CHAPTER 10. SUMMARY AND CONCLUSION

The GIS Technologies along with satellite remote sensing and digital image processing techniques occupy a prominent place among the modern computer tools and constitute invaluable support in the decision making of a problem with a spatial decision. Geoinformatics techniques are viable being utilized in recent decades as a critical apparatus in deciding the quantitative portrayal of morphometric of a watershed. In this study, the watershed has been analyzed, and the hydrological and sediment yield modeling have been done to propose conservation measures. The Remote Sensing and Geoinformatics methods made it simple to play out the morphometric investigation by setting up the slope and stream order map. The results uncovered that the mean estimation of Form Factor (Ff) is 0.29 and Compactness coefficient (Cc) is 3.16, which demonstrates the shape of the watershed is elongated. The mean estimation of Stream Frequency (Sf) is 1.22 which indicates that the basin has reduced infiltration capacity. The value 2.87 of bifurcation Ratio (Rb) proposes that the watershed is steady. The distinctive estimations of Texture Ratio (T) recommend that the basin has a fluctuating slope yet plain at the more significant part of the area. These results are further utilized for prioritizing watershed for soil erosion-prone areas and also for watershed management planning zones

Soil and water come under the category of the most important renewable natural resources on earth. Hence it is essential to manage natural resources sustainably to preserve them for the future. The morphometric parameters analyse drainage pattern only, but the soil characteristics and LULC pattern must also be considered. So, in this study prioritization of watershed is done utilizing three methods of analysis (Morphometric analysis, LULC analysis, and USLE analysis) and the results were combined to provide a reliable estimation. As the Ganga watershed in India is currently under environmental distress,

therefore in present work, analysis is done in this watershed using ArcGIS and ArcSWAT. Integrating the results of all the three methods, we found that Chandauli Region, Narahi Region, and Mirzapur Region Sub-watersheds are suffering from severe soil erosion problem, and Sarai Meer Region, Lalganj Region, and Ghazipur Region Sub-watersheds have least soil erosion. These results are further used for soil erosion and sediment yield modeling.

After estimating the soil erosion-prone areas, hydrological modeling was applied to the Ganga catchments which are more prone to soil erosion (Chandauli Region, Narahi Region, and Mirzapur Region) using ArcSWAT. The calibration was done using the three algorithms of GLUE, SUFI-2, and ParaSol; the results were used to compare these algorithms. The comparison showed that of the three calibration algorithms, SUFI-2 performed the best, as it accounted better for uncertainties and required the smallest number of computational parameters for calibration. Despite information uncertainty, the SWAT model creates excellent reproduction consequences for monthly time steps, which are helpful for water resource management in this watershed. The calibrated model is further utilized to facilitate investigation of the impacts of LULC dynamics and climate change on soil erosion.

To model the remedies of the soil degradation problem, it is imperative to know the main parameters responsible for soil erosion; then only effective measures can be developed. So the following primary objectives of this research are: to assess the potential impact of LULC dynamics on soil erosion and to assess the principal causes of soil erosion. The statistics method multivariate linear regression and SWAT both combined to find out the principal causes of soil erosion. From the results, it can be concluded that there is a high impact of LULC dynamics on sediment yield as due to land transitions, 26% of sediment

yield change was found in 11 years.

Erosion substantially affects the global carbon cycle (GCC). Being a light division and gathered in the upper region of the soil surface, SOC is specially evacuated by water and wind disintegration. While a small amount of SOC transported to freshwater systems might be ensured due to limited microbial movement, labile portions of SOC being transported over the scene en route to the depositional site are abandoned against deterioration. Contingent upon the site-explicit conditions concerning the aqueous routines and the level of air circulation, the rot may prompt the outflow of Carbon dioxide under vigorous situations, Methane under anaerobic conditions, and Nitrogen dioxide under the two circumstances. The procedure of soil erosion is a 4-step process: (I) detachment, (ii) breakdown, (iii) transportation and relocation, and (iv) sedimentation. In this project, the results concluded that about 2350 grams of CO_2 have already been emitted from the study area until now. And the results conclude that soil erosion can be one of the reasons behind the emission of greenhouse gases and global warming in this study area, and hence it may have direct impact on climate change. The detailed study can be done as the future scope of this research work, in which researchers would need to take help from the environment department of the country and would have to collect soil samples from different areas for several hundred years to analyses the exact impact of soil erosion on emission of greenhouse gases and its direct impact on climate change

The land type and the slope are the principal reasons for soil erosion. So the management practices which can be directly applied to reduce the impact of slope and land type would be most effective in the case of the present study area. The best management practices that are applied as the remedies of soil erosion problem in this area are 1.) Re-vegetation on barren and rangeland. 2.) Runoff volume and Velocity control hydraulic structures were

proposed like bund, check dams, Gabions, etc. From the results of the analysis on reduction of soil erosion due to these proposed remedial techniques, it can be concluded that the soil erosion can be reduced up to 50% if the proposed remedial measures are applied in the study area. The decrease in soil erosion will automatically improve the water quality of the watershed.

Till now many researchers have worked on estimation of soil erosion prone areas and impact of LULC dynamics and other factors on soil erosion. But most of them have either only identified the erosion prone areas, or estimated the impact of only one or two factors (at a time) on soil erosion. Some of them have worked on remedial measures of soil erosion. However in this thesis I have not only identified and prioritize the soil erosion prone areas but also have estimated the dominant cause behind soil erosion. Also in this work I have worked on proposing the deterrence techniques of soil erosion and also analyzed the improvement that could be made using these deterrence techniques. Three most popular calibrating techniques are compared in this which is not done in most of the research works. Also in chapter 9 of this thesis I have explored the relatively less studied area i.e. impact of soil erosion on climate change and gave the research on soil erosion, a new dimension. Most of the researchers could not think in this direction. Till now most of the work only considers climate change due to deforestation that cause due to nutrition loss from top layer of soil. But this is new for most of the people that soil erosion can also lead to the emission of Greenhouse gases which makes this work more unique.

In this study SWAT and GIS proved to be essential inventions for managing and modeling sediment yield and soil erosion in the Ganga watershed of Uttar Pradesh India. With the help of remote sensing and satellite image processing, it became effortless to do modeling and analysis in such a vast area.

Scope for Future Work

1. The prioritization and identification of soil erosion-prone areas were done for Uttar Pradesh State land degraded area; same can be done in other parts of the country, like Madhya Pradesh, Rajasthan where land degradation is the major problem. This will help in soil management to conserve the soil nutrients for farming and agriculture.
2. SWAT and GIS worked well for the hydrological and sediment yield modeling of the present study area in Ganga catchment. These techniques can be further used for water quality and pollution modeling also the soil properties modeling.
3. It was determined in the present study that the soil erosion may be the source of Greenhouse gases which are the leading cause of global warming and climate change. So with the help of scientific experiments, the exact amount of GHGs emission can be evaluated, and serious attention can be given to the carbon budget dynamics due to soil erosion.
4. Best management practices are proposed in this study as the deterrence techniques of soil erosion. These measures can be modeled physically to find out the exact amount of soil erosion reduction in the study area.