Measuring 'Quality of Life' of the Central Development Region of Nepal through integration of remote sensing and census data

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'Quality of life' varies from place to place due to several factors, including topography, biophysical endowment, access to infrastructure and markets, government policies, and demographic situations. Extant literature suggests that satellite-based measurements of land-cover changes can be related with population changes, farming practices, living conditions of people, the alteration of surface and sub-surface hydrology, and fragmentation of wildlife habitats. A survey of this literature finds consistent strong relationships between settlement locations and road network, which are further influenced by the nature of land use systems.

Our research adds to the growing number of remote sensing–based analyses that deal with land-cover dynamics, land use and cover changes in the Center Development Region (CDR) of Nepal during the last three decades. First, we develop a spatial database of land-cover change at the scale of Village Development Committee (VDC) unit-levels in the CDR for the years of 1975, 1990, 2000 and 2005, by using images from four different sensors: Landsat Multispectral (MSS) images of 1975, Thematic Mapper (TM) images of 1990, Enhanced Thematic Mapper (ETM) images of 2000, and the Advanced Spaceborne Thermal Emission and Reflection Radiometer (ASTER) images of 2005. Second, we bring the remote sensing and topographic information into a geographic information system (GIS) platform to examine the relationships between land-cover changes and socio-demographic variables, including population change, migration, income levels, poverty, employment rates, and proportional educational levels. This study spatially identifies deforestation areas by using transition matrices for the periods of 1975-1990, 1990-2000 and 2000-2005. It uses simple regression analyses for finding relationships of the above variables with deforestation.

The study has grouped elevation levels in meters into various classes (500 – 999, 1000 – 1499, 1500 – 1999, 2000 – 2999, 3000 – 3999, and 4000 – 4999). It finds a strong relationship between deforestation and

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elevation levels during the period of 1975 – 1990, indicating that people preferred to live in the higher elevation areas during this period due to the fear of malarial disease in the Tarai. But the analyses reveal a significant relationship between deforestation and lower elevations during the periods of 1990 – 2000 and 2000 – 2005, indicating the contemporary reality of Tarai's improved habitation situation in terms of 'quality of life.' Road network and malaria eradication have made Tarai's living conditions much more habitable after the 1990s. Likewise, our analyses further reveal significant relationships between deforestation and variables like population of *have-nots*, migration from other regions, districts, villages, and municipalities, government services, male population of 20 – 29 age group, female population of 15 – 39 age group, male illiterate population, and female illiterate population for the period of 1975 – 1990. For the periods of 1990-2000 and 2000-2005, in addition to the significant variables identified above, roads and river areas also were significant at 95 percent confidence interval. These analyses suggest that deforestation occurs due to both bio-physical and socio-economic factors. Deforestation in an agrarian economy means lost opportunities for local populations, because the rural people have to spend more time on fuel and forage collection, instead of other more productive agrarian work. Deforestation also means that the rural people are experiencing rising expenses due to increase in prices of fuel for cooking. Further analyses suggest that technological innovation and institutional improvements might have alleviated deforestation rates somewhat, but the implementation of these improvements has been marred by the civil war and political instability prevailing in the country for the last one and a half decades.

We also analyze the relationships between land tenure and deforestation and find that low levels of tenure security and the absence of well-defined property rights have often led to deforestation. Tenure insecurity and the present high net value of use of forest rather than its 'alternative uses' have encouraged local people to over-use forest resources. In addition, financial incentives for logging and timber production have also encouraged deforestation. We also observe a low probability of deforestation within a protected area because of deployment of military personnel. Our analyses also reveal that distances to infrastructure and markets have significant impacts on prices of forest products. Easy market access and high population density have high correlations with deforestation. Of equal significance, extremely low incomes, low wage rates, and "have-nots situation" that prevail in this part of Tarai among rural poor, landless and 'near-landless' sections of population do not give us much hope that the deforestation situation will

improve in the near future, since the immediate needs of survival of these impoverished underclass can, in the short-run, be only provided by the continued use and over-use of nearby accessible forest resources.

Although our focus is on the Central Development Region, we argue that the analytical and monitoring methods used in this case are transferable to other regions with similar environmental and socioeconomic characteristics to enable spatial imagery coverage of land use and cover change to be used to correlate, link and explain socio-economic and bio-physical variables' influences on deforestation.