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Associate Professor in Geography, M.S. G. Arts, Science and Commerce College, Malegaon Dist. Nashik Maharashtra
Email: profgautamkolte@gmail.com

Address for correspondence:
Dr. Kolte Gautam Laxman
Associate Professor in Geography, M.S. G. Arts, Science and Commerce College, Malegaon Dist. Nashik Maharashtra
Email: profgautamkolte@gmail.com

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Agricultural Land Use Change and Its Environmental Consequences: A Geographic Assessment

Dr. Kolte Gautam Laxman

Abstract

The agricultural land use is experiencing tremendous change in the world especially in developing countries such as India in which population increase, urbanization and shifting economic interests are modifying the traditional farming sceneries. This paper addresses the trend and causes of agricultural land use change and assesses the environmental impacts or implications of this development using a geographic perspective. The replacement of food grain with cash crop, increased irrigation and decline in falls and forest cover are among the trends that have extensive implications. These are soil erosion, drainage of water resources, deforestation, biodiversity erosion and greenhouse gas emissions. Through the prism of the case study of India, this study combines geospatial analysis, secondary data analysis, and case studies that are specific to the region in question to give the thorough picture of these dynamics. To track the change of land cover and evaluate the ecological effects, the Remote Sensing, GIS, and NDVI tools were employed. The paper highlights that the interpretation of spatial and temporal changes in land use is important to the sustainability of the environment. It ends with policy recommendations, including the promotion of agroecology, crop zoning, and the use of technologies that use less water. The results indicate the necessity of combined land-use planning, geospatial observations in real time, and agricultural operations that are ecologically sustainable to maintain the ecological balance and food security.

Keywords: *Agricultural land use, Environmental impact, Land cover change, Geographic assessment, India, Soil degradation, Water resource depletion, Deforestation, Biodiversity loss, GIS, Remote Sensing.*

Introduction

The relatively stable agricultural land use has undergone major alterations in the past decades in terms of human intervention, technological progression, and changes in policy. The pressure on population and urbanization, commercial agriculture, and state-sponsored reforms in the form of the Green Revolution drive these changes in such countries as India. Although these changes have resulted into higher productivity, they have resulted into significant damage to the ecosystems, hydrology, and soil systems. Geographic evaluation is useful in the study of land use changes, the spatial distribution of land use changes, their causes, and environmental impacts of land use changes. These dynamics will be critical in the planning of sustainable agricultural activities that are both environmentally friendly and economical. The objectives of the paper are to analyze the pattern of agricultural land use change in India, its effects on the environment, and propose a solution to the issue through geographic tools and analysis.

Objectives

1. To examine the time-space variations of agricultural land use change in India.
2. To determine the socio-economic and environmental forces that drive such changes.
3. To determine the environmental impact of changed land use on soil, water and biodiversity.
4. To introduce sustainable land management and policy measures to reduce negative impacts.

Methodology

The paper will utilize a mixed-method methodology of combining geospatial technology, secondary data analysis, and case study analysis to have a full geographic value evaluation. To examine land use and land cover (LULC) changes with time, remote Sensing and Geographic Information system (GIS) were used. The satellite data provided by sources like the MODIS, National Remote Sensing Centre (NRSC) was digested to produce the Normalized Difference Vegetation Index (NDVI) and digital maps of land classification.

The visual tools were used to identify spatial changes of the cropland, fallow land, and forest. Also, the government publications were used as secondary data (Agricultural Census, Forest Survey of India (FSI) and the Ministry of Agriculture of India) to compare the long-term tendencies of irrigation, cropping, and soil health. The national data was supplemented by relevant international databases, such as FAO and the World Bank. Localized case studies of Punjab, Maharashtra and western Ghats were also included in order to contextualize the effects in the various agro-ecological regions. An extensive literature review was also conducted on the basis of scholarly journals, research reports, and policy documents to add to the analysis and confirm observed trends.

Trends and patterns in agricultural land use change

The area of agricultural land has continuously grown worldwide resulting in the massive deforestation of forests, wetlands, and grasslands. The condition in India is complicated and dynamic. The net sown area increased by 118m to 141m between 1950 and 2020 and gross cropped area increased by 132m to 200m between 1950 and 2020. This is because Green Revolution resulted in massive growth of irrigated agriculture which currently occupies more than 100 million hectares. Such changes have however also been at a price: fallow land and pastureland have been very much reduced, and encroachment on forest has grown. Cropping patterns have also experienced a change wherein food grains have been replaced by cash crops such as sugarcane, cotton and soybean. Such land use changes have been notable in agriculturally rich states like Punjab, Maharashtra and Andhra Pradesh.

Motivating Factors of Land Use Change

The fluctuating agricultural land use in India is driven by a number of interrelated factors. The foremost force factor is the demographic pressure where the population of the nation has increased in number since 1951 to more than 1.4 billion people today and the people have high demand on food and land. Economic forces, which were greater mechanization, the liberalization of the market, and the emergence of agribusiness, have promoted the production of commercial crops at the cost of food security and environmental equilibrium. The transformations in technology, especially throughout the Green Revolution, brought in varieties that yielded high, as well as chemical-intensive agricultural methods that have substantially changed the conventional agricultural landscapes. Interventions at the policy level such as input subsidies and minimum support prices continued to give incentives to intensive production of water-intensive crops such as rice and sugarcane, in areas that had insufficient water supplies. Moreover, industrialization and urbanization have resulted in agricultural land changing to the non-agricultural purpose especially around the expanding cities and transport corridors.

