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# From Cropland to Concrete: Land Surface Transformation Surrounding Bhubaneswar and Its Impacts on Agriculture

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Land surface transformation is the process of altering the physical cover configuration of Earth's terrestrial skin by human activities or natural forces. It includes shifts from natural vegetation or water bodies into agricultural fields, urban concrete, or degraded soil, directly impacting local climates and ecosystems. The key driving factors for this transformation are Urbanization, Agricultural expansion, Infrastructure growth, and resource extraction. This, in turn, causes many environmental and climatic atrocities like Urban Heat Islands (UHI), hydrological disruption, and biodiversity loss.

## Introduction

Bhubaneswar, the capital city of Odisha, has undergone remarkable transformation over the past few decades. The city, once surrounded by lush green agricultural fields, vegetation, ponds, and open spaces, is now experiencing rapid urban expansion. New residential colonies, roads, commercial centers, institutions, and other infrastructure are rapidly growing but at the expense of green landscapes. Over the last 30 years, satellite observations have clearly shown the expansion of built-up areas around Bhubaneswar and the changes in agricultural land, vegetation, and other land use classes. The studies conducted between the early 1990s and now show considerable growth of urban areas in Bhubaneswar, and several changes have occurred in land use patterns (Das et al., 2022; Panigrahi & Sharma, 2025; Sing et al., 2026). For agricultural purposes, this change does not only involve the amount of land available. The conversion of agricultural and vegetation areas into buildings, concrete, and roads also alters the physical characteristics of these sites. Specifically, the heat absorption, retention, and release characteristics of the surface are affected. Such changes can have consequences for the thermal environment of the local area and the agricultural microclimate of the regions in close vicinity of the ever-growing city.

## Changes happening in Bhubaneswar

Land-use change is a process of changing land cover from one type to another. In Bhubaneswar, one of the significant changes that has been taking place is the transformation of agricultural and open land into built-up area. Research based on satellite imagery data has been carried out by Das et al. (2022), who estimated urban expansion in Bhubaneswar taking into account a period of 30 years. The authors studied the period between 1991 and 2021 and indicated that there were significant changes in land use and land cover. Later papers also dealt with the growth of urbanized areas in and around Bhubaneswar (Panigrahi & Sharma, 2025; Sing et al., 2026). In some cases, this process does not happen simply by replacing large agricultural areas with large urban areas. For the most part, development is gradual: a road crosses the agricultural land, settlements develop along the road, small parcels of land begin to be developed, small businesses appear, and the unique agricultural landscape ends up being converted into a fragmented one. For the farmer, the smaller and fragmented fields

become harder to cultivate efficiently, and access to irrigation, machinery, and farm roads can also change.

## The unseen transformation: The rising Land Surface Temperature

An underlying consequence of Urbanization is the change in Land Surface Temperature (LST). Land Surface Temperature refers to the temperature of the land surface of the Earth as it is recorded by means of satellite technology. This is not the air temperature as it can be recorded by weather stations. However, the measurement of LST plays a very important role when it comes to determining how different types of land surfaces react to sunlight. A concrete building, asphalt pavement, damp farmland, and a green field of crops will respond differently to the heat of the sun. Plant surfaces utilize some of the solar energy for the process of evapotranspiration, which is the loss of water from plants and soils into the atmosphere. In contrast, built structures such as concrete and asphalt tend to collect and keep significant amounts of solar energy, leading to warmer surface temperatures. As a result, when vegetation is replaced by built structures, the thermal properties of the environment change. Research findings from Bhubaneswar indicated a positive correlation between built-up areas of a city and its land surface temperature, while surface temperatures in vegetated zones are lower (Das et al., 2022; Panigrahi & Sharma, 2025; Singh et al., 2025).

