Chapter III

Results

Physico-chemical & Derived Factors
Results: a) Physico-Chemical and b) Derived factors.

a) Physico-Chemical factors.

1. Air temperature

In river Aghanashini air temperature ranged from 21.5 to 31.5°C with an average value of 26.83 ± 2.4°C and in river Kali it ranged from 22.75 to 32.75°C with an average value of 27.97 ± 2.38°C (Table 1).

Among the sampling spots of river Aghanashini, on an average, lowest air temperature was observed in Sarkuli spot (23.08 ± 2.15°C) and highest air temperature was observed in Bangane spot (29.79 ± 3.02°C, Table 2A). Among the sampling spots of river Kali, the lowest average air temperature was observed in Supa spot (27.21 ± 2.43°C, Table 2B) and highest average air temperature was observed in Bommanalli spot (29.33 ±2.43°C, Table 2B).

Monthly air temperature in different spots and in two rivers is given in Table 3. Figure 2 provides the monthly air temperature in different spots.

Among the sampling spots of river Aghanashini, minimum air temperature, 17°C, was observed at Maanimane during February '98 and maximum temperature, 35°C, was observed during April '96 in Bangane and Badaalghat spots (Table 3, Fig. 2). Among the sampling spots of river Kali, minimum air temperature, 19°C, was observed in Kadra spot during January '97 and maximum air temperature, 35°C, was observed in the same spot during May '96 and in Kodsalli spot during April and May '96 (Table 3, Fig 2).

Seasonal average maximum air temperature was observed during summer season in both the rivers and it reached minimum during winter season (Table 4). Among the sampling spots in both the rivers also, similar trend was observed (Table 5 A&B, Fig 3).
Comparison of the mean values of air temperature in two rivers showed no significant difference (Table 6). Comparison of variations in the monthly values of air temperature among the sampling spots in river Aghanashini showed significant difference ($F_{0.01 \ (3, \ 92)} =28.84$), but it showed no significant difference in river Kali (Table 7). Seasonal variation of air temperature among the sampling spots in river Aghanashini showed significant difference in all seasons, but in case of river Kali, such variations showed significant difference during winter season only ($F_{0.01 \ (3, \ 20)} =5.91$, Table 8). Comparison of seasonal variation of air temperature in a spot showed significant difference in all the sampling spots of river Aghanashini (Table 9), similarly, significant difference was observed in Kadra, Kodsalli and Bommanalli spots of river Kali (Table 9). But seasonal variation of air temperature showed no significant difference in Supa spot (Table 9).

2. Water temperature

Water temperature ranged from 22.5 to 29 °C in river Aghanashini and in river Kali it ranged from 22.25 to 29.25°C (Table 1). Mean water temperature was 25.20 ± 3.57 °C and 26.06 ± 3.5°C in river Aghanashini and Kali respectively (Table 1).

In both the rivers, on an average, water temperature was slightly less than the air temperature. However in Sarkuli spot of river Aghanashini, water temperature was slightly higher than the air temperature during April, May, June, October, December '97 and in February '98 (cf. Table 3 & 10). Among the sampling spots of river Kali also water temperature was more than the air temperature in Supa and Bommanalli spots during April '96, in Kadra and Kodsalli spots during June and October '97 and also in January '98 (cf. Table 3 & 10).
Average water temperature in different sampling spots varied. Among the sampling spots of river Aghanashini, the lowest mean water temperature was observed in Sarkuli spot (23.21 ± 1.93 °C) and highest was observed in Bangane spot (26.83 ± 2.26 °C, Table 2A).

Among the sampling spots of river Aghanashini, minimum water temperature, 20°C, was observed during January '97 in Sarkuli spot, and maximum water temperature, 32°C, was observed during June '97 in Bangane spot (Table 10, Fig. 4).

Among the sampling spots of river Kali also the mean water temperature varied. Lowest mean value 24.38 ± 1.41°C was observed in Supa spot and maximum mean value, 26.96 ± 1.81°C, was observed in Bommanalli spot (Table 2B). Minimum water temperature observed was 20°C during February '97 in Kadra spot and maximum water temperature observed was 30°C during May '97 in Bommanalli spot of river Kali (Table 10, Fig. 4).

In both the rivers water temperature reached maximum during summer season and minimum during winter season (Table 4). Among the sampling spots of river Aghanashini, minimum seasonal average water temperature, 21.5°C, was observed during winter season in Sarkuli spot and maximum seasonal average water temperature, 29.33 °C, was observed during summer season in Bangane spot (Table 5A, Fig.3B). Among the sampling spots of river Kali, minimum seasonal average water temperature, 23.5°C, was observed during winter season in Supa spot and maximum seasonal average water temperature, 28.67 °C, was observed during summer season in Kodsalli spot (Table 5A, Fig 3 B).
Seasonal average maximum and minimum water temperature closely followed the maximum and minimum air temperature (Table 5 A & B, Fig. 3).

Comparison of variation in the monthly values of water temperature among the sampling spots showed significant difference in river Aghanashini ($F_{0.01 (3.92)} = 16.13$) and also in river Kali ($F_{0.01 (3.92)} = 7.42$, Table 7). Seasonal variation of water temperature among the sampling spots showed significant difference in both the rivers (Table 8). Comparison of variation of water temperature among the seasons in a sampling spot showed significant difference in all the spots of river Aghanashini and river Kali (Table 9).

Water temperature showed positive correlation with air temperature in all the spots of river Aghanashini and in Kadra, Kodsalli and Bommanallli spots of river Kali (Table 11).

3. Electrical Conductivity (EC)

Electrical conductivity values ranged from 0.07 to 0.27 mhos with the mean value of 0.1 ± 0.04 mhos in river Aghanashini (Table 1). In river Kali it ranged from 0.12 to 0.29 mhos with the mean value of 0.17 ± 0.04 mhos (Table 1). Among the sampling spots of river Aghanashini, the average EC value ranged from 0.08 ± 0.02 in Badaalghat to 0.14 ± 0.14 mhos in Sarkuli spot (Table 2A). In the sampling spots of river Kali, minimum average EC value, 0.08 ± 0.01 m mhos, was observed in Supa spot and maximum average EC value, 0.25 ± 0.0, m mhos was observed in Bommanalli (Table 2B).

Among the spots of river Aghanashini, lowest EC value, 0.05 m mhos, was observed in Badaalghat during April '97 and maximum EC value 0.21 m mhos, was observed during April '96 in Bangane spot (Table 12, Fig. 5). In the sampling spots of river Kali, lowest EC
value, 0.05 m mhos, was observed in Supa spot during September '96 and maximum value, 0.44 m mhos, was observed during January '98 in Bommanalli spot (Table 12, Fig. 5).

It was observed that EC values were low in all the sampling spots of river Aghanashini (Table 2A ) and also in Supa spot of river Kali (Table 2B ).

In river Aghanashini average maximum seasonal EC value was observed during summer season (0.13 m mhos) and it was minimum during post-monsoon season (0.08 m mhos, Table 4). In river Kali, it was high during winter season (0.19 m mhos) and in the remaining seasons it was low (0.17 m mhos, Table 4).

Among the sampling spots of river Aghanashini maximum seasonal average EC was observed in Sarkuli spot during summer season (0.24 m mhos) and minimum seasonal average value was observed in Bangane spot during post-monsoon season (0.07 m mhos, Table 5A, Fig. 6). In the sampling spots of river Kali, maximum seasonal average value of EC was observed during winter season in Bommanalli (0.29, m mhos) and minimum seasonal average EC value was observed during monsoon and post-monsoon seasons in Supa spot (0.07 m mhos Table 5B, Fig. 6).

Comparison of variations in the mean value of EC between river Aghanashini and river Kali showed significant difference ($t_{0.01 (46)} = 2.69$, Table 6). Comparison of variation of monthly values of EC among the sampling spots also showed significant difference in river Aghanashini ($F_{0.05 (3,92)} = 3.42$) and also in river Kali ($F_{0.01(3,92)} = 17.84$, Table 7). Variation of EC value in a season in the sampling spots was found to differ significantly during monsoon season ($F_{0.01 (3,28)} = 7.03$) and also during post-monsoon season ($F_{0.01 (3,12)} = 8.23$) in river Aghanashini (Table 8). In river Kali, it showed significant difference
during summer season \( (F_{0.01} (3,20) = 14.10) \), post-monsoon season \( (F_{0.01} (3,22) = 20.28) \) and winter season \( (F_{0.01} (3,20) = 12.25, \) Table 8). Comparison of seasonal variation of EC in a sampling spot showed no significant difference in all the sampling spots in both the rivers (Table 9).

4. Turbidity

Wide variations were observed in the turbidity values in both the rivers and in all the sampling spots. It ranged from 1 to 212.5 NTU in river Aghanashini and in river Kali it ranged form 1.5 to 28.75 NTU (Table 1). The average turbidity value was 21.06 ± 52.92 NTU and 6.04 ± 6.64 NTU in river Aghanashini and Kali respectively (Table 1).

On an average, it was observed that Kali river is less turbid than river Aghanashini.

