.5		
		C-M	24	26	27.5	27	31.5		
		C-W	24	26	27.5	27	31.5		
		A-E	7.485	7.1	8.235	7.291	7.87		
2	pH	A-M	7.535	7.13	8.285	7.364	7.79		
		A-W	7.469	7.11	8.338	7.379	7.84		
		B-E	7.24	6.94	7.733	7.056	7.89	6.9	8.338
		B-M	7.127	6.93	7.782	6.995	7.86		
		B-W	7.14	6.9	7.806	7.018	7.87		
		C-E	7.855	6.94	8.212	7.031	7.91		
		C-M	7.485	6.95	7.982	7.081	7.92		
		C-W	7.465	6.9	7.911	7.022	7.86		
3	Conductivity	A-E	82.8	85.64	75.98	80.77	59.59		
	in umho/cm	A-M	83.29	79.21	76.05	80.46	59.86		
		A-W	85.33	76.75	75.91	80.1	61.99		
		B-E	99.01	89.24	97.21	104.8	83.17		
		B-M	90.86	90.2	85.34	88.95	69.43	59.59	99.01
		B-W	92.14	87.21	85.11	92.06	70.25		
		C-E	92.36	86.03	84.87	92.9	69.93		
		C-M	90.65	88.84	85.57	92.14	68.7		
		C-W	92.36	85.37	85.05	92.78	66.83		
4	TDS in mg/l	A-E	39.78	42.7	39.29	41.18	31.84		
		A-M	40.57	39.41	39.46	41	32.03		
		A-W	41.94	38.3	39.38	40.85	33.17		
		B-E	48.52	44.53	50.56	53.46	44.49	31.84	53.46
		B-M	44.57	44.99	44.35	45.39	37.16		
		B-W	45.17	44.18	44.25	46.96	37.58		
		C-E	45.21	42.93	44.08	47.37	37.41		
		C-M	44.45	44.23	44.45	47	36.77		
		C-W	45.22	42.81	44.17	47.32	35.77		
5	TSS in mg/l	A-E	6	14	44	26	72		
		A-M	72	3	14	32	81		
		A-W	5	6	42	27	16		
		B-E	10	9	73	37	120	3	174
		B-M	101	43	16	49	60		
		B-W	43	10	40	53	150		
		C-E	3	11	174	33	83		

SL.No.	Parameters	Sampling	February	March	April	May	June	Min.	Max.
		C-M	4	10	8	25	80		
		C-W	10	7	42	20	64		
6	Chloride in	A-E	1.161	1.355	1.548	1.548	0.58		
	mg/l	A-M	1.161	1.355	1.548	1.548	0.58		
		A-W	1.161	1.355	1.548	1.548	0.58		
		B-E	1.548	1.548	1.936	1.548	1.355	0.58	1.936
		B-M	1.548	1.548	1.936	1.548	1.355		
		B-W	1.548	1.548	1.936	1.548	1.355		
		C-E	1.548	1.936	1.548	1.936	1.742		
		C-M	1.548	1.936	1.548	1.936	1.742		
		C-W	1.548	1.936	1.548	1.936	1.742		
7	Alkalinity at	A-E	34.66	98.7	40.83	35.34	23.35		
	pH 4.25 in	A-M	34.07	70.5	40.77	32.33	24.53		
	mg/l of	A-W	33.95	65.8	40.65	34.31	23.17		
	$CaCO_3$	B-E	38.3	61.68	46.11	32.38	25.14		
		B-M	34.83	56.4	39.06	32.43	23.31	23.17	98.7
		B-W	35.54	55.22	38.3	34.12	25.09		
		C-E	35.72	54.05	43.76	35.39	25		
		C-M	34.07	51.81	39.24	35.15	24.72		
		C-W	37.42	52.87	39.01	34.59	23.87		
8	Ca-Hardness	A-E	17	17	18	16	11.5		
	in mg/l	A-M	17	20	16	17	12.5		
		A-W	21	17	18	16	11		
		B-E	18	17	17	19	14	11	21
		B-M	19	18.5	19	18	14		
		B-W	19	17.5	17	18	12.5		
		C-E	19	18	19	18	14		
		C-M	20	18	17	17	12.5		
		C-W	20	18	17	18	14		
9	Mg-Hardness	A-E	11	20	8	16	8.5		
	in mg/l	A-M	21	10	9	12	6.5		
		A-W	7	11.5	10	12	9		
		B-E	14	13.5	15	20	10	6.5	21
		B-M	11	12.5	17	19	8		
		B-W	15	15.5	15	12	10.5		
		C-E	11	18	13	15	9		
		C-M	10	13	13	13	15		
		C-W	11	17	17	13	9		
10	Total	A-E	28	37	26	32	20		
	Hardness	A-M	38	30	25	29	19		
	in mg/l	A-W	28	28.5	28	28	20		
		B-E	32	30.5	32	39	24	19	39
		B-M	30	31	36	37	22		