Environmental Consequences

The environmental effects of agricultural land use change are extensive and may be usually harsh. Among the most noticeable ones, one can single out soil degradation which takes the form of erosion, salinization, and the loss of nutrients. The heavy application of chemical fertilizers and ploughing has contributed to the falling soil fertility in some of the areas. Overuse of canal irrigation has caused waterlogging and salinity in the irrigated areas like Haryana and Punjab. Another important issue of concern is the depletion of water resources. More than 60 percent of Indian irrigation is now based on ground water with major depletion affecting states susceptible to drought such as Rajasthan and Maharashtra. The groundwater tables in certain areas have reduced by over four meters within the last 20 years. Another important consequence of agricultural frontiers is deforestation and a decrease in biodiversity. Chhattisgarh, Odisha, and Madhya Pradesh have cleared their forest lands in order to cultivate them and the habitat is being fragmented and native species are vanishing. Monoculture agriculture causes a decrease in biodiversity and loss of ecosystem resilience particularly whereby there are high presence of GM or hybrid seeds. Also, the changes cause climate change by releasing more and more methane and nutrous oxide, especially by paddy fields and artificial fertilizers. Land cover changes also modify the local climatic conditions, raising temperatures, and diminishing the capacity to store carbon.

Case Studies

Punjab is a sharp illustration of the advantages as well as the downfalls of agricultural modernization. Despite being at the forefront of Green Revolution, Punjab now faces a problem of declining water levels, soil degradation and depleted crop varieties as a result of its rice-wheat mono culture. In Maharashtra and especially in Vidarbha, farmers are now exposed to crop failures, debt and distress because of the shift to cash crops such as cotton and soybean without the irrigation infrastructure to support the crops. These unsustainable practices have been associated with high rates of farmer suicides that have been recorded in the region. Plantation farming is a threat to the Western Ghats, which is a known biodiversity hot spot. The ecological balances have been disturbed by the substitution of native forests with tea, coffee, and rubber plantation which have led to soil erosion, and a decrease in hydrological stability. These instances highlight the impacts of the agricultural land use change on the regions specific to them.

The use of Geospatial Tools in Assessment

The geospatial technology has now emerged as a very important resource in checking and evaluating the land use dynamics. Land use and land cover (LULC) using satellites enable the accurate visualization of agricultural patterns to be made. The NDVI (Normalized Difference Vegetation Index) can be used to determine the health of crops, the density of vegetation, and the productivity of the land. Digital Elevation Models (DEMs) are useful in the detection of susceptible areas in soil erosion and water run-offs. The use of GIS platforms can provide a combination of several layers of spatial data, including soil type, rainfall, slope, and land use, to provide composite vulnerability maps. These instruments play a significant role in evidence-based planning and enable policy-makers and scientists to focus on the areas where intervention is required and implement specific conservation strategies.

Policy Lapses and Governance Problems

Although India has various national missions as well as agricultural policies, there has been no integrated land use policy that balances agricultural productivity and environmental sustenance. There is a laxity in the enforcement of land zoning and the environmental impact assessment is usually not present in agricultural planning. The division of farmlands also makes it difficult to practice sustainable methods at a large scale. Further, water, electricity, and fertilizer subsidies tend to promote wastefulness in the resources and dis-incentivize the process of environmental friendly farming. There is also the issue of the absence of coordination between the various departments of the government and poor investments in real-time monitoring and geospatial infrastructures.

Recommendations

To address the challenges of agricultural land use change, a combination of technological, policy, and grassroots measures is essential. First, there is a need to promote agroecological practices such as crop rotation, intercropping, and integrated nutrient management to restore soil health and biodiversity. Second, crop zoning policies should guide farmers toward selecting crops based on agro-climatic suitability and water availability, thus reducing overreliance on water-intensive crops in dry zones. Third, efficient irrigation systems like drip and sprinkler irrigation should be widely adopted, supported by government subsidies and technical training. Strengthening land use planning through GIS-based decision support systems can help identify vulnerable regions and manage agricultural expansion responsibly. Additionally, awareness and capacity building among farmers are crucial for the adoption of sustainable practices. Policymakers must also reform subsidy structures to reward conservation efforts and penalize ecologically harmful practices.

Conclusion

Agricultural land use change, while necessary to meet food demands, has produced serious environmental consequences. The degradation of soil, depletion of water, and reduction in biodiversity are clear indicators that current agricultural practices are not sustainable. This paper demonstrates that a geographic approach—utilizing spatial analysis, case studies, and geospatial technologies—can reveal the extent and nature of these changes and guide corrective actions. The future of Indian agriculture lies in balancing productivity with sustainability through integrated land use planning, community participation, and science-based policymaking.

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Conflicts of interest

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