Among the sampling spots of river Aghanashini, lowest average value was observed in Maanimane spot (18.88 ± 42.04 NTU) and highest turbidity value was observed in Sarkuli spot (24.67 ± 75.09 NTU, Table 2A). Maximum turbidity value 360 NTU, was observed during July '97 in Sarkuli spot of river Aghanashini (Table 13, Fig.7 ). Among the sampling spots of river Kali, lowest average turbidity value 4.46 ± 4.12 NTU was observed in Bommanalli spot and highest average turbidity was observed in Kodsalli spot (9.13 ± 14.47 NTU. Table 5 B ). Maximum turbidity value 66.0 NTU, was observed in Kodsalli spot during July '97 (Table 13, Fig.7).

Lowest seasonal average turbidity value, 1.13 NTU, was observed during summer season and highest seasonal average turbidity value, 51.72 NTU, was observed in monsoon season in river Aghanashini (Table 4). In river Kali, seasonal average turbidity was minimum during summer season (2.13 NTU) and it was maximum during monsoon season (11.91 NTU, Table 4).
Among the sampling spots of river Aghanashini and Kali lowest average seasonal turbidity value was observed during summer season and maximum seasonal average turbidity was observed during monsoon season (Table 5A & B, Fig.8).

Comparison of variation of turbidity among the seasons in a sampling spot showed significant difference in Kadra spot ($F_{0.05 \ (3,20)} = 4.89$), Kodsalli spot ($F_{0.05 \ (3,20)} = 3.39$) and in Supa spot ($F_{0.05 \ (3,20)} = 3.70$) of river Kali (Table 9).

5. Total Solids (TS)

Total solids ranged from 0.01 to 2.68 gm/L in river Aghanashini and in river Kali it ranged from 0.04 to 5.17 gm/L (Table 1). The average value was $0.32 \pm 0.54$ gm/L in river Aghanashini and $0.50 \pm 1.03$ gm/L in river Kali (Table 1).

Among the sampling spots of river Aghanashini, the lowest average TS value $0.16 \pm 0.11$ gm/L, was observed in Maanimane and highest average value, $0.55 \pm 2.08$ gm/L, was observed in Bangane (Table 2A). In the sampling spots of river Kali, lowest average value, $0.17 \pm 0.12$ gm/L, was observed in Kodsalli and highest TS value, $0.44 \pm 0.78$ gm/L, was observed in Supa spot (Table 2B).

In river Aghanashini minimum TS value, 0.002 gm/L, was observed in Bangane spot during March '96 and in Maanimane spot during April '97. Maximum TS value 10.20 mg/L was observed during Dec '97 in Bangane spot (Table 14, Fig.9). In river Kali, lowest TS value, 0.006 gm/L, was observed in Kodsalli spot during March '97 and highest value 20.19 gm/L was observed in Bommanalli spot during Feb 98 (Table 14, Fig. 9).

The seasonal average TS value was lowest during summer season (0.06 gm/L) and highest during winter season (0.06 gm/L) in river
Aghanashini (Table 4). In river Kali also lowest seasonal average TS value was during summer season (0.08 gm/L) and high during winter season (9.07 gm/L, Table 4). The seasonal average TS value varied in the sampling spots in both rivers (Table 5 A& B, Fig.10).

It can be observed from the Tables 5 A & B that seasonal average TS values were minimum during summer season in all the sampling spots in both the rivers. But maximum seasonal average TS values varied. It was maximum during winter season in Bangane spot (1.08 gm/L), in Badaalghat it reached maximum during post-monsoon season (1.08 gm/L), in Maanimane spot it reached maximum during winter season (0.23 gm/L) and in Sarkuli spot it was highest in winter season (0.29 gm/L, Table 5 A& B, Fig.10). Among the sampling spots of river Kali, it was high during post-monsoon and winter seasons (0.26 gm/L) in Kadra. In Kodsalli, it was highest during monsoon season (0.26 gm/L). In Bommanalli it was maximum during winter season (3.49 gm/L) and in Supa spot it was maximum during post-monsoon season (1.16 gm/L, Table 5 A & B, Fig.10).

Comparison of the variation of the mean TS values between the river Aghanashini and Kali showed no significant difference (Table 6). Comparison of variations of TS among seasons showed significant difference in Maanimane spot ($F_{0.05 (3, 20)}$ =4.86, Table 7) of river Aghanashini and in Kodsalli spot ($F_{0.01 (3, 20)}$ =6.26) of river Kali (Table 7).

TS showed positive correlation with turbidity in Maanimane spot ($r=0.52$) and in Sarkuli spot ($r=0.77$, Table 11) of river Aghanashini.

6. pH

Mean pH value was 7.21 ± 0.36 and 7.43 ± 0.34 for river Aghanashini and Kali respectively (Table 1). pH was varying from acidic to
alkaline in different months and seasons in different sampling spots in both the rivers. Even then average pH value was alkaline in both the rivers (Table 1).

Average pH value in the sampling spots of river Aghanashini ranged from 7.0 ± 0.35 in Sarkuli to 7.32 ± 0.43 in Bangane spot (Table 2 A). Average pH value increased from head water spot Sarkuli to down stream spot Bangane (Table 2 A). In the sampling spots of river Kali the average pH value was alkaline (Table 2 B). It ranged from 7.04 ± 0.36 in Supa spot to 7.72 ± 0.50 in Bommanalli spot (Table 2 B).

Among the sampling spots of river Aghanashini, minimum pH value (6.07) was observed during January '96 in Maanimane and maximum (8.25) was observed during June '96 in Bangane (Table 15, Fig.11). In river Kali, lowest pH value (6.47) was observed in Bommanalli spot during July '97 and maximum value (8.79) was observed in Bommanalli spot during May '97 (Table 15, Fig.11).

Seasonal average pH value in river Aghanashini ranged from 7.06 during post-monsoon season to 7.28 in winter season (Table 4). In river Kali, seasonal average minimum pH was observed during monsoon and winter season (7.30) and it was maximum during post-monsoon season (7.70, Table 4).

Water was acidic during monsoon season with average pH value of 6.96 and in post-monsoon season with pH value of 6.74 in Sarkuli spot (Table 5 A, Fig.12). Maximum seasonal average pH value 7.48 was observed during summer season in Bangane spot of river Aghanashini (Table 5A, Fig.12). In river Kali, lowest average seasonal pH value, 6.95, was observed in winter season in Supa spot and maximum seasonal average pH value, 8.11, was observed in Bommanalli spot during post-monsoon season (Table 5 B, Fig. 12).
Comparison of mean pH value between the two rivers showed significant difference ($t_{0.05\ (46)} = 2.22$, Table 6). Comparison of monthly variation of pH among sampling spots showed significant difference in river Aghanashini ($F_{0.05\ (3,92)} = 3.29$) and in river Kali ($F_{0.01\ (3,96)} = 10.34$, Table 7).

Variation of pH in a season among sampling spots showed significant difference in Supa spot only during winter season ($F_{0.05\ (3,20)} = 4.65$, Table 8).

Comparison of variation of pH among the seasons in a sampling spot showed significant difference in Supa spot of river Kali (Table 9).

Correlation of pH with other physico-chemical factors is given in table 11. It showed, -ve correlation with EC in Sarkuli spot ($r = -0.48$) and -ve correlation with nitrate in Maanimane spot ($r = -0.48$). Positive correlation of pH was observed with hardness in Bangane spot ($r = 0.47$). pH showed +ve correlation with sodium in Kodsalli and -ve correlation in Sarkuli spot.

7. **Free Carbon di-oxide (Free CO$_2$)**

Mean free CO$_2$ value was 17.96 ± 9.12 mg/L and 21.63 ± 11.28 mg/L in river Aghanashini and Kali respectively (Table 1). It ranged from 1.1 to 41.74 mg/L in river Aghanashini and 3.99 to 42.94 mg/L in river Kali (Table 1).

Average free CO$_2$ value among the sampling spots of river Aghanashini ranged from 15.90 ± 11.80 in Sarkuli spot to 19.49 ± 11.84 mg/L in Badaalghat (Table 5 A). In the sampling spot of river Kali it ranged from 19.71 ± 11.53 in Kadora spot to 29.23 ± 18.79 mg/L in Bommanalli (Table 5B).
Among the sampling spots of river Aghanashini, lowest value of free CO$_2$, 0.50 mg/L, was observed in Maanimane during October '97 and maximum was observed in Sarkuli spot during August '96 (Table 16, Fig.13). Among the sampling spots of river Kali, free CO$_2$ was absent in Bommanalli spot during January February '98 and maximum value recorded was 77.70 mg/L in the same spot during September '96 (Table 16, Fig. 13).

Seasonal average of free CO$_2$ was lowest during summer season (15.19 mg/L) and highest during monsoon season (20.38 mg/L) in river Aghanashini (Table 4). In river Kali, seasonal average value of free CO$_2$ was minimum during winter season (13.65 mg/L) and maximum during monsoon season (31.52 mg/L, Table 4).

Among the sampling spots of river Aghanashini and Kali seasonal average maximum and minimum free CO$_2$ varied. It was minimum during monsoon season in Bangane spot (11.98 mg/L) and during summer in Badaalghat (11.98 mg/L, Table 5A, Fig.14). Maximum seasonal average value of free CO$_2$, 26.30 mg/L, observed in Maanimane during winter season (Table 5 A, Fig.14). Among the sampling spots of river Kali, minimum seasonal average value of free CO$_2$ was observed in Kadra spot during winter season (11.32 mg/L) and maximum value, 42.20 mg/L was observed in Bommanalli during monsoon season (Table 5 B Fig. 14).

