Chapter 09

CONCLUSION

The Bengal basin represents one of the geologically youngest and tectonically most active denudation regime of the world which includes the second largest delta - the Bengal delta -, and gives passage to the one of the highest sediment dispersal systems - the G-B-M system - of the world. The basin encompasses the total lower drainage area of the G-B-M system which owes its significance in the global river scenario because of its one of the highest chemical denudation rate and flux of total dissolved solids to the oceans globally.

The nature of the bed sediments in the Bengal basin suggest that they are most nearly equivalent to the material carried in suspension. A major fraction of this sediment load is also capable of resuspension. The sediments are geologically immature and capable of interacting with the dissolved constituent. This implies that they could be potential trap of contaminants as well as nutrients. Also, since the sediments are derived from the highly populated and extensively cultivated floodplain they might carry anthropogenic contaminants and have the capability of polluting the aquatic environment. Thus this sediment mass offers a good opportunity for studying their various geochemical components.

Atmospheric contribution in the chemistry of the eastern segments of the G-B-M system viz., the Brahmaputra and Meghna is somewhat important in case of K⁺, Cl⁻ and SO₄²⁻, while the Ganges receives insignificant atmospheric contribution in the Bengal basin. The chemical weathering and erosion in the denudation regime of the river system is primarily responsible for its major chemistry. The major chemistry of the river system is found to be a function of the area of the drainage basin, climatic condition prevailing over the basin and the basin geology. Overall, the chemistry of the Ganges and the Brahmaputra is dominated by carbonate weathering. In the Meghna, however silicate weathering is slightly prominent and it tends to be more
influenced by the atmospheric contribution.

The G-B-M river system represents 3.8% of the global annual discharge and ≈5% of the annual global chemical flux to the world oceans. This chemical flux (223 \( \times 10^6 \) tons.yr\(^{-1} \)) is quantitatively second only to the Amazon, although the river system represents the discharges only about 21% of the annual water discharge of the Amazon. The chemical denudation rate of the Ganges and the Brahmaputra in the Bengal basin is one of the highest globally (79 and 114 t/km\(^2\)/yr respectively), which suggest enormous weathering and erosion in the drainage basin.

Variation in the concentration of C, N and P in the bed sediments of the G-B-M system, Bengal basin is not conspicuous. However, the Ganges show higher concentration of organic carbon as compared to that of the other channels. At high sediment discharge period - when major share of the suspended sediments come from resuspension of bed sediments - the organic matter carried by the river system appears to be more biodegraded. This suggests that organic matters in the bed sediment are more biodegraded. It is observed in the Bengal basin that the TC and TN concentration in the bed sediment are regulated by the organic sources. However, the phosphorus content in the Brahmaputra and Meghna could have a phosphorite origin, while in the Ganges the P may have an anthropogenic source. P show an anomalous concentration with respect to mean grain size of the sediment. The TOC and TC shows excellent correlation with the mean grain size of the bed sediments of the Brahmaputra and the Meghna. However, in the Ganges such relationship is absent. This implies that, in the Brahmaputra and Meghna the TC is related with organic matter and fine grained sediments while in the Ganges the TC may occur mainly in the form of organo-metallic compounds and attached with Fe-Mn oxide coatings in the sediment. The C/N ratio in the bed sediments represents the presence of higher content of ION compounds.

The suspended sediments are always high in phosphorus concentration, and in the Brahmaputra and Meghna the concentration of P in the suspended sediments is evenly related with the weight percent of clay content. However, phosphorus has
a strong tendency towards particulate phase in the Meghna and Brahmaputra while it prefers mostly the dissolved phase in the Ganges.

The concentration of plant available phosphorus is low but uniform in the river bed sediments of the Bengal basin. It shows direct relationship with the productivity of biomass in the river channel.

The major, minor and trace elements show a very similar pattern of distribution in the Bengal basin. It is evident from the correlation coefficient values, that the influence of alumino-silicates - as a controlling factor in the elemental inventory - diminishes from the Meghna toward the Ganges. The influence of carbonates is prominent in the particulate chemistry of the Ganges. Mn and C, in the < 63 μm grain-size fraction of the bed sediments of the Ganges is higher as compared to that of other major channels. The high concentration of Mn in the Ganges may be related with anthropogenic sources. The major elemental concentration when compared between different grain sizes, it is observed that, Si, Ca, Mg and Na has always lower concentration in the < 4 μm fraction, while Fe and Mn has higher concentration in the < 4 μm fraction. The variation in concentration of major elements in different grain size fractions are related with mineralogical differences of the sediment size fractions.

Most of the minor and trace elements show stronger affinity toward finer grain-size. Most of these heavy metals also show good positive correlation with Fe, suggesting that Fe-oxide coatings play an important role in the accumulation of trace metals. The Ganges show slightly lower concentration of most of the heavy metals in the < 63 μm fraction of the bed sediments as compared to that of the other channels. However, Mn is in high concentration in the < 63 μm fraction of the Ganges. It is observed in a general way that higher concentration of heavy metals occur in the < 4 μm fraction of bed sediments as compared to that of the other coarser fractions.

The elemental concentration of bed sediments in the Ganges-Brahmaputra-Meghna river system, Bengal basin show similarity with that of average soil of the
world, except that Na concentration is low, and Fe and Mn concentration is high in the world average soils. The suspended sediment chemistry of the Bengal basin is deficient in Ca and Mg, and enriched in P as compared to that of the world average particulate chemistry. In comparison with the Peninsular Indian rivers, the sediment of the G-B-M system is rich in K and deficient in Na, which is related to the differences in mineralogical composition of the sediments. The bed sediments of the Bengal basin are low in V, Cr and Co, in comparison with the average soil chemistry of Bangladesh, which is related to the relative mobility of these elements in a dynamic river environment.

The concentration of trace elements according to depth in the Bengal basin is either quite uniform or varies within a very narrow limit throughout the basin. The concentration of the non-detrital fraction of heavy metals show a higher concentration in the Ganges bed sediments, suggesting relatively more anthropogenic perturbation of the river channel. The non-detrital fraction of the heavy metals also show good correlation with the mean grain-size of the sediments. In a general way, the sediments of the Bengal basin show relatively higher concentration of the non-detrital fraction of Pb and Mn, and low Fe, Zn, Ni and Cu as compared to that of their respective detrital fractions.

Si, Fe, Mn and Ti are the significant elements that govern the major sediment chemistry of the Bengal basin. The major chemistry of the Bengal basin is also more influenced by the Ganges sediment chemistry. The elements viz., Al, Ca, P and Zn govern the major elemental chemistry of the suspended sediment. The mean grain-size offers the major control in the distribution of TOC, TN and PAP. The mean-size of sediments have a major control over the distribution of trace elements. Factor analysis suggests that, particle size is the prime governing influence in the concentration and distribution of nutrients and heavy metals in the Bengal basin.

The sediment of the G-B-M system, Bengal basin represents relatively unperturbed chemical environment except for Mn in the Ganges. The Mn enrichment can be assigned to anthropogenic sources.
Considering the quantity of sediment transported by the G-B-M system annually through the Bengal basin to the Bay of Bengal, a more comprehensive study - based on extensive sampling of suspended sediments covering seasonal and spatial variations - on the nature of nutrients and heavy metals is needed. Such study will help in developing a thorough understanding of the basin wide geochemical processes, and flux of the river system to the ocean, which in turn determines the role of the river system in global biogeochemical cycle.