IMPACT OF SOIL AND WATER CONSERVATION MEASURES ON LULC AND GROUNDWATER IN OLANTHICHIRA WATERSHED, MALAPPURAM DISTRICT

by

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Summary and Conclusion

CHAPTER V

SUMMARY AND CONCLUSIONS

Land and water are vital resources essential for sustaining life and supporting various developmental activities. As the global population grows, the demand for these resources also increases, leading to significant challenges such as resource depletion, environmental degradation, land use conflicts and water scarcity. Watershed management plays a crucial role in addressing these challenges by promoting the sustainable use of natural resources, balancing human needs with environmental health. Soil and water conservation measures (SWCM) are integral components of watershed management as it directly contributes to achieve its goals.

These measures have significant effects on land use and land cover (LULC) and groundwater resources. Evaluation of these measures ensures the effectiveness and helps to improve the future strategies. It also justifies the investments by showing tangible environmental and economic benefits. Remote sensing (RS) aids in monitoring and evaluating these measures by providing valuable spatial and temporal insights. In Kerala, Department of Soil Survey and Soil Conservation (DSSSC) implemented soil and water conservation measures in Olanthichira watershed under Rural Infrastructure Development Project with NABARD assistance.

Olanthichira watershed is spread over an area of 814 ha in Edayoor and Melmuri villages of Marakkara and Edayoor panchayats in Kuttippuram block of Malappuram District, Kerala. The watershed lies between 76° 02’ 45” to 76° 04’ 30” E longitude and 10° 55’ 15” to 10° 58’ 30” N latitude. This study aimed to assess the effects of soil and water conservation measures on LULC and groundwater table in the Olanthichira watershed, Malappuram, using geospatial techniques.

A reconnaissance survey was conducted to identify and assess the status of soil and water conservation measures that implemented by the DSSSC in Olanthichira watershed. Morphometric parameters of the watershed were analysed using SRTM DEM to identify various characteristics of the watershed to establish quantitative relationships and patterns within it.

RS technique was adopted for pre-treatment (2015) and post-treatment (2023) change analysis in Land use and Land cover (LULC) using Landsat 8-9 (OLI/TIRS) satellite imageries for the years 2015 and 2023 on cloud free days. Supervised classification (maximum likelihood classification) was conducted to measure the changes in LULC. The kappa coefficient technique and error matrix were used to evaluate the accuracy of LULC classified maps of watershed using 300 randomly selected points. Normalized difference Vegetation Index (NDVI) was carried out to identify the difference between NDVI values for the year 2015 and 2023. The results were analysed for assessing the changes occurred due to implementation of the soil and water conservation measures.

The impact of soil and water conservation measures on groundwater levels was evaluated using three techniques such as graphical, statistical, and spatial-temporal analysis. The seasonal variation of groundwater level from 2015 to 2023 at three observation wells were plotted against precipitation to analyse their relationship. This approach helps in understanding the dynamics of groundwater recharge and the influence of rainfall patterns over the period. Then groundwater levels during pre-treatment and post-treatment were compared using the paired t-test to assess whether the average groundwater levels have changed significantly between the two periods.

Spatial and temporal variations of groundwater table of Olanthichira watershed were analysed with the help of groundwater level data collected from the observation wells for assessing the impact of soil and water conservation measures. Groundwater table for the month of April and November months were monitored to study the pre-monsoon and post-monsoon fluctuations. Groundwater table maps were prepared for both pre-monsoon and post-monsoon periods for nine consecutive years from 2015 to 2023 using ArcGIS 10.7.1. The point interpolation using Ordinary Kriging method was carried out to obtain raster maps of pre-monsoon and post-monsoon groundwater table for the Olanthichira watershed.

The reconnaissance survey stated that the soil and water conservation structures, including check dams, contour bunds, cross-checks, roof water harvesting structures, and retaining walls, were found to be in good condition. The construction of check dams proving particularly useful in controlling water flow and reducing soil erosion. Farmers reported significant benefits from these measures, there is remarkable increase on the ground water level led to enhance the agricultural productivity and better soil stability.