Comparison of variation of free CO$_2$ among the seasons in a sampling spots showed significant difference in all the spots of river Kali (Table 9).

8. Dissolved Oxygen (DO)

Dissolved oxygen value ranged from 9.60 to 23.55 mg/L in river Aghanashini and its range was from 7.80 to 14.85 mg/L in river Kali
Mean DO value was $13.19 \pm 2.73$ and $11.35 \pm 1.82$ mg/L in river Aghanashini and river Kali respectively (Table 1).

Average DO value among the sampling spots of river Aghanashini ranged from $11.93 \pm 2.05$ in Sarkuli to $14.30 \pm 3.6$ mg/L in Badaalghat (Table 5 A). Among the sampling spots of river Kali the average DO value ranged from $10.25 \pm 2.98$ in Kadra spot to $12.29 \pm 3.92$ mg/L in Bommanalli spot (Table 5 B). Minimum DO, 6.60 mg/L, was observed during March '96 in Bangane spot and maximum value, 30.60 mg/L, was observed during October '97 in Maanimane spot of river Aghanashini (Table 17, Fig. 15). In the sampling spots of river Kali, minimum DO observed was, 1.8 mg/L, in Kadra during February '97 and maximum DO observed was, 21.0 mg/L, in Bommanalli spot during April '97 (Table 17, Fig. 15).

Lowest seasonal average DO value was observed during summer season (12.23 mg/L) and maximum value was observed during post-monsoon season (15.08 mg/L) in river Aghanashini (Table 4). In river Kali, minimum seasonal average DO value 9.86 mg/L, was observed during post-monsoon season and maximum value, 11.98 mg/L, was observed during monsoon season (Table 4).

It was observed that DO was always $>9$ mg/L in all the seasons in all the spots in both rivers (Table 5 A &B).

Among the sampling spots of river Aghanashini, maximum seasonal average DO value, 16.35 mg/L, was observed in Badaalghat and Maanimane spots during post-monsoon period and minimum DO value, 10.73 mg/L, was observed during summer season in Sarkuli spot (Table 5A, Fig. 16). In the sampling spot of river Kali, seasonal average DO value was maximum in Bommanalli spot during summer season
(13.4 mg/L) and it was minimum in Kadra spot during post-monsoon season (9.15 mg/L, Table 5B, Fig.16).
Comparison of mean DO value between rivers showed significant difference \((t_{0.01 (46)} = 2.75, \text{ Table 6})\). DO showed -ve correlation with air temperature in Sarkuli spot \((r = -0.48)\) and in Bangane spot it showed -ve correlation with COD \((r = -0.51)\) and DOM \((r = -0.45, \text{ Table 11})\).

9. Free ammonia (FA)
Free ammonia values ranged from 0.08 to 0.65 mg/L and 0.09 to 1.63 mg/L in river Aghanashini and river Kali respectively (Table 1). Average value of FA was 0.30 ± 0.17 mg/L and 0.39 ± 0.40 mg/L in river Aghanashini and river Kali respectively (Table 1). Average value of FA in different sampling spots of river Aghanashini ranged from 0.25 ± 0.16 in Maanimane to 0.36 ± 0.38 mg/L in Badaalghat spot (Table 2A). Among the sampling spots of river Kali, average value of FA ranged from 0.35 ± 0.58 in Supa to 0.44 ± 0.52 mg/L in Bommanalli spot (Table 2B). Lowest FA value, 0.03 mg/L, was observed during March '96 in Badaalghat and Maanimane spots and highest value, 1.46 mg/L, was observed in Badaalghat spot during Dec ’97 and in Sarkuli spot during July ’96 (Table 18, Fig.17). In case of sampling spots of river Kali, lowest FA value (0.06 mg/L) was observed in Supa during August ’97 and highest value, 4.37 mg/L, was observed during March ’96 in Kadra spot (Table 18, Fig.17).
In river Aghanashini minimum seasonal FA value was observed during summer and post monsoon season (0.24mg/L) and maximum value was observed during monsoon season (0.33mg/L, Table 4). In river Kali, seasonal average value of FA was minimum during monsoon season (0.24mg/L) and it was maximum during summer season (0.72 mg/L, Table 4).
Among the sampling spots of river Aghanashini, lowest seasonal average FA value, 0.16 mg/L, was observed in Bangane spot during post-monsoon season and the maximum seasonal average value (0.59 mg/L) was observed in Badaalghat spot during winter season (Table 5A, Fig.18). In the sampling spots of river Kali, lowest seasonal average FA value, 0.19 mg/L, was observed in Kodsalli during monsoon season and maximum average seasonal FA value, 0.93 mg/L, was observed in Bommanalli spot during summer season (Table 5B, Fig.18).

FA showed +ve correlation with AA at Maanimane spot (r = 0.51, Table 11).

10. Albuminoid ammonia (AA)

Average value of albuminoid ammonia (AA) was 0.23 ± 0.23 mg/L in river Aghanashini and it was 0.31 ± 0.36 mg/L in river Kali (Table 1). It ranged from 0.05 to 1.09 mg/L and 0.09 to 1.69 mg/L in river Aghanashini and Kali respectively (Table 1). Average AA value was 0.22 ± 0.35mg/L, 0.19 ± 0.15 mg/L, 0.21 ± 0.20mg/L and 0.29 ± 0.38 mg/L respectively in Bangane, Badaalghat, Maanimane and Sarkuli spots of river Aghanashini (Table 2A). In the sampling spot of river Kali, the average AA value was 0.38±0.56mg/L in Kadra spot, 0.25±0.22 mg/L in Kodsalli spot, 0.38±0.53 mg/L in Bommanalli spot and 0.23±0.32 mg/L in Supa spot (Table 2B).

Among the sampling spots of river Aghanashini, lowest monthly AA value 0.02 mg/L was observed in Bangane during March '96 and in Sarkuli during April '96 (Table 19, Fig.19). Among the sampling spots of river Kali, lowest monthly value of AA, 0.04 mg/L, was observed in Kodsalli spot during April '96 and maximum monthly value, 2.60 mg/L, was observed in Kadra spot during April '96 (Table 19, Fig.19).
Average seasonal value of AA for both rivers is given in Table 4. Lowest average seasonal AA value was observed during summer and post-monsoon seasons (0.16 mg/L) and highest seasonal average value of AA was observed during winter season (0.33 mg/L) in river Aghanashini (Table 4). In river Kali lowest average seasonal AA value was observed in monsoon season (0.17 mg/L) and highest average seasonal AA value was observed during summer season (0.47 mg/L, Table 4).

Among the sampling spots of river Aghanashini, lowest seasonal average AA value, 0.13 mg/L, was observed during summer season in Bangane and it was lowest during post-monsoon season in Badaalghat. Seasonal average maximum value of AA was (0.47 mg/L) in Bangane during winter season (Table 5A, Fig.20). Among the sampling spots of river Kali, minimum seasonal average value, 0.12 mg/L, was observed during monsoon season in Supa and maximum average seasonal AA value, 0.63 mg/L, was observed in Kadra spot (Table 5B, Fig.20).

AA showed +ve correlation with FA at Maanimane spot (r = 0.55, Table 11).

11. Nitrate

It is seen from the Table 1, that nitrate ranged from nil to 0.16 mg/L in river Aghanashini and it ranged from 0.01 to 1.30 mg /L in river Kali. The mean nitrate value in river Aghanashini was 0.03 ± 0.04 mg/L and in river Kali was 0.16 ± 0.31 mg/L (Table 1). Among the sampling spots of river Aghanashini the lowest mean nitrate value was observed in Bangane (0.02 ± 0.03 mg/L) and it was high in other spots (in Badaalghat, 0.04 ± 0.08 mg/ L; in Maanimane 0.04 ± 0.05mg /L and in Sarkuli 0.04 ± 0.06 mg /L, Table 2A). Lowest average nitrate value among the sampling spots of river Kali was observed in Supa spot.
(0.10 ± 0.15 mg/L) and highest average value was observed in Kodsalli spot (0.23 ± 0.69 mg/L, Table 2B).

In the sampling spots of river Aghanashini, nitrate was absent during some of the months and its maximum monthly value, 0.41 mg/L, was observed in Badaalghat during October '96 (Table 20, Fig.21). Among the sampling spots of river Kali also nitrate was absent during some of the months and its highest value, 3.39 mg/L, was observed in Kodsalli spots during March '97 (Table 20, Fig.21).

Lowest seasonal average value of nitrate, 0.02, mg/L, was observed during summer and winter seasons and its highest seasonal value, 0.06 mg/L, was observed during post-monsoon season in river Aghanashini (Table 4). Seasonal average value of nitrate was minimum during post-monsoon season (0.05 mg/L) and it was maximum during summer season in river Kali (0.23 mg/L, Table 4). Among the sampling spots of river Aghanashini lowest seasonal average value of nitrate, was observed during summer season in Badaalghat (0.01 mg/L) and highest seasonal average value, was observed in Badaalghat during post-monsoon season (0.12 mg/L, Table 5A, Fig.22). In the sampling spots of river Kali, seasonal average value of nitrate was lowest in Bommanalli during summer season (0.02 mg/L) and it was maximum (0.02 mg/L) in Kodsalli during summer season (0.02 mg/L, Table 5B, Fig.22).

