CHAPTER 6
CONCLUSION

The present study, which is the first of its kind on the Siang river, has been based on a limited number of samples with the main objective of finding the heavy metal distribution pattern in the water column and bed sediment. Considering the difficulties and logistics associated with collection of samples from the highly turbulent river system and the mountainous terrain, the present set of data can be considered as the baseline data for future studies with respect to water and sediment quality, metal speciation and the overall contents, and the adsorptive properties of the sediment with respect to a few metals of importance. A few important conclusions from the study can be summarized as below:

➢ The Siang river water is neutral to slightly alkaline in nature (average pH = 7.4) like all other major Indian rivers. The variation of pH in the river water is very less with respect to space: In the monsoon period, there occurs slight decrease in the pH value which can be correlated with the dilution by the rain water. Out of the three feeder streams, the water of one of the streams, FS1, is alkaline (average pH = 7.8) while the other two streams have water with pH similar to the main river water.

➢ The values of the physico-chemical parameters (pH, EC, TDS, TSS, TS, Hardness, etc.) are within the WHQ tolerance limits. The electrical conductivity, total dissolved solids, major cations and anions show maximum values at site S2 after which the values decrease in the downstream direction. The large values are due to the input from the feeder stream, FS1 at the site S2. Site S7 showed second highest values of EC and TDS, which is due to the anthropogenic influence. Free CO$_2$ was found to be present in considerable concentration from which it can be concluded that the river is acting as a sink for the atmospheric carbon dioxide.

➢ The dominance of rock weathering in the chemistry of the river water is observed in the study. Significant carbonate weathering followed by silicate weathering control the major ion chemistry of the river water.

220
The average concentrations of the trace metals in the water column reveal dilution in the monsoon period and subsequent increase during the pre-monsoon and the post-monsoon periods. The metals can be found at higher concentration at site 2 irrespective of the seasons, which is again due to the contribution from the feeder stream, FS1. A general downward decreasing trend of the dissolved trace metals from site 2 onward indicates greater lithogenic influx at site 2 and dilution-dispersion thereafter.

The observed charge balance between major cations (Σ⁺) and major anions (Σ⁻) for the river indicates significant precision and accuracy in data generation in the present study. A set of linear equations was also derived between pairs of variables. These relationships can vary well be utilized for the theoretical calculation of other parameters without going through elaborate experimental observation under similar set of physicochemical conditions.

Sediments of the river reflect sandy character with more than 80% sand. The sandy nature of the sediments was also confirmed by the sediment bulk density values. The pH of the sediment was alkaline in nature and showed higher values in the monsoon period. Carbonate content of the sediments is moderately high. Clay portion of the sediments was found to contain calcite, kaolinite, illite and gibbsite. The slightly alkaline condition and moderately high electrical conductivity indicate that the sediment contains the inorganic constituents and metal ions in the form of oxides, hydroxides and carbonates.

The sediment was found to be enriched with respect to Pb, Co, Cd and Zn while the concentrations of other trace metals were within the average shale values. The abundance of the trace metal content was found to be in the order of Al > Fe > Ca > Mg > K > Na > Mn > Zn > Cr > Ni > Co > Pb > Cu > V > Cr. The concentrations of all the trace metals, excepting Pb, Ni, and Co, decline slightly in the downstream direction. In the pre-monsoon and post-monsoon periods, the concentrations of most of the metals in the sediments decrease downstream. The uniformity in the
distribution of metals in the sediments indicates that the anthropogenic contributions coming from human activities in the banks of the river are negligible as at present.

The relative mobility of these metals on the basis of M/Al follows the order:

Pre-monsoon : Fe > Mn > Zn > Hg > Cr > Ni > Co > V > Pb > Cu > Cd
Monsoon : Fe > Mn > Zn > Cr > Hg > Co > Pb > Ni > Co > V > Cd
Post-monsoon : Fe > Mn > Zn > Hg > Cr > V > Ni > Pb > Co > Cu > Cd

> Physical partitioning (granulometric study) of the sediments indicates increase in metal content with decreasing particle size. Highest amount is associated with the most mobile clay fraction. This may also be the reason of the slight decline in concentration of some heavy metals in the downward direction.

> The chemical partitioning of nine heavy metals reveals their higher association with residual fraction (F5). Out of the nine heavy metals, five metals namely Co, Mn, Ni, Pb and Zn pose the threat of pollution if the pH of the river water decreases.

> The adsorption of Cu^{2+}, Pb^{2+}, Zn^{2+} and Cr^{6+} ions onto fractionated Siang river sediments with respect to pH, contact time, optimum sediment amount and competitiveness amongst the ions suggests that the river sediment is acting as a sink for these metal ions. The order of adsorption is Cu(II) > Pb(II) > Zn(II) > Cr(VI) when present together and the order of desorption is Cr(VI) < Pb(II) < Cu(II) < Zn(II). The adsorption of the ions follows the first order kinetics.

> The decrease in concentration of the heavy metals in the downstream direction during monsoon is attributed to the higher amount of suspended sediment in the river, which acts as good adsorbent for the heavy metals and is being flushed out by large volume of the rainwater.

> Of the three-feeder streams, one stream (locally known as Sirki kala), FS1, showed enrichment with respect to Mn, V, Zn though it is free from anthropogenic activity. More over the alkalinity of the sediments of this stream was highest from which it
can be concluded that, the feeder stream FS1 carry coarse grain size sediment enriched with oxide or carbonates of these metals. Concentration of calcium, sodium and potassium was also maximum in this stream in the present study. Dissolved metals and other physicochemical parameters of this feeder stream were found to influence the quality of water and sediment at site 2. Otherwise there are no other reasons which can explain the observed higher values of chemical parameters in this site than site 1. To find out the significant lithogenic contribution of heavy metals specially Fe and Mn a detailed study is necessary. The two other feeder streams did not show any mentionable difference from the main stretch in their chemical characteristics.

➤ The present study has helped to create a database for the otherwise pristine Siang river basin with respect to geochemical behavior. The river basin which is yet to be explored geologically may be a rich source for further scientific studies.

Suggestions for further work

The present work can be further extended by taking up the following works:

a) More sampling points may be selected covering the entire length of the Siang River to find out the probable source of heavy metals Co, Mn, Zn which are present in higher concentration than the normal shale value.

b) A few more physicochemical parameters like BOD, COD, Nitrate, oil and grease etc may be included in the monitoring.

c) Along with the bed sediments, the analysis can be carried out in the suspended sediments of the River,

d) A few more elements like As, Se, etc. may be included in the monitoring,

e) The adsorption-desorption characteristics of the sediment need more exhaustive treatment.

***************