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## RESEARCH PAPER

# Landscape transformation analysis employing compound interest formula in the Nun Nadi Watershed, India



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### KEYWORDS

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**Abstract** The Nun Nadi watershed is close to the Dehradun city and some settlements are spread over the Mussoorie hills. Landsat TM images of the year 2000 and 2009 were used to analyze the changes in Land Use/Land Cover (LULC) data employing compound interest formula. The main reason to choose the time period is that Dehradun was declared capital of Uttarakhand state of India in the year 2001. We observed rapid changes in the LULC data in the time period studied. This is primarily due to urban growth that increased exponentially after 2001 near Dehradun city and Mussoorie hills. The highest positive change rate was observed in the built-up and agricultural land which increased 8.39 and 9.92 percent, respectively. Interestingly we noticed that the dense and sparse vegetation shrunk in terms of land coverage, on the other hand, drastic negative change was observed in the bare/barren soil class. Taken together, these results indicate significant changes in various land use categories.

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## 1. Introduction

Increasing human pressure on land disturbs the whole environment. Urbanization, desertification, and agriculture are some human driven land use change examples that significantly altered the surface of the earth and in this sense land use is an important element of global change (Vitousek, 1992; IPCC, 2000). The global, regional and local scale studies are obtaining a great deal of attention for the characterization of the carbon cycle (Melillo et al., 1993; Myneni et al., 1997). An understanding of land use/land cover change at different scales is important

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in an increasingly human-dominated biosphere. The correct identification and interpretation in land cover and/or land use change is of great interest in environmental change studies (Dale, 1997; Lambin et al., 2001; Vitousek et al., 1997).

It has been identified that land-cover change has the most pervasive human impact on natural systems (Vitousek, 1994) and urbanization is perhaps the most severe agent which is highly responsible for land cover change because of its dissimilarity to native habitats and its permanence (Marzluff and Ewing, 2001). 14% of the world's population was residing in urban areas only by 1900 and this figure had increased to 47% by 2000 (Brockhoff, 2000). At the end of 2030, the percentage would be 60% of the urban population.

The human modification on the earth's terrestrial surface is responsible for the change in land use. Even though, natural processes may also contribute to changes in land cover, the major driving force is human induced land uses (Allen and Barnes, 1985). Although humans have been modifying land to obtain food and other essentials for thousands of years, yet current rates, extents and intensities of land use /land cover change are far greater than ever in human history, leading to unprecedented changes in ecosystems and environmental processes at local, regional and global scales. Today, land use / land cover changes encompass the greatest environmental concerns of the human population including climate change, biodiversity depletion and pollution of water, soil and air.

The history of urban growth indicates that urban areas are the most dynamic places on the earth's surface. Despite their regional economic importance, urban growth has a considerable impact on the surrounding ecosystem (Yuan et al., 2005). Most often the trend of urban growth is toward the urban-rural-fringe where there are less built-up areas, irrigation and other water management systems. In the last few decades, a tremendous urban growth has occurred in the world, and demographic growth is one of the major factors responsible for the changes. This urban growth is a common phenomenon in almost all countries over the world though the rate of

growth varies. Currently, these are the major environmental concerns that have to be analyzed and monitored carefully for effective land use management.

The updating and obtainment of information about the current condition and the continuous dynamic changes of our earth's surface in remote high-mountain regions is a task where remote sensing technologies can best display their advantages. Land use cover (LUC) assessment is one of the most important parameters to meaningfully plan for land resource management. LUC inventories are assuming increasing importance in various resource sectors like agricultural planning, settlements surveys, environmental studies and operational planning based on agro-climatic zones. The knowledge of spatial land cover information is essential for proper management, planning and monitoring of natural resources (Zhu, 1997). The multi-temporal data are frequently used to generate landscape-based metrics and to assess landscape condition and monitor status and trends over a specified time interval (Jones et al., 1997).

Remote Sensing (RS) and Geographic Information System (GIS) tools have been used for collecting significant amounts of data from the earth's surface. RS provides an excellent source that helps in updating land use/land cover (LULC) information and through that, changes can be extracted, analyzed and simulated efficiently. RS in the form of aerial photography provides widespread information of urban changes (Bauer et al., 2003). It should also be noted that LULC mapping using remote sensing has long been a research focus of various investigators (Civco et al., 2002). Thus, currently, monitoring and mediating the adverse consequences of land use/land cover change while sustaining the production of essential resources has become a priority of researchers and policy makers around the world (Erle and Pontius, 2007).

## 2. Study area

Nun Nadi Watershed (NNWS) is located in the North Eastern part of the Doon Valley between 30°20'08" to 30°28'18" N lat-

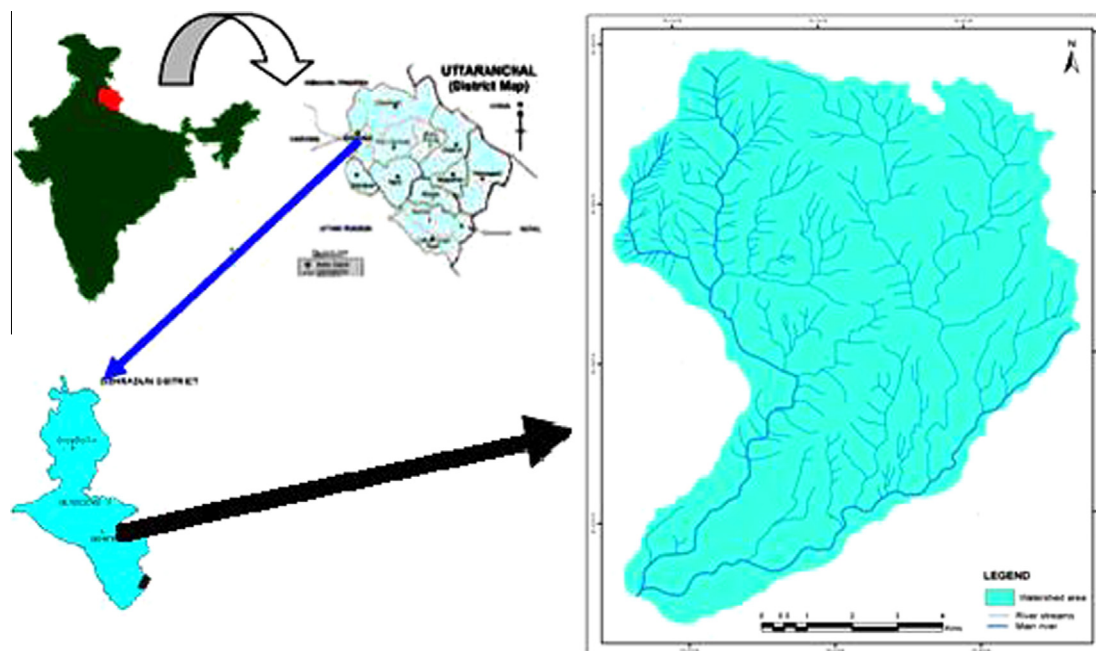


Figure 1 Geographical location of the Nun Nadi Watershed.

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