Nitrate showed -ve correlation with DO at Kodsalli spot (r = -0.58), it showed +ve correlation with free-CO₂ at Badaalghat spot (r = 0.55). Negative correlation of nitrate with pH was observed at Maanimane spot (r = -0.48) and also at Bangane spot (r = -0.53, Table 11).
12. Phosphate

Phosphate values ranged from nil to 0.68 mg/L in both rivers (Table 1). The average phosphate value in river Aghanashini was 0.31 ± 0.24 mg/L and in river Kali was 0.31 ± 0.20 mg/L (Table 1). Average phosphate value in different spots of river Aghanashini ranged from 0.24 ± 0.21 in Sarkuli spot to 0.35 ± 0.27 mg/L in Bangane spot (Table 2A). Among the sampling spots of river Kali, the average phosphate value ranged from 0.25 ± 0.17 mg/L in Kadra spot to 0.41 ± 0.25 mg/L in Bommanalli spot (Table 2B).

Phosphate was absent in some months and its maximum monthly value, 0.80 mg/L, was observed during April '97 in Bangane and Maanimane spots of river Aghanashini (Table 21, Fig.23). In river Kali, its maximum monthly value, 0.80 mg/L, was observed during February '97 in Kodsalli and Bommanalli spots (Table 21, Fig.23).

In river Aghanashini, lowest seasonal average value of phosphate was observed during monsoon and post-monsoon seasons (0.23 mg/L) and it was highest (0.46 mg/L) during winter season (Table 4). In river Kali, lowest seasonal average value of phosphate was observed during summer season (0.27 mg/L) and it was highest during winter season (0.39 mg/L, Table 4). Among the sampling spots of river Aghanashini, average value of phosphate was minimum during post-monsoon and monsoon seasons in Sarkuli spot (0.16 mg/L) and it was maximum in Badaalghat during winter season (0.52 mg/L, Table 5A, Fig.24). Among the sampling spots of river Kali, lowest seasonal average value was observed in summer and monsoon seasons in Kadra spot and in summer season in Kodsalli spot (0.22 mg/L), while the highest value was observed during winter season in Bommanalli spot (0.56 mg/L, Table 5B, Fig.24).
Comparison of variation of phosphate values in a season among the sampling spots showed significant difference in winter season in the sampling spot of river Kali (Table 8).

Phosphate showed correlation with different factors (Table 11).

13. Chloride

Chloride values ranged from 4.74 to 34.49 mg/L in river Aghanashini and 8.49 to 50.23 mg/L in river Kali (Table 1). Mean value of chloride was $15.16 \pm 7.59$ mg/L and $23.30 \pm 9.86$ mg/L in river Aghanashini and Kali respectively (Table 1). Average values of chloride in different sampling spots of river Aghanashini ranged from $13.82 \pm 6.82$ in Badaalghat to $16.87 \pm 8.22$ mg/L in Bangane (Table 2A). It ranged from $20.16 \pm 10.72$ in Supa spot to $31.90 \pm 12.81$ mg/L in Bommanalli spot of river Kali (Table 2B).

Monthly minimum chloride value, 2.99 mg/L, was observed during August 96 in Badaalghat and monthly maximum chloride value, 49.98 mg/L, was observed in Sarkuli spot of river Aghanashini (Table 22, Fig.25). Among the sampling spots of river Kali, monthly minimum chloride value, 4.99 mg/L, was observed in Supa during December '97 and monthly maximum value, 53.98 mg/L was observed during March '97 in Bommanalli spot (Table 22, Fig.25).

Minimum seasonal average value of chloride in river Aghanashini was observed during winter season (11.49 mg/L) and maximum value was observed during summer season (17.70 mg/L, Table 4). In river Kali, lowest seasonal average chloride value was observed in monsoon season (19.33 mg/L) and highest value was observed during summer season (31.32 mg/L, Table 4). In the sampling spots of river Aghanashini, lowest seasonal average value was observed in Badaalghat during winter season (10.66 mg/L) and its maximum value was observed in Bangane
spot during summer season (19.99 mg/L, Table 5A, Fig.26). In the sampling spots of river Kali, lowest seasonal average value of chloride was observed in Kodsalli spot during post-monsoon season (11.49 mg/L) and highest chloride content was observed during summer season in Bommanalli spot (41.65mg/L, Table 5B, Fig.26).

Comparison of mean value of chloride between the rivers showed significant difference \( t_{0.01(46)} = 3.24 \), Table 6). Variations of monthly values of chloride among the sampling spots in river Aghanashini was found non-significant (Table 7), but it showed significant difference in river Kali \( F_{0.01(3.92)} = 5.20 \), Table 7).

Variation of chloride values in a season among the sampling spots showed significant difference in river Kali during post-monsoon \( (F_{0.05(3.12)} = 5.60) \) and winter season \( (F_{0.05(3.20)} = 4.18 \), Table 8).

Comparison of seasonal variation of chloride in a sampling spot showed significant difference in Bommanalli spot \( (F_{0.05(3.20)} = 3.21 \), Table 9).

Chloride showed +ve correlation with rainfall in Sarkuli spot \( (r = 0.45) \) and with air temperature at Bommanalli spot \( (r = 0.45 \), Table 11).

14. Sulphate

Mean sulphate value in river Aghanashini was 5.70 ± 3.71 mg/L and in river Kali it was 5.57 ± 3.44 mg/L (Table 1). It ranged from 1.00 to 14.13 mg/L in river Aghanashini and in river Kali it ranged from 2.00 to 17.88 mg/L (Table 1). The average value of sulphate in different spots of river Aghanashini ranged from 4.75 ± 3.29 mg/L in Badaalghat spot to 6.31 ± 4.79 mg/L in Bangane spot (Table 2A). Among the sampling spots of river Kali, the average value of sulphate ranged from 5.04 ± 3.38 mg/L in Supa spot to 6.13 ± 4.69 mg/L in Kodsalli spot (Table 2B).
Sulphate was absent in Bangane spot during January '98 and its maximum monthly value, 18.0 mg/L, was observed during July '97 (Table 23, Fig.27). But among the sampling spots of river Kali minimum monthly value, 1.5 mg/L, was observed during different months in all the sampling spots. Maximum monthly value 28.0 mg/L was observed in Bommanalli spot during June '96 (Table 23, Fig.27).

Minimum seasonal average value of sulphate in river Aghanashini was observed during winter season (3.33 mg/L) and maximum seasonal average value was observed during post-monsoon season (8.25 mg/L, Table 4). In river Kali, seasonal average value of sulphate was minimum during winter season (3.96 mg/L) and it was maximum during monsoon season (7.73 mg/L, Table 4).

In the sampling spots of river Aghanashini, minimum seasonal average value of sulphate was observed in Bangane during winter (2.50 mg/L) and it was maximum during post-monsoon season in the same spot (9.63 mg/L, Table 5A, Fig.28). In the sampling spots of river Kali, minimum seasonal average value of sulphate was observed during winter season in Kodsalli (2.83 mg/L) and its value was maximum during monsoon season (9.75 mg/L) in the same spot (Table 5B, Fig.28).

Comparison of variations of sulphate value among seasons in a sampling spot showed significant difference in Bangane spot ($F_{0.05 (3,20)}=3.34$, Table 9) of river Aghanashini and in Kodsalli spot ($F_{0.05 (3,20)}=3.27$, Table 9) of river Kali.

Sulphate showed - ve correlation with bicarbonate at Kodsalli spot ($r = 0.50$, Table 11).

15. Bicarbonate

Bicarbonate values ranged from 9.15 to 31.11 mg/L in river Aghanashini with an average value of 19.55 ± 5.88 mg/L (Table 1). In
river Kali it ranged from 11.59 to 81.74 mg/L with the mean value of 33.24 ± 17.46 mg/L (Table 1). Mean value of bicarbonate in different spots of river Aghanashini ranged from 14.85 ± 5.92 mg/L in Sarkuli spot to 21.45 ± 8.39 mg/L in Badaalghat spot (Table 2A). In the spots of river Kali the minimum average mean value of bicarbonate was observed in Kadra spot (22.16 ± 13.74 mg/L) and maximum mean value (57.84 ± 31.55 mg/L) was observed in Bommanalli spot (Table 2B).

In the sampling spots of river Aghanashini, monthly minimum value of bicarbonate, 4.88 mg/L, was observed during January '97 in Bangane spot and monthly maximum value, 43.92 mg/L, was observed during July '96 in Badaalghat (Table 24, Fig.29). In the sampling spots of river Kali, minimum monthly value of bicarbonate, 4.88 mg/L, was observed during December '97 in Kadra and Kodsalli spots and maximum monthly value, 136.64 mg/L, was observed in Bommanalli spot during April '96 (Table24, Fig.29).

Lowest seasonal average value of bicarbonate in river Aghanashini was observed during winter season (15.81 mg/L) and highest seasonal average value was observed during summer season (21.92 mg/L, Table 4). In the river Kali, seasonal average value of bicarbonate was minimum during winter season (21.66 mg/L) and it reached maximum during summer season (47.48 mg/L, Table 4).

