EVALUATING TAMIRABARANI RIVER WATER QUALITY THROUGH LANDUSE ANALYSIS IN THE TWO CATCHMENTS (PAPANASAM AND MANIMUTHAR) IMPACTS OF WETLANDS ON STREAM NITROGEN CONCENTRATION

Project Final Report Submitted to

State Land Use Board (SLUB)

STATE PLANNING COMMISSION, Chennai

By

Prof. Dr. N. Chandrasekar
(Head)
Principal Investigator
Centre for GeoTechnology
Manonmaniam Sundaranar University
Tirunelveli – 627 012
AUGUST – 2011
SUMMARY

The present study is carried out in the upper catchments of Tamirabarani River (Papanasam and Manimuthar) for evaluating the impact of landuse on river water quality. The area is located in Tirunelveli district and forms a part of the foot hills of Western Ghats. The catchment of Papanasam and Manimuthar are the major source of providing fresh water to River Tamirabarani, which feeds the district of Tirunelveli and Tuticorin.

In order to understand the stream dynamics in different landuse, a morphometric analysis was carried to evaluate the Papanasam and Manimuthar catchments physical characteristics. Survey of India topographic maps on a 1:50,000 scale and the SRTM DEM data (90 m resolution) was used for delineating the study area. Based on the data the slope, aspect and topographic elevation maps with contours for the catchments were prepared.

The drainage networks of the catchments were scanned from Survey of India (SOI) Toposheets No. 58H/2 and 58H/6 (1:50000) and digitized in ArcGIS 9.2 platform. Based on the drainage order, the drainage channels were classified into different orders. Catchments parameters viz area, perimeter, length, stream length, stream order were also calculated. Later it is used to calculate other parameters like bifurcation ratio, stream length ratio, stream frequency, drainage density, texture ratio, total relief, relief ratio, elongation ratio, circulatory ratio, form factor and length of overland flow with the help of established mathematical parameters.

The result reveals that the Papanasam and Manimuthar catchments have been classified as fifth order basin. Lower order streams mostly dominate the basin. The drainage density value of Papanasam and Manimuthar catchments are less than 5.0 and reveal the permeability of subsurface strata, which is a characteristic feature of coarse drainage. The aspect of Papanasam catchment has dominated by east facing slopes which indicates high moisture content, whereas Manimuthar catchment was dominated by west facing slopes indicating low moisture content as the evaporation rate is higher in west facing slopes. This is because of intense sun's radiation towards the west. The stream length ratio of Papanasam catchment shows variations indicating changes in slope and topography whereas Manimuthar catchment shows an increasing trend from lower order to higher order indicating mature geomorphic stage. Bifurcation ratio of the study area indicates that the area does not exercise a dominant influence on the drainage pattern.

The study area experiences intermediate to fine drainage textures. The development of stream segments in the basin area is more or less affected by rainfall. However the present day drainage has evolved from a high density drainage associated with wet climatic condition to a drainage characterized by sporadic or intermittent runoff, consistent with drier conditions. Elongation ratio indicates that the study area experiences high relief and steep slope with less elongated catchments. The less elongated shape of the basin is mainly due to the guiding effect of thrusting and faulting. Relief ratio indicates that the discharge capability of these catchments is very high and the groundwater potential is meager.
Water quality monitoring was carried out to understand the physico-chemical parameters in 17 sampling points in Karayar Lake/reservoir and 11 sampling points in Manimuthar Lake/reservoir. The accurate geographic positions of the sampling points have been determined using a portable global position system—GPS (Garmin GPSMAP76). Application of Inverse Distance Weighted (IDW) geographic distribution simulation algorithm was used to build a spatial model using ArcGIS. Finally, the assessment of major ions and nutrients and their probable source are evaluated for the sustainability of Lake Karayar and Lake Manimuthar.