SL.No.	Parameters	Sampling	February	March	April	May	June	Min.	Max.
		B-W	34	32	32	30	23		
		C-E	30	36	32	33	23		
		C-M	30	31	30	30	27.5		
		C-W	31	30	34	31	23		
11	DO in mg/l	A-E	5.6	7	8.9	2.2	7.1		
		A-M	8.5	6.2	9	6.7	6.4		
		A-W	10.9	6.1	8.5	6.3	5.4		
		B-E	8.3	4.5	4.9	6.4	4	2.2	10.9
		B-M	6.6	4.8	7.3	3.1	3.7		
		B-W	8.3	4.5	6.8	5.9	3.5		
		C-E	8.2	4.8	8.6	5.5	3.7		
		C-M	7.9	3.9	7.9	5.8	3.7		
		C-W	7.8	4.5	8.6	5.8	3.9		
12	BOD in mg/l	A-E	1.4	0.6	1.3	1.2	1.3		
	at 26^o C	A-M	1.8	0.3	1.2	1.5	1.1		
		A-W	3.1	1.4	0.6	4.8	0.4		
		B-E	1.4	0.6	3.1	1.8	1	0.3	4.8
		B-M	1.9	1.1	0.4	0.6	1.2		
		B-W	1.4	1.6	1.4	4.3	0.8		
		C-E	2.2	1.7	2.1	0.5	1.5		
		C-M	3.1	1.9	2.2	0.3	0.7		
		C-W	2.2	1.4	1.7	1.2	0.6		
13	COD in mg/l	A-E	12.8	38.2	9.6	8	7.9		
		A-M	16.5	38.2	13.7	4	21.6		
		A-W	12.8	38.2	11.7	4	7.9		
		B-E	18.5	21.7	17.8	4	8	4	38.2
		B-M	16.5	21.7	9.6	4	7.9		
		B-W	17.6	38.2	30.1	12	20.9		
		C-E	16.9	30	17.8	4	11.4		
		C-M	16.5	29.9	15.8	4	14.8		
		C-W	32.9	30	12	4	11.4		
14	TKN in mg/l	A-E	2.279	1.853	1.461	1.026	0.748		
	as Ammonia	A-M	2.7316	2.035	1.878	1.1832	1.13		
	'N'	A-W	2.818	1.286	2.348	1.479	0.695		
		B-E	5.358	2.087	1.132	1.6	1.409		
		B-M	4.297	3.2	1.582	0.869	1.061	0.399	5.358
		B-W	2.069	2.801	0.922	0.851	0.399		
		C-E	2.157	2.905	1.844	0.626	0.608		
		C-M	2.192	1.548	1.339	1.13	0.452		
		C-W	1.48	1.635	0.939	0.991	1.792		
15	TPP in mg/l	A-E	505.07	626.88	811.08	736.86	1093.32		
	as phosphate	A-M	1509.26	546.46	882.38	766.51	1023.25		
	'P'	A-W	1987.59	519.92	620.93	1054.7	1099.27		