Among the sampling spots of river Aghanashini, seasonal average values of bicarbonate was minimum during winter season in Sarkuli spot (11.06 mg/L) and it reached maximum during summer season in Bangane spot (25.12 mg/L, Table 5A, Fig.30). In river Kali, lowest seasonal average value of bicarbonate was observed during winter season in Kadra spot (14.23 mg/L) and it was maximum during summer season in Bommanalli spot (76.45 mg/L, Table 5B, Fig.30).
Comparison of mean value of bicarbonate in two rivers showed significant difference ($t_{0.01 (46)}=3.72$, Table 6). Variation in the monthly values of bicarbonate among sampling spots showed significant difference in river Aghanashini ($F_{0.05 (3,92)}=3.88$) and in Kali ($F_{0.01 (3,92)}=15.63$, Table 7). Comparison of variation of bicarbonate in a season among the sampling spots showed significant difference in river Kali during monsoon season ($F_{0.01 (3,28)}=6.56$), post-monsoon season ($F_{0.01 (3,12)}=6.62$) and winter season ($F_{0.01 (3,20)}=7.97$, Table 8).

Comparison of seasonal variation of bicarbonate in a spot showed significant difference in Kadra ($F_{0.01 (3,20)}=3.28$) and in Kodsalli spot ($F_{0.01 (3,20)}=4.69$, Table 9).

Bicarbonate showed +ve correlation with water temperature at Bangane spot ($r = 0.59$) and at Sarkuli spot ($r = 0.56$). It showed +ve correlation with AA at Kadra spot ($r = 0.49$) and with FA at Bommanalli spot ($r = 0.63$). Table 11 provides correlation of bicarbonate with other factors.

16. Total alkalinity

In river Aghanashini, total alkalinity value ranged from 7.50 to 25.50 mg/L and in river Kali it ranged from 9.50 to 67.0 mg/L (Table 1). The mean alkalinity value of river Aghanashini was $15.77 \pm 4.82$ mg/L and it was $27.66 \pm 14.10$ mg/L in river Kali (Table 1). Among the sampling spots of river Aghanashini, the minimum average alkalinity value, $12.17 \pm 4.86$, was observed in Sarkuli spot (Table 2A) and maximum average value, $17.58 \pm 6.88$ mg/L, was observed in Badaalghat spot (Table 2A). In the sampling spots of river Kali, the average total alkalinity value ranged from $18.17 \pm 11.27$ in Kadra to $48.66 \pm 25.29$ mg/L in Bommanalli (Table 2B).
In the sampling spots of river Aghanashini, lowest monthly value, 4.0 mg/L was observed in Bangane spot during January '97 and highest monthly value, 36.0 mg/L was observed in Badaalghat during July '96 (Table 25, Fig.31). In the sampling spots of river Kali, lowest monthly value, 4.0 mg/L, was observed during December '97 and highest monthly value, 56.0 mg/L, was observed in Kodsalli during April '96 (Table 25, Fig.31).

In river Aghanashini, lowest seasonal average alkalinity value was observed during winter season (12.92 mg/L) and maximum average value was observed during summer season. (18.0 mg/L, Table 4). In river Kali, seasonal average alkalinity value was low during winter (17.75 mg/L) and it was high during summer season (38.92 mg/L, Table 4). In both the rivers the seasonal average maximum and minimum values of total alkalinity differed spot to spot, season to season (Table 5A & B, Fig.32).

Comparison of mean value of total alkalinity between the rivers was found to differ significantly ($t_{0.1(46)} = 3.9$, Table 6). Comparison of monthly values of alkalinity among the sampling spots also showed significant difference in both the rivers ($F_{0.01(3,92)} = 3.90$ in river Aghanashini and $F_{0.01(3,92)} = 17.5$ in river Kali, Table 7). Comparison of variation of alkalinity in a season among sampling spots showed significant difference in river Kali during monsoon season ($F_{0.01(3,28)} = 9.6$), post-monsoon season ($F_{0.01(3,20)} = 7.69$, Table 8). Comparison of seasonal variation of alkalinity in a sampling spot showed significant difference in river Kali in Kadra spot ($F_{0.05(3,20)} = 3.28$) and Kodsalli ($F_{0.05(3,20)} = 4.65$, Table 9).

Correlation of total alkalinity with other factor is given in Table 11.
17. Hardness

Average hardness value was 34.10 ± 6.43 mg/L in river Aghanashini and it was 56.98 ± 11.96 mg/L in river Kali (Table 1). Hardness values ranged from 17.50 to 44.00 mg/L in river Aghanashini and in river Kali it ranged from 42.00 to 83.50 mg/L (Table 1). Among sampling spots of river Aghanashini, the lowest average value was observed in Sarkuli spot (28.67 ± 7.86 mg/L) and highest average value of hardness was observed in Badaalghat spot (37.42 ± 8.95 mg/L, Table 2A). Among the sampling spots of river Kali, the minimum average value was observed in Supa spot (38.00 ± 15.59 mg/L), while the maximum average value was observed in Bommanalli spot (88.0 ± 19.79 mg/L, Table 2B).

In river Aghanashini, monthly minimum value of hardness, 10.00 mg/L, was observed in Sarkuli spot during August '96 and it reached maximum (58.0 mg/L) during October '96 in Badaalghat and during June '96 in Bangane spot (Table 26, Fig.33). In river Kali, lowest hardness value, 14.00 mg/L, was observed in Supa spot during April '97 and it was maximum, 130.00 mg/L, during January '98 in Bommanalli spot (Table 26, Fig.33).

The average seasonal value of hardness ranged from 31.92 mg/L in summer season to 37.38 mg/L during post-monsoon season in river Aghanashini (Table 4). In river Kali, it was minimum during post-monsoon season (15.50 mg/L) and maximum during summer season (63.83 mg/L, Table 4). The minimum seasonal average value of hardness in the sampling spots of river Aghanashini was observed in Sarkuli spot during post-monsoon season (25.50 mg/L) and it was maximum during post-monsoon season in Badaalghat (49.50 mg /L, Table 5A, Fig.34). In the sampling spots of river Kali, seasonal average value of hardness ranged from 31.50 mg/L in Supa spot during post-monsoon season to
94.67 mg/L during summer season in Bommanalli spot (Table 5B, Fig.34). Maximum seasonal average value of hardness was observed during monsoon season in Supa spot, but in other spots, it was high during summer season (Table 5B, Fig.34).

Comparison of variation of monthly hardness values among sampling spots showed significant difference in both the rivers ($F_{0.01(3,92)} = 4.10$ for river Aghanashini and $F_{0.01(3,92)} = 43.46$ for river Kali, Table 7).

Variation of hardness in a season among sampling spots showed no significant difference in river Aghanashini (Table 8), but such variation was found to be significant in all the seasons in the sampling spots of river Kali (Table 8). Comparison of seasonal variation of hardness in a sampling spot showed significant difference in Badaalghat spot ($F_{0.01(3,20)} = 5.85$, Table 9) of river Aghanashini, but in river Kali, the seasonal variation was found to be non-significant in all the spots (Table 9).

Hardness showed correlation with different factors. These are given in Table 11.

**18. Chemical Oxygen Demand (COD)**

Mean COD value in river Aghanashini was $26.59 \pm 18.29$ mg/L and it ranged from 3.60 to 63.20 mg/L in this river (Table 1). Mean value of COD in river Kali was $33.79 \pm 17.29$ mg/L and it ranged from 12.00 to 62.40 mg/L (Table 1). Among the sampling spots of river Aghanashini, the mean COD value was minimum in Badaalghat ($25.30 \pm 20.32$ mg/L) and it was maximum in Sarkuli spot ($28.59 \pm 19.27$ mg/L, Table 2A). Among the sampling spots of river Kali, minimum COD value, $30.93 \pm 17.73$ mg/L, was observed in Supa spot while maximum value $36.99 \pm 17.48$ mg/L, was observed in Bommanalli spot (Table 2B).

Lowest monthly COD value, $1.60$ mg/L, was observed during November '97 in Bangane and Sarkuli spots, during March '97 in
Maanimane spot (Table 27, Fig.35). Maximum monthly COD value, 72.00 mg/L, was observed during October '96 in Sarkuli spot (Table 27, Fig.35). In the sampling spots of river Kali, minimum monthly COD value, 6.40 mg/L, was observed during February '98 in Kodsalli spot and maximum monthly value, 99.20 mg/L, was observed during December '96 in Kadra spot (Table 27, Fig. 35).

In river Aghanashini, seasonal average value of COD value was minimum during winter season (14.47 mg/L) and it was maximum during post-monsoon season (32.19 mg/L, Table 4). In river Kali, minimum seasonal average value of COD was observed during winter season (29.28 mg/L) and it was maximum during monsoon season (34.80 mg/L, Table 4). Among the sampling spots of river Aghanashini the seasonal average maximum and minimum COD values varied in the spots. Summer season maxima of COD was observed in Bangane (32.97 mg/L) and in Badaalghat (33.32 mg/L). It was maximum during post-monsoon season in Maanimane (36.80 mg/L) and in Sarkuli (36.40 mg/L, Table 5A, Fig.36). But minimum seasonal average value of COD was observed during winter season in all the spots (Table 5A, Fig.36). Among the sampling spots of river Kali, the seasonal average value of COD was maximum during post-monsoon season in Kadra spot (34.83 mg/L), but in the remaining spots it was maximum during summer season (Table 5B, Fig.36). Minimum seasonal average value of COD was observed during monsoon season in Kadra spot (31.00 mg/L), but in the other spots the seasonal average value was observed during winter season (table5B, Fig.36).

