CHAPTER - 1

INTRODUCTION

A river basin represents the most active component in the hydrological cycle. In material transport, the river plays a very important role. More than 90% of continental weathering products are transported to the oceans. Therefore, the chemistry of river depends not only on the materials brought in by the tributaries of the river but also by the inputs intruding from the ocean. A number of physical, chemical and biological processes occur in the system which determines the net flux of materials from river to the ocean. In natural system, materials so transported are recycled through geological time at very slow rates. For example, it is estimated that sediments are completely recycled every 250 million years. Individual elements, such as Na, K, Mg, Fe etc. are recycled at different rates due to different composition of sediments and varying ability of elements to combine with organic matter which in turn bind with the sediments.

In our present day conditions, man has considerably altered the natural rate of processes due to increasing erosion and resources consumption. In a river basin, diverse factors influence the hydrological activities weathering of drainage basin rocks, erosion of weathered products, fractionation of individual metals between water, sediments and biota etc. Mechanical and chemical weathering results in suspended and dissolved load in rivers, which represent quantitatively the most important input to the oceans.

The world rivers with 1.2 thousand cubic kilometers of water account for only 0.0001 percent of total volume of water in the hydrosphere (Lvovich, 1973). A river basin represents an obvious natural unit within which one can examine weathering geochemistry of weathering and erosion on a continental scale. The sediments that are
carried by rivers are responsible for flooding in rivers and therefore, there is a need for maintenance of in-channel structures. Most important of all, the sediment particles adsorb many contaminants, such as pesticides, radionuclides and toxic metals, that are transported, deposited and stored as part of the sedimentary component of the river system. It is estimated that annually about 37,000 km$^3$ of water and 15 to 16 X 10$^9$ tonnes/year of sediments are discharged by rivers to the coastal zones of the world (Milliman and Meade, 1983; Walling and Webb, 1983); the contribution from the Indian rivers being 1.2 x 10$^9$ tonnes/year (Subramanian, 1980).

The coastal oceans are the land margins affected by the salt water and include the salt marshes, lagoons, mangroves and estuaries affected by penetration of salt wedges (Global Change, 1990). These coastal environments have high-energy state due to mixing and advection caused by ocean currents and fresh-water buoyancy. These are buffer zones between land and open oceans into which inputs of materials, including freshwater, occurring from land via rivers and atmosphere. There occurs biogeochemical interactions between the various parameters and are characterized by active fluxes, transformation and accumulation of organic and inorganic matter and are sensitive to any global changes. Heavy metals, hydrocarbons, organic residues, radioactive wastes and other contaminants are major hazards in the estuarine and coastal environments.

India has a coastal strip running over 7,516.6 km$^2$ (Pal, 1998). There are various major and small rivers running across the country as life giving veins. The west coastal plains are narrow and confined to a belt of about 10-25 Km wide stretching between Arabian Sea and the Western Ghats and from Cape of Comorin to Rann of Kutch for about 1500 km (Pal, 1998).

Biogeochemical cycling refers to the biologically driven chemical transformations that underlie exchange of water and nutrients between the biosphere and atmosphere, biosphere and geosphere or biosphere and hydrosphere. Microorganisms are crucial to this recycling. An imbalance in a biogeochemical cycle will have dramatic consequences on a global scale. Reservoirs such as lithosphere, hydrosphere and atmosphere are sources of elements. The air sea exchange of gases, the land-sea
transfer of nutrients, detritus (Mann, 1988) and other particulate materials, the fluxes of materials between sediments and the overlying water column, and the inputs of energy and nutrients from the open ocean— all account for the biogeochemical fluxes in the near coastal environments. Associated chemical transformations contribute to productivity of the system and link aquatic system to atmosphere and terrestrial systems on both regional and global scales.

River geochemistry is concerned with complex interactions in the system rock-water-air-life, that gives rise to a wide range of chemical characteristics in the surface environment. The redistribution of elements from bed rock in the drainage area into the surface environment occurs as a result of physical and chemical weathering which transforms rock which is hard, frequently non-porous and of low reactivity; to sediment which is soft, porous and chemically active. Physical weathering breaks the rocks into smaller particles, thereby increasing the surface area exposed to air and water, which are the main agents of the chemical weathering. During chemical weathering, primarily rocks are changed into different phases that are stable under surface conditions characterized by lower temperature and pressure and the presence of water and air. These changes are due to various chemical weathering processes such as dissolution, oxidation, hydrolysis and acid hydrolysis. The redistribution of elements involves interactions between bedrock and water containing dissolved gas, with replacement of bedrock by particulate and colloidal products, having physical properties which are intermediate between bedrock and water, together with fragments of minerals and rocks which are resistant to weathering and solutions.

To understand the geochemical mass balance between land and ocean, the estimation of mass transfer by rivers from the continents to the ocean is very important. Hence several attempts have been made to understand river transport of materials both in regional and global scale. Mass transfer studies on river basins have been carried out by Gibbs (1977), Martin and Meybeck (1979), H Ming Hui et al., (1982), Milliman and Mead (1983), Stallard and Edmond (1983), on a global scale and Subramanian (1983), Sarin and Krishnaswamy (1984), Biksham and Subramanian (1988), Vaithyanathan et al., (1988), Chakrapani and Subramanian (1990) on local continental scale on the Indian rivers.
Measurement of river load occupies an important position in the study of fluvial denudation systems, both at the scale of the small catchment and the larger river basin. Solid and dissolved materials in rivers are derived from allochthonous and autochthonous sources. Their nature and rate of transport are controlled by the physical characters of the river and by the complex geochemical processes that occur within them (Ittekkot and Arain, 1986). River sediments are products of inheritance of environments. The study of mega and micro environments of (accumulation) sedimentation the prevailing energy conditions, turbulence of water, velocity of currents, relief of the high altitude areas and gradients of the basin of the sedimentation are very well reflected by the textural parameters of the sediments. This has been used to characterize depositional environments and to recognize the mechanism of sediment transport and deposition. Similarly, mineralogy of the detritals and clays can be most useful for provenance studies and it can also give the information on paleoclimates of the source area and on the nature of the source itself. River borne sediments are sensitive to changes and reflect the processes prevalent at the time of their deposition. The rate of sediment and elemental accumulation largely depends on supply rate at any given time. Sediment cycling through our environment also undergoes quantitative change-textural, mineralogical and chemical.

Rivers have played an important role in human development. Historically, settlement along rivers had occurred because the rivers provided both water supply and transportation. As a result of human proximity, rivers have been considerably affected by activities ranging from agriculture and flood control to the input of human and industrial waste (Lerman, 1980). Their effects which are not only of recent origin, have a considerable impact on the transport of water dissolved and suspended matter. The physical and chemical erosion is further accelerated by socio-economic processes either to bring new land into production to increase their existing productivity or to change existing land use. Thus, the awareness for biogeochemical studies has attained its momentum.

Influence of natural and anthropogenic forces are vital in transformation and shaping of features on land surface. Theses transformations have both short and long term implications to earth’s lithosphere, biosphere, hydrosphere and atmosphere. Increasing population pressure on finite land resources and implications of land
transformations to sustenance of human population call for an immediate need to understand the consequences of these transformations. In the light of the above background, it is a necessary prerequisite to understand the land use/land cover change. An attempt has been made in present study of Western Ghats region using remote sensing and GIS on certain broad aspects of land use/land cover changes which have taken place between Goa and Mangalore during the period of 1963-2003.