The examination of the phyico-chemical parameters of the lake water, as well as their geographic distribution reveals that most of the water quality parameters are below the permissible limit of WHO standards for drinking and irrigational purposes. In post-monsoon period, the inlet streams play an important role in lake water restoration, as the major anions and cations concentrations are found low in the inlet points. The post-monsoon period water quality parameters is found more pristine then the pre-monsoon period. Reservoir catchment resource management should be given a serious consideration as it is a natural lake and plays an important role in the maintaining of a stable ecosystem.

Moreover, Spatial and seasonal assessment of Tamirabarani River water chemistry is also determined to understand the interactions between soils and underlying geology, topographic features, rainfall and atmospheric inputs, anthropogenic sources and catchment hydrology. Within a Geographical Information System (GIS) framework, spatial datasets, such as land use and geology, have been used to explore the controls on river water quality in a variety of environments and across a range of scales.

Understanding the relationships between land use characteristics and river water chemistry provides a base for determining how future changes in land use and climate will impact on river water quality and functioning. Therefore, it is important to determine the processes that regulate river water chemistry in landscapes under increasing pressure from human population, whether from urbanization or more intensive food production.

The results of river water chemistry reveals that the turbidity and high concentration of nitrogen compounds in the river water is probably due to confluence of leached organic matter from the vicinity of agricultural lands and turbulence of water in the upstream areas. Moreover, the high concentration of nitrogen compounds, phosphate and sulphate may be due to fertilizer inputs. EC and TDS are contributed from anthropogenic activities especially from fertilizers. The high level of DO in post-monsoon period is due to confluence of rainwater and turbulence of river water.

Moreover, Cluster analysis was applied to the river-water quality dataset with a view to group the similar sampling sites spread over the river stretch. Where, all the sampling sites on the river were grouped into three statistically significant clusters at similarity. The clustering procedure generated three groups of parameters in a very convincing way, such that those that were in the same groups have similar characteristic features and natural background source types. It is evident that the
cluster analysis technique is useful in offering reliable classification of surface waters in the whole region and will make possible to design a future spatial sampling strategy in an optimal manner.

The interpretation of land-use/land-cover data derived from Landsat TM imagery reveals that, Agricultural land-use have significantly affected the Tamirabarani river catchments, modifying the landscape properties and leading to nitrogen load, both in the upper and lower part of the study area. The dominant land use types in this catchment were forestland, Agriculture land, and waste land with shrubs. The water area in the upstream and regions enlarged, mainly due to the increment of impounded area caused by the construction of reservoirs, while the water area of downstream region diminished, mainly occurred in the east part of this region with concentrated ponds and swamps distribution. Land use and landscape pattern in Tamirabarani river catchments resulted from the direct and indirect impacts of human activities, such as agricultural development, water project, and urban construction. Many water projects (e.g., water supply, channels, reservoirs, etc.) were carried out for the sake of flood prevention, irrigation, urban water supply, etc., leading to the enlargement of water area in the upstream and midstream regions. Ponds and swamps are widely distributed in the downstream region, but many of them dried up and transformed into saline or alkaline land or farmland because of the overexploitation of water resource. Besides the invading and occupying to river flood plain by agriculture activities and urban construction, water area diminished greatly in the downstream region. Land use practices should be adjusted on landscape scale to contribute to ecological protection of Tamirabarani river catchments.

Evaluating the impact of anthropogenic activities on river water quality is required to conserve water quality and natural resources, and to adequately manage land uses in catchments. Agricultural land use within catchments has been linked to increased concentrations of nitrogen in stream waters. In a catchment scale, various land uses along with agricultural land area receiving anthropogenic nitrogen inputs, the proportion of agricultural land within the catchment was found to be one of the most important predictors of NO3-N concentration in stream water. On the other hand, forest and wetlands could play an important role in mitigating degradation of water quality. From the results of this study, it is concluded that the impact of land uses in stream nitrogen concentration is strongly influenced by the presence of wetlands and forests, which have a high denitrification potential, arising from the high soil moisture content. It is important to quantify a function of the biogeochemical hot spot such as forest and wetlands within catchment for understanding biogeochemical nitrogen flux of stream water by developing a conceptual framework of varied temporal and spatial monitoring plans.