VEGETATION RESPONSE TO INTENSIVE COMMERCIAL HORTICULTURE IN CENTRAL HIGHLANDS, KENYA

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ABSTRACT:

Rapid rise and heterogeneous clustering of intensive commercial horticulture within the central highlands of Kenya has broad impacts on watersheds and the sustainable resource management. Degradation of forests, land and water resources, accompanied by population pressure on unstable agricultural watersheds contributes to long-term reduction of watershed sustainability, and a great challenge to sustainable watershed management. This is particularly the case because spatial arrangement and distribution patterns of vegetation are predominantly related to a wide range of ecosystem elements such as water availability, rainfall, soil fertility and land use practises. Human induced changes in these elements, for example over extraction of fresh water for irrigation, land clearing, soil erosion and release of pollutants into water bodies may have direct effects on vegetation condition impacting ecosystem functions. The present study aims to provide a stronger understanding of the impacts of increased anthropogenic disturbances on watersheds resources, specifically in sub-watersheds showing proliferated commercial farming, by analysing long term annual vegetation trends at sub-watersheds scale. The base condition results present information applicable in decision making models towards sustainable resource use and management.

25 years of long term NOAA Global Inventory Modeling and Mapping Studies (GIMMS) Normalized Difference Vegetation Index (NDVI) time series vegetation data was analysed to detect trends in annual NDVI as an indicator of vegetation dynamics and status in sub-watersheds undergoing intensive horticulture. In order to describe the response of vegetation to changes in watershed characteristics, NDVI trends before 1990s (i.e. 1982-1989) and after 1990s (i.e. 1990-2006) were evaluated. GIMMS NDVI provides the longest bi-weekly maximum value composites aggregated to an 8 x 8 km pixel resolution data (1981-2006), and recently extended to 2010. The quality and consistency of the GIMMS data were assured by the correction for: sensor degradation, sensor inter-calibration differences, solar zenith and viewing angles, volcanic aerosols, atmospheric water vapour and cloud cover. The maximum value composite NDVI (a maximum daily NDVI value for the 15-day period) minimizes atmospheric effects and cloud contamination effects. Data for the first 15 days for each month, for 25 years, was used in zonal statistics in ArcGIS 10.1©, alongside a study area mask to extract the mean monthly NDVI for sub-watersheds from 1982-2006. The mean annual NDVI was also obtained. The impact of bare and sparsely vegetated pixels on the NDVI trend was reduced by using all pixels in sub-watershed in the zonal statistics to derive a single mean NDVI. The slope of NDVI trends and the Spearman's correlation coefficient (r) were used to assess the sign and strength of the spatial temporal relationships.

The study results show considerable decline in annual trend of vegetation within sub-watersheds experiencing intensive commercial horticulture, implying deteriorating plant cover. Statistical analysis indicate significant differences in annual NDVI slopes prior to 1990 and after 1990 ($p < 0.05$; $p < 0.1$ respectively) when export horticulture in Kenya rapidly expanded.Majority sub-watersheds show negative trends post 1990's possibly due to increased anthropogenic disturbances related to proliferation of commercial horticulture. A noticeable sudden drop in annual NDVI trends in the year 2000 across the study area, was as a result of very severe to severe land degradation that coincided with a drought period, accelerating soil degradation and reduced per capita food production (reported by UNEP 2002).

Understanding the linkage between vegetation condition and the effects of human induced pressure at the sub-watershed scale can help natural resource managers approach conservation measures more effectively. Sustainable actions can then be focused on vulnerable pockets, to reduce the risks of continued degradation.