ABSTRACT

Theme of the thesis deals with the means of comprehensive watershed management. Efforts are made throughout the course to generate the necessary scientific inputs for optimum development of watersheds. Remote sensing has been used as a tool to the maximum extent possible to generate these inputs that can be used by the watershed managers for sustainable development of watersheds. Optical satellite data IRS1A/1B L-2 and microwave Synthetic Aperture Radar (SAR) data ERS-1 were used for the study. Eleven small watersheds were chosen as study area, which is located between 86°47'38" and 87°18'27" East longitudes, 21°49'11" and 23°15'41" North latitude. The watersheds are part of Bankura and Midnapore districts of West Bengal, India.

Generally land use / land cover (lu/lc) forms the primary layer for any integrated approach to sustainable development of natural resources. Lu/lc output was generated using stratified approach to avoid the agriculture-forest spectral confusion. Non-forest areas were classified by digital classification of IRS L-2 data by supervised mode with maximum likelihood algorithm using necessary ground truth information, while the forests and the water bodies were segregated by density slicing of Normalised Difference Vegetation Index (NDVI) using appropriate field information. Round the year lu/lc outputs were generated by processing separately both Kharif (monsoon season) and Rabi (winter – post monsoon) seasons' satellite data and finally creating one aggregated output showing the agricultural information of both the seasons. Prior to aggregation, the individual lu/lc layer of either season was refined with reference to each other in order to eliminate any gross error that might have crept in the individual season's output, using a software program that works in GIS mode. Similar exercise was repeated and two agricultural seasons' outputs pertaining to 1988-89 and 1992-93 were generated. This was done with a view to probing the changes in land use pattern that has occurred during the period under study. The results showed that by and large there has been an overall agrarian improvement in all the watersheds under study as reflected in substantial rise in cropping intensity, conversion of upland waste to some sort of productive use, etc. Results of change detection study over a period of time point to certain level of amelioration/ denigration of the cultural uses of lands by the owners/ mangers. During the period of study the status of forests has not changed substantially. There is no perceptible sign of deterioration in the stand. By and large the canopy cover improved over the period with a corresponding dwindling of areas under degraded/blank forests. Obviously these form crucial information for resource planners.

Study of soil resources of the watersheds yielded vital inventory of soils as Taxa in accordance with USDA norms of Taxonomic classification - highest level of specificity was the target and thus soil series (association) were abstracted. Nineteen soil series were recognized with the help of morphological features of representative soil series and the physico-chemical analysis results of 84 soil profile horizon samples. Study of hierarchical taxa identified in the area reveals 19 soil series, 16 families, 14 subgroups, 9 great groups, 6 suborders and 3 orders. Except for the highly degraded and the fluvial sway,

almost all the relatively older soils qualify for Alfisols. Out of 19 series identified, 12 soil series came under Alfisols. Only two minor (area-wise) orders were accommodated to Entisols (3 soil series) and Inceptisols (4 soil series). They owe their existence either to agents of soil degradation or recent alluvial deposit both preventing the soilscape from in-situ development. Appropriate software program was developed in GIS mode for study of land utilization vis-à-vis existing soil resources – to find out how optimum the current land-use is on a particular soilscape. Study on sustainable utilization of soils revealed a very encouraging trend. None of the eleven watersheds under study evinced any substantial change for the worse during the span of study. On the whole, the results demonstrated that there has been an overall change for the better uses of land resources in the watersheds under study.

A software package for prioritization of microwatersheds was developed with soil information, lu/lc layer and the microwatershed layer as the inputs. Development of such package is imperative in the face of resources crunch for conservation / remedial measures of watersheds. With the help of the output the watershed managers would be in a position to choose objectively the most vulnerable microwatersheds for soil conservation. Comparative study of all the eleven watersheds showed that one particular watershed, Silai-upper happened to be the most vulnerable where immediate attention of the watershed manager was necessary, whereas Dhalkisor-east watershed having no area at all under *very high* priority could be ignored for the time being.

ERS-1 SAR data was used to study land use / land cover. It is perceived that the speckles distribution in the image space is not just random, but is contingent on the terrain cover. A software program was developed to map speckles only leaving other pixels of the image and then it automatically creates clusters of the speckles if the latter is within a specified threshold of speckle-density in the image space. The clusters were compared with the ground truth blocks of some prominent lu/lc categories. The analysis indicates that the speckles map developed is useful for delineation of some selective land cover categories having the dominance of high tonal value speckles. Only then there is a prospect of encountering a uniformly better density of speckles which could be clustered by the software and provide the proper shape of the land cover class in tune with the actual ground reality. Utility of the speckles map is limited to certain themes and not applicable to general lu/lc mapping. Detailed study was made with hybrid FCCs generated from two optical bands and one SAR band. The one with IRS B4 (red), B3 (green) and ERS-1SAR (blue) offered a fairly good product of reasonable interpretability. Although some classes like eucalyptus and sal forests and a few others were better interpretable in hybrid FCC compared to the optical data FCC, a blanket statement about the superiority of the former can hardly be made.