COD showed +ve correlation with air temperature at Kodsalli (r = 0.54) and at Maanimane spot (r = 0.62). It showed -ve correlation with DO at Bangane spot (r = -0.51, Table 11).
19. Dissolved organic matter (DOM)

Dissolved organic matter ranged from 1.13 to 8.21 mg/L in river Aghanashini and 2.22 to 12.69 mg/L in river Kali (Table 1). Mean value of DOM was 3.70 ± 1.55 mg/L and 5.22 ± 1.93 mg/L in river Aghanashini and Kali respectively (Table 1). Average DOM value in different spots of river Aghanashini ranged from 3.43 ± 1.49 in Badaalghat to 4.36 ± 2.45 mg/L in Sarkuli spot (Table 2A). In the sampling spots of river Kali it ranged from 3.81 ± 1.26 mg/L in Supa to 6.44 ± 2.07 in Bommanalli spot (Table 2B).

Among the sampling spots of river Aghanashini minimum DOM, 0.25 mg/L, was observed in Badaalghat during February '98 and maximum DOM value, 12.50 mg/L, was observed in Sarkuli spot during June '96 (Table 28, Fig.37). In the spots of river Kali, minimum DOM value, 1.63 mg/L, was observed in Supa spot during July '96 and maximum DOM value, 21.50 mg/L, was observed in Kadra during April '96 (Table 28 Fig.37).

Lowest seasonal average DOM value, 2.67 mg/L, was observed during winter season and maximum seasonal DOM value, 4.24 mg/L, was observed during summer season in river Aghanashini (Table 4). In river Kali, minimum seasonal value of DOM was observed during monsoon season (3.96 mg/L) and maximum was observed during summer season (7.25 mg/L, Table 4). Among the sampling spots of river Aghanashini minimum value of DOM was observed during winter season in all the spots, maximum DOM was observed during summer season in Bangane (4.01 mg/L), in Badaalghat (3.88 mg/L), in Maanimane (4.15 mg/L). But in Sarkuli spot, DOM was more during monsoon season (5.06 mg/L, table5A, Fig.38). Among the sampling spot of river Kali, DOM
was maximum during summer season and it was minimum during monsoon season in all the spots (Table 5B, Fig.38).

Mean value of DOM was more in river Kali than in Aghanashini (Table 1) and the comparison of the mean value showed significant difference ($t_{0.01 (46)} = 3.02$, Table 6). Monthly variation of DOM among sampling spots in river Kali showed significant difference ($F_{3,01 (3,92)} = 4.44$ Table 7). Comparison of variation of DOM in a season among sampling spots in river Kali showed significant difference during monsoon season ($F_{0.05 (3.28)} = 3.63$), post-monsoon season ($F_{0.05 (3.12)} = 3.52$) and winter season ($F_{0.05 (3.20)} = 4.72$, Table 8). Comparison of seasonal variation of DOM in a sampling spot showed significant difference in Kodsalli ($F_{0.01 (3,20)} = 4.94$) and in Bommanalli spot ($F_{0.01 (3,20)} = 6.54$, Table 9).

DOM showed +ve correlation with air temperature and rainfall. It showed -ve correlation with DO (Table 11).

20. Calcium

Calcium concentration ranged from 3.60 to 11.22 mg/L in river Aghanashini and it ranged from 7.62 to 21.64 mg/L in river Kali (Table 1). Mean value of calcium was $5.65 \pm 2.00$ mg/L in river Aghanashini and it was $11.58 \pm 3.18$ mg/L in river Kali (Table 1). Among the sampling spots of river Aghanashini the average calcium value ranged from $3.64 \pm 1.34$ in Sarkuli spot to $6.57 \pm 3.95$ mg/L in Badaalghat spot (Table 2A). In the sampling spots of river Kali, minimum average value of calcium was observed in Supa spot ($7.81 \pm 3.01$mg/L) and maximum average value was observed to Bommanalli spot ($19.08 \pm 6.07$ mg/L, Table 2B). Lowest monthly value of calcium, 1.60 mg/L, was observed during April '96 in Sarkuli spot and maximum value, 19.23 mg/L, was observed in Badaalghat during March '96 (Table 29, Fig.39). In case of
sampling spots of river Kali, lowest, monthly calcium value, 1.60 mg/L, was observed in Bommanalli during Dec '97 and maximum monthly value, 35.77 mg/L, was observed in March '96 in the same spot (Table 29, Fig.39).

Minimum seasonal average value of calcium in river Aghanashini was observed during post-monsoon season (4.30 mg/L) and maximum seasonal average value was observed during summer season (6.81 mg/L, Table 4). In river Kali, minimum seasonal average value was observed during winter season (10.02 mg/L) and maximum seasonal average value was observed during summer season (14.79 mg/L, Table 4). Among the sampling spots of river Aghanashini, maximum seasonal average value of calcium was observed during monsoon season (4.10 mg/L) in Sarkuli spot and in the remaining spots it was maximum during summer season (Table 5A, Fig.40). Minimum average seasonal value was observed during summer season in Sarkuli spot (3.21 mg/L), and in the other spots it reached minimum during post-monsoon season (Table 5A, Fig.40). In the sampling spots of river Kali seasonal maximum average value of calcium was observed during summer season (Table 5B, Fig.40). Minimum seasonal average value of calcium was observed during post-monsoon season in Kadra spot, during winter season in Kodsalli and Bommanalli spots and it was minimum during monsoon season in Supa spot (Table 5B, Fig.40).

Mean value of calcium was higher in river Kali and the comparison of the mean values between the river showed significant difference ($t_{0.01 (46)} = 7.74$, Table 1 & 6). Variation of calcium content in a month in the sampling spots showed significant difference in river Aghanashini ($F_{0.01 (3,92)} = 5.90$) and also in river Kali ($F_{0.01 (3,92)} = 31.17$, Table 7). Comparison of variation of calcium value in a season among sampling
spots showed significant difference during winter season ($F_{0.01 (3,20)} = 4.15$) in river Aghanashini (Table 8) and in all the seasons in river Kali (Table 8). Seasonal variation of calcium content in a sampling spot showed significant difference in Kadra spot ($F_{0.05 (3,20)} = 4.52$) of river Kali (Table 9).

Calcium showed correlation with different factors and these details are given in Table 11.

21. Magnesium

In river Aghanashini, magnesium concentration ranged from 0.73 to 9.52 mg/L and in river Kali it ranged from 1.95 to 10.13 mg/L (Table 1). Mean value of magnesium was $5.53 \pm 1.71$ mg/L in river Aghanashini and in river Kali it was $6.83 \pm 2.10$ mg/L (Table 1). Average magnesium value in different spots of river Aghanashini ranged from $5.20 \pm 1.99$ in Bangane to $5.90 \pm 2.62$ mg/L in Maanimane (Table 2A). Among the spots of river Kali, it ranged from $4.97 \pm 3.65$ in Supa spot to $9.74 \pm 3.90$ mg/L in Bommanalli spot (Table 2A). Magnesium was absent during several months in the sampling spots of river Aghanashini and its maximum monthly value, 12.69 mg/L, was observed in Sarkuli spot during April '96 (Table 30, Fig.41). In the sampling spots of river Kali, monthly minimum value was nil in Supa spot during April '97 and maximum monthly value, 16.59 mg/L, was observed during January '98 in Bommanalli spot (Table 30, Fig.41).

In river Aghanashini, minimum seasonal average value of magnesium was observed during summer season (4.45 mg/L) and maximum seasonal average value, was observed during post-monsoon season (6.49 mg/L, Table 4). In river Kali, it was minimum during summer season (6.05 mg/L) and maximum during winter season (7.53 mg/L, Table 4). Among the sampling spots of river Aghanashini,
minimum seasonal average value of magnesium was observed during summer season in Bangane (3.63 mg/L), in Badaalghat (2.72 mg/L) and in Maanimane (5.34 mg/L). But it was minimum (4.03 mg/L) during post-monsoon season in Sarkuli spot (Table 5A, Fig.42). Seasonal average value of magnesium was maximum during post-monsoon season in Bangane, Badaalghat and Maanimane, but in Sarkuli spot it was high during summer season (6.10 mg/L, Table 5A, Fig.42). Among the sampling spots of river Kali, seasonal average value of magnesium was minimum during summer season in Kadra (4.40 mg/L), during post-monsoon season in Kodsalli (5.49 mg/L) and also in Supa spot (3.54 mg/L), but it was minimum during monsoon season in Bommanalli spot (7.68 mg/L, Table 5B, Fig.42). Maximum seasonal average value of magnesium was observed during winter season in Kadra spot (7.64 mg/L) and Bommanalli spot (11.79 mg/L). It was maximum during summer season in Kodsalli (7.03 mg/L) and during monsoon season in Supa spot (6.71 mg/L, Table 5B, Fig.42).

Comparison of mean value of magnesium was found to differ significantly between the rivers ($t_{0.01}\left(46\right) = 2.34$, Table 6). Variation in the monthly values of magnesium among the sampling spots of river Kali showed significant difference ($F_{0.01(3,92)} = 9.17$, Table 7). Comparison of seasonal variation of magnesium among the spots showed significant difference during winter season in river Kali ($F_{0.01(3,20)} = 8.62$, Table 8). Comparison of seasonal variation in a spot showed significant difference ($F_{0.05(3,20)} = 3.53$) in Badaalghat of river Aghanashini (Table 9).