SL.No.	Parameters	Sampling	February	March	April	May	June	Min.	Max.
		B-E	2198.54	736.8	956.66	1045.79	1203.25	415.94	2234.19
		B-M	1521.15	748.69	932.89	814.05	1224.05		
		B-W	415.94	457.53	864.56	891.3	811.08		
		C-E	561.51	698.18	1342.89	686.3	698.18		
		C-M	796.22	573.4	713.04	787.315	1022.02		
		C-W	2234.19	588.25	1013.11	710.06	1331		
16	Turbidity	A-E	0.7	1.1	2.1	1.7	3.6		
	in NTU	A-M	1.1	1.1	1.9	2	3.1		
		A-W	1.2	0.5	1.6	2	3.5		
		B-E	0.2	0.3	0.6	0.8	2.6	0.2	7.7
		B-M	1.1	0.4	0.7	2.1	2.6		
		B-W	1.2	0.6	0.9	1.4	3.6		
		C-E	0.8	0.6	1.8	1.2	7.7		
		C-M	1.1	0.5	1.3	1.4	2.9		
		C-W	0.5	0.8	1.8	1.1	3.2		

Sample Site ‘A’ = River bridge at Maskalaibari – Up stream

Sample Site ‘B’ = Old Dolana Pool behind Jalpaiguri Police Station

Sample Site ‘C’ = River at Min-Bhaban – Down stream

Maskalaibari side of the river bank at location ‘A’, Sadar Girls School side of the river bank at location ‘B’ and the Min-Bhaban side at location ‘C’ are designated as ‘E’, the vertically opposite bank in each site is marked as ‘W’ and the mark ‘M’ is always the middle stream of ‘E’ and ‘W’.

B. pH:

pH is a measurement of the acidity or basic quality of water. At extremely high or low pH levels (for example 9.6 or 4.5), the water becomes unsuitable for most organisms. Young fish and insects are also very sensitive to changes in pH. Most aquatic organisms adapt to a specific pH level and may die if the pH of the water changes even slightly. pH can vary from its normal levels (6.5 to 8.2) due to pollution from automobiles and coal-burning power plants. Many lakes in eastern Canada, the north-eastern US, and northern Europe are becoming acidic because they are downwind of polluting industrial plants. Drainage from mines can seep into streams and ground water and make the water more acidic as well [3].The present study shows the normal range of pH (Table 1).

C. Conductivity of water:

Conductivity is a measure of the ability of water to pass an electrical current. Conductivity in water is affected by the presence of inorganic dissolved solids such as chloride, nitrate, sulphate, and phosphate anions (ions that carry a negative charge) or sodium, magnesium, calcium, iron, and aluminium cations (ions that carry a positive charge). Organic compounds like oil, phenol, alcohol, and sugar do not conduct electrical current very well and therefore have a low conductivity when in water. Conductivity is also affected by temperature: the warmer the water, the higher the conductivity. A failing sewage system would raise the conductivity because of the presence of chloride, phosphate, and nitrate; an oil spill would lower the conductivity. The conductivity of rivers in the United States generally ranges from 50 to 1500 µmhos/cm. Studies of inland fresh waters indicate that streams supporting good mixed fisheries have a range between 150 and 500 µhos/cm. Conductivity outside this range could indicate that the water is not suitable for certain species of fish or macro-invertebrates. Industrial waters can range as high as 10000µmhos/cm [4]. Range of conductivity preferred for irrigation water should be less than 250µmho/cm [5]. The conductivity for present case the average ranges from 59.59 to 99.01 mg/l. The conductivity of site B is higher than the other two. This is due to the pollution of dhobighat and the main city nearer to this site.

D. Total Dissolved Solids:

Total dissolved solids (TDS) are a measure of dissolved matter (salts, organic matter, minerals, etc.) in water. Inorganic constituents comprise most of the total concentration of TDS. TDS can be naturally presented in water or the result of mining, oil and gas drilling or some industrial or municipal TDS can be toxic to aquatic life through increases in salinity or changes in the composition of the water, or it may include substances that are toxic to people or aquatic life. Most aquatic ecosystems involving mixed fish fauna can tolerate TDS levels of 1000 mg/l. [6]. The present study shows that the average value of TDS varies from 31.84 to 53.46 and highest value is carried out by the Site B.