The morphometric analysis revealed that Olanthichira watershed is a micro-watershed with a dendritic drainage pattern. The mean bifurcation ratio (3.722) showed that the watershed is less affected by structural disturbance and the drainage pattern is not much influenced by geologic structures. The drainage density of 1.836 km/ km^2 pointed that the subsurface strata are permeable and a characteristic of very coarse drainage with values below 5.0 which suggested the watershed is in an early mature stage of the fluvial geomorphic cycle.

The smaller values of shape parameters specifically form factor (0.43), elongation ratio (0.74) and circularity ratio (0.44) showed elongated shape of a watershed which provide low discharge runoff with flatter peak for extend period. The relief aspects of the watershed resulted gentle slope with moderate topographic variations. It is observed that stream segments up to the second order traverse higher altitudinal zones, which are characterized by steep slopes, while the third and fourth order stream segments occur in relatively flat areas, where maximum runoff infiltration takes place. These locations are suitable for construction of check dams.

In this study, the classified LULC map showed an overall accuracy level of 88 percent and 84.33 percent for pre-treatment (2015) and post-treatment (2023) respectively with the corresponding kappa statistics of 0.827 and 0.784 respectively. The LULC change analysis showed a decrease in plantation and barren land by 134.72 ha and 12.11 ha respectively during the project period along with a decrease in waterbody by 6.12 ha. On the other hand, the built-up area and agricultural land increased by 71.01 ha and 82.73 ha respectively. The percentage change in agricultural land was the highest at 10.16 percent indicated a positive change in LULC. The waterbody data indicated a reduction of approximately 0.75 percent, or 6.12 ha, over the project period. This decline is attributed to constructing structures like dry rubble check dams, concrete check dam and gully checks in depressions. The LULC maps might not fully capture these sites due to the lower spatial resolution of satellite imagery. Furthermore, the transformation of 15.66 ha of barren land into agricultural land and 4.37 ha of barren land into plantation reflected the impact of soil and water conservation measures, which led to improve the soil structure, fertility and soil moisture content. The NDVI value during 2015 ranged from 0.04 to 0.52 while it ranged from 0.07 to 0.59 during 2023. The high NDVI values increased from 0.52 to 0.59, indicated an increase in vegetation cover. This growth reflected the positive impact of soil and water conservation measures.

Graphical analysis showed that the groundwater levels generally exhibit small, gradual fluctuations over the period indicated that the aquifer system is relatively stable despite variations in rainfall. Even in years with minimal rainfall (2016 and 2020), the groundwater did any significant decline. This possibly due to the effects of soil and water conservation measures. Over the years, groundwater level does not show a significant long-term decline suggesting that the recharge from check dams was roughly balancing extraction. The paired t-test resulted in a p-value of 0.0155 which is below 0.05 significance threshold indicating that the increase in groundwater levels is statistically significant.

Spatial and temporal variations of groundwater table of Olanthichira watershed were analysed and an increase in trend of groundwater table was observed in the study area during 2015 to 2023. The positive value of groundwater fluctuation map indicated increase in groundwater table of Olanthichira watershed during both pre-monsoon and post-monsoon. Groundwater level fluctuation was ranged from 0.066 m to 1.434 m during pre-monsoon, it ranged from 1.5 m to 2.75 m during post-monsoon season. The maximum fluctuation of groundwater table observed in upper portion of Olanthichira watershed indicated the effects of soil and water conservation measures and its contribution to increase groundwater table.

From this study, it can be concluded that the watershed treatment taken up in the study area showed significant positive changes in the LULC and groundwater level. The concrete check dams, in particular have been effective in storing water for irrigation and replenishing groundwater. This reduced drought hazard in watershed area and some part of land was brought under irrigation. Regular monitoring and management are necessary to sustain the benefits of these conservation practices and maximize their long-term effectiveness.