Magnesium showed -ve correlation with DOM, EC, total alkalinity and hardness. It showed -ve correlation with calcium (Table 11).
22. Potassium

In river Aghanashini mean value of potassium was $1.0 \pm 0.97$ mg/L and it ranged from 0.43 to 5.38 mg/L (Table 1). In river Kali, mean value was $1.44 \pm 0.40$ mg/L and it ranged from 0.95 to 2.68 mg/L (Table 1). Among the sampling spots of river Aghanashini, the average potassium value ranged from $0.58 \pm 0.23$ in Sarkuli to $1.64 \pm 3.92$ mg/L in Bangane spot (Table 2A). Among the sampling spots of river Kali, lowest average value, $0.43 \pm 0.11$ mg/L, was observed in Supa spot and highest average value, $3.48 \pm 1.52$ mg/L, was observed in Bommanalli spot (Table 2B).

In river Aghanashini, lowest monthly value of potassium, 0.10 mg/L, was observed during April 97 in Bangane and it reached maximum (20.0 mg/L) during November 97 in the same spot (Table 31, Fig.43). In the sampling spots of river Kali, lowest monthly value observed was, 0.10 mg/L, during October 97 in Kodsalli spot and maximum monthly value observed was, 9.00 mg/L, during January 98 in Bommanalli spot (Table 31, Fig.43).

In river Aghanashini minimum seasonal average value of potassium, 0.70 mg/L, was observed during winter season and maximum average seasonal value, 1.79 mg/L, was observed during post-monsoon season (Table 4). In river Kali, seasonal average value of potassium was minimum during post-monsoon season (1.35 mg/L) and also during monsoon season (1.36 mg/L) and it was maximum during winter season (1.55 mg/L, Table 4). Among the sampling spots of river Aghanashini, in Sarkuli spot minimum seasonal average value of potassium was observed during post-monsoon and winter seasons (0.45 mg/L) and maximum value was observed during summer season (0.78 mg/L. Table 5A, Fig.44). In Maanimane spot minimum seasonal average value was
observed during post-monsoon season (0.63 mg/L) and it was maximum during summer season (1.27 mg/L).

Post-monsoon minima and summer season maxima was also observed in Badaalghat spot (Table 5A, Fig.44). But in Bangane spot seasonal average minimum value of potassium was observed during winter season (0.78 mg/L) and maximum value was observed during post-monsoon season (5.48 mg/L, Table 5A, Fig.44). In the sampling spots of river Kali, seasonal average value of potassium was minimum during post-monsoon season in Kodsalli (0.65 mg/L) and in Supa (0.35 mg/L). Minimum seasonal average value of potassium was observed during monsoon season in Kaara (0.66 mg/L) and it was minimum during summer season (2.72 mg/L) in Bommanalli spot (Table 5B, Fig.44). Maximum seasonal average value of potassium was observed during summer season in Kadra (1.72 mg/L) in Kodsalli, and also in Supa (0.52), but in Bommanalli spot it was maximum during winter season (4.32 mg/L, Table 5B, Fig.44).

Comparison of mean value of potassium between the rivers showed significant difference ($t_{0.05} (46) = 2.06$, Table 6). Variation of monthly potassium value in different spots in river Kali was found to differ significantly ($F_{0.05} (3,92) = 57.74$, Table 7). Variation of potassium content in a season among sampling spots was found to be significantly different during winter season in the sampling spots of river Aghanashini ($F_{0.01} (3,20) = 21.19$, Table 8). Such variation was found to differ significantly in all seasons in the sampling spots of river Kali (Table 8). Variation of potassium in a season in a spot showed significant difference in Maanimane spot ($F_{0.05} (3,20) = 4.51$) and also in Sarkuli spot ($F_{0.05} (3,20) = 3.72$, Table 9). In river Kali, seasonal variation of potassium in a spot was found to differ significantly in Supa spot ($F_{0.05} (3,20) = 3.31$, Table 9).
Correlation of potassium with other factors is given in Table 11.

23) Sodium

Sodium value ranged from 2.20 to 6.28 mg/L in river Aghanashini with the mean value of 4.44 ± 1.17 mg/L (Table 1). In river Kali, it ranged from 3.35 to 32.38 mg/L with the mean value of 9.51 ± 6.96 mg/L (Table 1). Lowest mean value of sodium in the sampling spots of river Aghanashini was observed in Sarkuli (3.43 ± 0.89 mg/L) and it was maximum (4.98 ± 2.0 mg/L) in Bangane spot (Table 2A). Among the spots of river Kali, average value of sodium ranged from 3.06 ± 0.84 in Supa spot to 23.98 ± 26.89 mg/L in Bommanalli spot (Table 2B).

Among the sampling spots of river Aghanashini, lowest monthly value (1.50 mg/L) was observed during October '96 in Sarkuli spot and maximum monthly value, 12.00 mg/L, was observed during November '96, in Bangane spot (Table 32, Fig.45). In the sampling spots of river Kali, lowest monthly value of sodium, 1.90 mg/L, observed during May '96 in Supa spot and highest value, 115.0 mg/L, was observed in Bommanalli during January '97 (Table 32, Fig.45).

In river Aghanashini lowest seasonal average value of sodium was observed during monsoon season (3.73 mg/L) and the highest seasonal average value, 5.13 mg/L, was observed during summer season (Table 4). In river Kali, average seasonal value of sodium was minimum during summer season (6.93 mg/L) and it was maximum during winter season (13.30 mg/L, Table 4). Among the sampling spots of river Aghanashini, minimum seasonal average value of sodium was observed during monsoon season in Bangane (3.95 mg/L). It was minimum in Badaalghat during monsoon and post-monsoon seasons (3.75 mg/L). In Maanimane it was minimum during post-monsoon season (3.73 mg/L) and also in
Sarkuli spot during post-monsoon season (2.75 mg/L, Table 5A, Fig.46). It was maximum during post-monsoon season in Bangane (5.93 mg/L), but in Badaalghat and Maanimane it was maximum during summer season, in Sarkuli spot its value reached maximum during winter season (4.05 mg/L, Table 5A, Fig.46). Among the sampling spots of river Kali, minimum seasonal average value of sodium was observed during monsoon season in Kadra (4.49 mg/L). Its value was minimum during post-monsoon season in Kodsalli (4.48 mg/L) and in Supa spots (2.48 mg/L), but in Bommanalli, average seasonal value of sodium was minimum during summer season (10.87 mg/L, Table 5B, Fig.46). Summer season maxima of average seasonal value of sodium was observed in Kadra (8.37 mg/L) and Supa spot (3.23 mg/L), while it was maximum during winter season in Bommanalli (38.75 mg/L) and in Kodsalli (5.65 mg/L, Table 5B, Fig.46).

Comparison of mean value of sodium between the rivers, Aghanashini and Kali, showed significant difference ($t_{0.05.46} = 2.52$, Table 6). Monthly variation of sodium value among the sampling spots showed significant difference in river Aghanashini ($F_{0.01(3,20)} = 12.22$) and also in river Kali ($F_{0.01(3,20)} = 5.70$, Table 7).

Comparison of variation of sodium value in a season among sampling spots showed significant difference in river Aghanashini during summer season ($F_{0.01(3,20)} = 6.59$) and during winter season ($F_{0.01(3,20)} = 5.0$, Table 8). Such variation in seasons among the sampling spots of river Kali was found significantly different (Table 8). Comparison of variation of sodium value in a season in a sampling spot was found to differ significantly in Badaalghat ($F_{0.05(3,20)} = 3.83$) and Maanimane ($F_{0.01(3,20)} = 5.38$, Table 9). No such significant difference was observed between the seasons in any of the sampling spots of river Kali (Table 9).
Sodium showed +ve correlation with EC, total alkalinity and hardness (Table 11).

24. Iron

Iron content ranged from 0.04 to 2.80 mg/L and 0.04 to 2.14 mg/L in river Aghanashini and Kali respectively (Table 1). The average values of iron are 1.06 ± 0.79 mg/L and 1.06 ± 0.76 mg/L in river Aghanashini and Kali respectively (Table 1). Among the sampling spots of river Aghanashini the mean value ranged from 0.98 ± 0.79 mg/L in Maanimane to 1.13 ± 0.97 mg/L in Badaalghat spot (Table 2A). It ranged from 0.85 ± 0.84 mg/L in Supa spot to 1.29 ± 1.19 mg/L in Bommanalli spot of river Kali (Table 2B).

Minimum monthly value of iron, 0.04 mg/L, was observed in different spots of river Aghanashini (Table 3, Fig.47) and maximum monthly value, 3.10 mg/L, was observed during July '97 in Sarkuli spot and in Bangane spot during April '97 (Table 3, Fig.47). In river Kali, lowest iron value was, 0.02 mg/L, observed during May '96 in Kadra spot and maximum iron value, 3.30 mg/L, was observed in Bommanalli spot during July '96 (Table 3, Fig.47).