E. Total Suspended Solids:

Total suspended solid content of water depends on the amount of suspended particle, soil, silt and is directly related to turbidity of water. Disposal of sewage and industrial effluents contributes suspended matter to river. The Indian Standard Institution has specified a maximum limit of 30 mg/l for suspended solid. References [7] and [8] observed high suspended solids at waste discharge point of Haraz river, Iran. Low level of suspended solids was reflecting good health of Kosi River at Uttrakhand. The present study shows that the average value of TSS varies from 3 to 174 mg/l and highest in sample Site C that is in downstream.

F. Chloride:

In irrigation waters, chloride is the most troublesome anion. Chloride is toxic to plants and is undesirable to steel boilers due to acceleration of corrosion by other factors [2]. Chlorides have constituted the utmost of anions of natural waters which may come as pollution across sanitary and industrial waters. Concentration of chlorides in the natural waters is variable. The minimum value of chloride is 0.58 mg/l and maximum 1.936 mg/l in our study area.

G. Alkalinity:

Alkalinity is an important parameter used in corrosion control and helps in evaluating the buffering capacity of wastewaters. Alkalinity at pH 4.25 in mg/l of $CaCO_3$ is 23.17 (minimum) and maximum 98.7. This is within WHO's permissible limit.

H. Hardness:

Calcium and magnesium ions are the major contributors to scale formation in water supplies. Water having hardness value more than 300mg/l is undesirable for dying and textile industries and also for high temperature boilers [2]. Water with a total hardness in the range of 0 to 60 mg/L is termed soft, from 60 to 120 mg/L moderately hard, from 120 to 180 mg/L hard, and above 180 mg/L very hard. Based on this, the water samples in this study can be classified as soft water as the total hardness limit is 19 – 39 mg/l.

I. Dissolved Oxygen:

Dissolved oxygen in water is essential for aquatic life. Deficiency of dissolved oxygen gives bad odour to water due to anaerobic decomposition of organic waster [2]. DO in our study ranges from 2.2 to 10.9 mg/l.

J. Biological Oxygen Demand:

BOD test is found to be more sensitive test for organic pollution. According to the Royal Commission of sewage disposal water having BOD more than 5 mg/l is unsafe for domestic use [9]. The BOD limits from 0.3 - 4.8 mg/l which is just at the borderline of the prescribed limit.

K. Chemical Oxygen Demand:

The estimation of COD is of great importance for water having unfavourable conditions for the growth of microorganisms, such as presence of toxic chemicals. The WHO'S tolerable limit is 10 mg/l. According to this our study sample is unsafe for use because minimum COD is 4 mg/l and maximum 38.2 mg/l.

L. Total Kjeldal Nitrogen:

The main sources of nitrogen compounds in water are fertilizers that mainly contain nitrate, but also ammonia, ammonium, urea and amines. The most widely applied nitrogen fertilizers are probably $NaNO_3$ (sodium nitrate) and NH_4NO_3 (ammonium nitrate). Organic fertilizers mainly contain nitrogen as proteins, urea or amines. When nitrogen fertilizers are applied outside the growing season, this is completely useless and negatively affects the environment. The fertilizers cannot be taken up or immobilized, causing them to end up in groundwater and drinking water [10]. TKN in mg/l as ammonia 'N' 0.399 - 5.358 in our study.

M. Total Phosphate Phosphorus:

Phosphate contamination comes from disposal of detergent contaminated sewage and directs cloths in water and also use of fertilizer, pesticides. Phosphate was present in high amount in our collected samples. Phosphate ranged from 415.94–2234.19 $mg L^{-1}$ (WHO's permissible limit is 45mg/L).The average concentrations of phosphate due to water runoff through the applications of fertilizer and pesticides by the host communities since majority of people are predominantly farmer. The main crop in this area is rice and jute. The bhadoi rice is harvested in August and September. The jute is mainly harvested in March [11]. So phosphate content in water is also high in dry season.

N. Turbidity:

The magnificent parameter of river pollution is turbidity, as is well established by many studies already. The present study shows the turbidity in the range of 0.2 – 7.7 NTU. World Health Organization prescribed the highest desirable limit 5.0 NTU and maximum permissible limit 25.0 NTU. In most stations the value of turbidity present is within the desirable limit. It reveals that the river pollution is well within the safe level.

IV. CONCLUSION

This work has presented the levels of physicochemical parameters in water samples collected from River Karola. The results revealed that there was an indication of some physicochemical pollution in the bodies of water although some values of these parameters are within acceptable range. The study further revealed that the water is not safe for drinking but almost good for aquatic life and also for irrigation purpose in some extend. Usually phosphates and nitrogen are not present in the water samples during dry season, present in the wet season but in our study area phosphate and Total Kjeldal Nitrogen content in water is high in dry season also. Thus this work will serve as baseline information for future work.

REFERENCES

[1] *APHA, Standard methods for examination of water and waste water.* 17th ed. APHA,Washington D. C. 1197 PP. (1989).

[2] N. Manivasakam, *Physico-chemical examination of water, sewage and industrial effluents*. Pragati Prakashan, Meerut. India. (1980).

[3] Earth Force, Water Quality Parameters, [Online]. Available at http://www.eeweek.org/assets/files/water.

[4] United States Environmental Protection agency [EPA] -*Water: Monitoring & Assessment*.

[5] H.H. Willard, L.L. Merritt and J.A. Dean: *Instrumental method of analysis*. 3rd edition, Van No Strand, New York, 91958.

[6] Boyd, E. Claude (1999). *Water Quality: An Introduction*. The Netherlands: Kluwer Academic Publishers Group. ISBN 0-7923-7853-9.

[7] Bhaskar Bhadra, *Journal of Environmental Biology*, 26(2), 277-286 (2005).

[8] A.A. Keramat, (2008). Environmental Impact on Nutrient Discharged by Aquaculture waste water at on the Haraz river. *J.of Fish. and Aquat. Sci.*, 3(5): 275-279.

[9] Her Majesty's Stationary Office: *Analysis of raw, portable and waste waters*. DOE, London (1972).

[10] Available Online at: http://www.lenntech.com/periodic/water/nitrogen/nitrogen-and-water.htm.

[11] J.F. Grunning, *Eastern Bengal and Assam District Gazetteers.*

Himangshu Shekhar Mandal was born in 14th Nov. 1977 at Malda district in West Bengal, India. He has passed Secondary education in 1993 from Kushida High School, Malda, West Bengal, India, and passed Higher Secondary education in 1995 from Malda Zila School, West Bengal, India. Also he has completed Graduation with Honours in Chemistry in 1998 from Malda College, West Bengal, India, and has completed Post Graduation in Inorganic Chemistry in 2000 from University of North Bengal, India.

He worked as a project fellow at University of North Bengal from 2001 to 2003. Here is some publication of him:

1. Monitoring Water quality and pollution status of Kaljani River at Alipurduar Municipality in Jalpaiguri District,West Bengal, India. Advances in Applied Science Research, 2011, 2 (5):158-166.

2. Assessment of seasonal variation in physico-chemical characteristics and quality of Torsha River water for irrigation used in Cooch Behar and Jalpaiguri districts of West Bengal, India. J. Chem. Pharm. Res., 2011, 3(6):265-270.

Amrita Das was born in 8th Aug. 1976 at Jalpaiguri, West Bengal, India. She has passed Secondary and Higher Secondary education from Sunity Academy, Cooch Behar, West Bengal, India in 1993 and 1995 respectively. Aslo she has completed Graduation with Honours in Chemistry in 1998 from A.B.N. Seal College, Cooch Behar, West Bengal, India, and Post Graduation in Inorganic Chemistry in 2000 from University of North Bengal, India.

She worked as a research scholar at Indian Institute of Technology, Guwahati from 2001 to 2003. Here is some publication of her:

1. Rationalizing the effect of amino acid side chain, pyridine and imidazole on the assembly and reversible disassembly of a octanuclear Cu(2) complex. Crystal growth and design, 2007, 7(9): 1818-1824.

2. Monitoring Water quality and pollution status of Kaljani River at Alipurduar Municipality in Jalpaiguri District,West Bengal, India. Advances in Applied Science Research, 2011, 2 (5):158-166.

3. Assessment of seasonal variation in physico-chemical characteristics and quality of Torsha River water for irrigation used in Cooch Behar and Jalpaiguri districts of West Bengal, India. J. Chem. Pharm. Res., 2011, 3(6):265-270.