In river Aghanashini minimum seasonal mean value of iron, 0.71 mg/L, was observed during winter season and it was maximum (1.39 mg/L) during monsoon season (Table 4). In river Kali, seasonal average iron value was minimum during winter season (0.31 mg/L) and it was maximum (1.44 mg/L) during monsoon season (Table 4). Among the sampling spots of river Aghanashini, lowest seasonal average value of iron was observed during winter season in Bangane spot (0.61 mg/L), Badaalghat spot (0.83 mg/L) and Maanimane (0.44 mg/L). But in Sarkuli spot, it was minimum during summer season (0.78 mg/L) and maximum
during monsoon season (1.26 mg/L, Table 5A, Fig.48). In Bangane spot and Badaalghat spot also it was maximum during monsoon season, but in Maanimane, it was maximum during post-monsoon season (1.59 mg/L, Table 5A, Fig.48). In the sampling spots of river Kali, seasonal average value of iron was minimum during summer season in Kadra (0.78 mg/L) and Supa spot (0.64 mg/L). But in Kodsalli spot, it was minimum during winter season (0.77), where as in Bommanalli spot, it was minimum during post-monsoon season (0.59 mg/L, Table 5B, Fig.48). Seasonal average value of iron was maximum during monsoon season in all the sampling spots of river Kali (Table 5B, Fig.48).

Comparison of variation of iron concentration among the seasons in a sampling spot showed significant difference in Maanimane spot ($F_{0.05 (3,20)} = 4.18$, Table 9).

Iron showed -ve correlation with total alkalinity and bicarbonate (Table 11).

25. Silica

Mean value of silica in river Aghanashini was 3.47 ± 1.82 mg/L and it was 3.80 ± 1.69 mg/L in river Kali (Table 1). It ranged from 1.50 to 9.0 mg/L and 1.50 to 7.0 mg/L in river Aghanashini and Kali respectively (Table 1). Among the sampling spots of river Aghanashini, mean value of silica ranged from 3.00 ± 1.98 in Sarkuli to 3.63 ± 1.86 mg/L in Maanimane spot (Table 2A). In the sampling spots of river Kali, mean value of silica ranged from 2.58 ± 5.04 in Supa spot to 4.88 ± 2.49 mg/L in Bommanalli spot (Table 2B).

Silica was absent in some months in Bangane, Badaalghat and Sarkuli spots and the monthly maximum value observed was 12.0 mg/L in Bangane spot during April '96 (Table 34, Fig.49). In the spots of river Kali, lowest monthly value, 1.0 mg/L, was observed in Supa spot during
February and November '97, in Kadra spot during November '97 (Table 34, Fig.49). Maximum silica content observed was 9.0 mg/L during May '96 in Bommanalli spot (Table 34, Fig.49).

In both the rivers silica was maximum during summer season and it was minimum during post-monsoon season (Table 4). Among the sampling spots of river Aghanashini, minimum seasonal average value of silica was observed during post-monsoon season in all the spots (Table 5A). Maximum seasonal average of silica was observed during summer season in Bangane spot (4.83 mg/L), Badaalghat spot (4.0 mg/L) and Sarkuli spot (4.17 mg/L), while in Maanimane maximum seasonal average value, 4.50 mg/L, was observed during monsoon season (Table 5A, Fig.50). In the sampling spots of river Kali, silica content was minimum during winter season in Kadra spot (2.83 mg/L) and Kodsalli spot (3.0 mg/L), but it was minimum during post-monsoon season in Bommanalli spot (4.0 mg/L) and also in Supa spot (2.0 mg/L, Table 5B, Fig.50). Maximum seasonal average value of silica was observed during summer season in Kadra spot (4.33 mg/L), Kodsalli spot (4.67 mg/L) and Bommanalli spot (5.50 mg/L), but it was maximum during monsoon season (2.88 mg/L) in Supa spot (Table 5B, Fig.50).

Comparison of monthly value of silica among the sampling spots of river Kali showed significant difference \( F_{0.05 (3,92)} = 5.42 \), Table 7). Variation of silica value in a season among the sampling spots of river Aghanashini showed significant difference in post-monsoon season \( F_{0.05(3,12)} = 5.23 \), Table 8) and it showed significant difference in winter season \( F_{0.05(3,20)}= 4.0 \) in the sampling spots of river Kali (Table 8).

Silica showed + ve and -ve correlation with different factors. These details are given in Table 11.
Results:  b). Derived Factors : (I) Ionic composition and (II) Salinity

(I) Ionic composition

Overall ionic composition of river Aghanashini is as follows:

(All values are in mg/L)

Ca > Mg > Na > K : HCO₃ > Cl > SO₄

(5.52) (5.29) (4.46) (1.08) : (19.05) (14.9) (5.74)

And in the river Kali it is in the following sequence:

Ca > Na > Mg > K : HCO₃ > Cl > SO₄

(11.55) (9.96) (6.53) (1.44) : (33.61) (23.27) (5.35)

It was observed that in river Aghanashini, among the cations Ca and Mg dominated. But in river Kali, though Ca dominated, Na replaced Mg. In both rivers anionic composition was similar.

Among the sampling spots of river Aghanashini Ca was dominant in Bangane, Badaalghat and Maanimane spots, but in Sarkuli spot, Mg was the dominant cation (Table 35A). In Bangane spot, Mg was subdominant, in Badaalghat and Maanimane spots, Na replaced Mg, but in Sarkuli spot, Ca replaced Na. In the sampling spots of river Kali (Table 35B), Ca was dominant in Kadra, Kodssalli and Supa spots, but in Bommanalli spot Na was the dominant cation.

It is seen from the Table 36A that in river Aghanashini, Ca was dominant during summer and monsoon seasons, but Mg replaced it during post-monsoon and winter seasons. There was no change in the anionic composition. In river Kali Ca was the dominant cation during summer and monsoon seasons, but it was replaced by Na during post-monsoon and monsoon seasons (Table 36A). Among anions, though HCO₃ was dominant during summer, monsoon and post-monsoon seasons, Cl replaced it during winter season (Table 36B).
Seasonal variation in ionic composition was observed in the sampling spots in both the rivers (Table 37 A & B).

II) Salinity

Monthly salinity values in rivers and in different sampling spots are given in Table 38 and in Figure 51. Salinity values ranged from 33.73 to 74.82 mg/L with the mean value of 56.40 ± 11.91 mg/L in river Aghanashini (Table 1) and in river Kali, it ranged from 53.25 to 138.92 mg/L with the mean value of 90.93 ± 21.11 mg/L (Table 1). Among the sampling spots of river Aghanashini, the mean salinity value ranged from 48.83 ± 14.63 mg/L in Sarkuli spot to 61.26 ± 16.48 mg/L in Bangane spot (Table 2A). Among the sampling of river Kali, mean salinity value ranged from 65.26 ± 18.15 mg/L in Supa spot to 150.18 ± 42.07 mg/L in Bommanalli spot (Table 2B). On the basis of average salinity value, the sampling spots of river Aghanashini are in the following sequence –

Sarkuli < Badaalghat < Maanimane < Bangane
(48.33 mg/L) (57.31 mg/L) (58.21 mg/L) (61.26 mg/L)

The sampling spots of river Kali are in the following sequence –

Supa < Kadra < Kodsalli < Bommanalli
(65.26 mg/L) (69.85 mg/L) (78.41 mg/L) (150.18 mg/L)

Among the sampling spots of river Aghanashini lowest salinity value 26.14 mg/L was observed during January '98 in Sarkuli spot and maximum salinity value, 92.55 mg/L, was observed during November '96 in Bangane spot (Table 38, Fig.51). In the sampling spots of river Kali, lowest salinity value, 34.05 mg/L was observed during December '97 in Kodsalli spot and it was maximum (228.98 mg/L) during April '96 in Bommanalli spot (Table 38, Fig.51).
In river Aghanashini salinity was minimum during winter season (46.50 mg/L) and it was maximum during summer season (62.12 mg/L, Table 4). In river Kali also, it was minimum during winter season (80.11 mg/L) and maximum during summer season (112.9 mg/L, Table 4). Among the sampling spot spots of river Aghanashini, salinity was minimum during winter season in all the spots (Table 5A, Fig. 52). It was maximum during summer season in Bangane (70.39 mg/L), Badaalghat (62.55 mg/L) and Maanimane (64.51 mg/L), but in Sarkuli spot it was maximum during monsoon season (55.39 mg/L, Table 5A, Fig. 52). Among the sampling spots of river Kali, salinity was minimum during winter season in Kodsalli (59.43 mg/L) and in Supa spot (50.29 mg/L). It was minimum during post-monsoon season in Kadra spot (53.80 mg/L), while in Bommanalli it was minimum during monsoon season (126.45 mg/L, Table 5A, Fig. 52). Salinity was maximum during summer season in all the spots of river Kali (Table 5B, Fig. 52). Comparison of mean salinity values of river Aghanashini and Kali showed significant difference \( t_{0.01} (46) = 6.98 \), Table 6. Comparison of monthly values of salinity among sampling spots showed significant difference in river Aghanashini \( F_{0.05} (3,92)=3.56 \) and also in river Kali \( F_{0.01} (3,92) = 48.5 \), Table 7. Comparison of variation of salinity in a season among sampling spots showed significant difference in river Aghanashini during summer season \( F_{0.05} (3, 20) = 3.56 \) and in all seasons in river Kali (Table 8). Comparison of variation of salinity in a sampling spot among seasons showed significant difference in Kadra \( F_{0.05} (3,20) = 4.42 \), Kodsalli \( F_{0.01} (3,20) =10.56 \) and Supa spot \( F_{0.01} (3,20) =7.60 \), Table 9. Salinity showed correlation with many major ions, air and water temperatures, bicarbonates and total alkalinity (Table 11).