## An agronomic point of concern

At first sight, LST and urbanization seem to be the topics of interest for geographers or town planners. However, it is of the same importance for agronomists as well, especially in the case of swiftly developing territories, e.g., the suburbs of Bhubaneswar. Agriculture relies heavily on the interaction of plants, soil, water, and atmosphere. Any significant alteration of the surroundings' land cover may impact this interaction. In the case when agricultural land is surrounded by buildings, the following changes may occur:

Land transformation, landscape fragmentation, modified surface energy balance, changes in surface temperature and humidity, changes in crop microclimate. Thus, all the remaining agricultural lands are going to be part of an increasingly modified landscape. That does not mean that increasing the LST will inevitably bring down crop yields. It is necessary to remember that the response of crops to rising temperatures depends on plant species, variety, stage of growth, soil moisture, irrigation conditions, season, and many others. Anyway, the increase in temperature will lead to higher heat load and evaporative demand, especially in hot and dry periods.

## Impacts on agriculture and soil

**1. Rise in thermal stress:** It has been seen that with the rise in temperatures at sensitive life stages, including flowering and grain filling, most agricultural products would get negatively affected by the same. Hence, when the landscape becomes warmer and drier, crops continue to be adversely affected by heat stress during hot seasons.

**2. Increased requirement of water:** As the land continues to get hotter, there will be increased evaporative demand. In areas with access to irrigation water, thereby increasing the requirement of efficient management of irrigation to ensure soil moisture. This becomes an essential requirement in peri-urban regions, where agricultural water will be competing with domestic and industrial water demand.

**3. Alterations in soil moisture:** Vegetated and agricultural areas are in constant interaction with soil moisture. Changes in vegetation cover and development of impermeable surfaces alter infiltration, runoff, and water availability. In urban areas, water falling on roads and other impermeable surfaces does not infiltrate into agricultural soils; it quickly becomes runoff. Hence, urban development affects local water balance.

**4. Changes in crop microclimate:** The microclimate of fields surrounded by vegetation differs from that of fields surrounded by impervious surfaces and structures. Changes in shade, wind, humidity, solar radiation, and soil temperature influence the microclimate of crops.

Understanding these changes is crucial for the formulation of appropriate crop and water management practices.

## Peri-urban agriculture: The land connecting city and village

The agricultural structure that exists surrounding Bhubaneswar is a key example of peri-urban agriculture; a territory where agriculture and urban lifestyle meet.

These territories create good opportunities for providing fresh products such as vegetables, fruits, dairy products, and others to the nearby urban population. The close proximity of peri-urban territories allows the growing of expensive and short-cycle crops.

However, peri-urban agriculture also has its challenges, including:

1. Conversion of land for agriculture to other uses.
2. Fragmentation of agricultural lands.
3. Rising prices of land.
4. Competition for water.
5. Change in soil and environmental conditions.
6. Higher heat.
7. The pressure to move away from traditional farming.

All these developments give rise to the conclusion that the problem is not in the stopping of urban development, but the necessity to plan the urban development that will help protect productive agricultural landscapes.

## Agriculture as a Cooling Space

Agricultural land should best be seen beyond how much crop production it can yield. Healthy cropland is a multifunctional space. It produces food, absorbs carbon, fosters biodiversity, allows water to infiltrate into the soil, and cools the nearby air by way of evapotranspiration. Thus, greenery can serve as a means of regulating climate naturally. This vital function of greens and agricultural lands near Bhubaneswar makes it critical to preserve them not only for farmers but also for the general city population. Instead of treating agricultural land as land that may be converted into buildings one day, planners also need to realize the role of this land in improving the state of the environment.

## The Role of Farmers

While land-use planning is controlled by government and urban management, farmers can take initiatives that promote greater resilience for the remaining agricultural land.

**1. Preserve soil moisture:** Practices such as mulching, conserving residues, and improving soil organic matter can help in the preservation of moisture and reduce excessively high temperatures in the soil.

**2. Practice efficient irrigation:** Using drip irrigation or any other effective irrigation system can help in achieving greater efficiency in water use.

**3. Cultivate a variety of crops:** Having different crops allows farmers to lessen the dependency on one crop while having a more flexible operation in climate change.

**4. Choose the necessary varieties:** Heat-resistant and local crop varieties play an even more important role when the intensity of heat grows.

**5. Combine tree and crop production:** Agroforestry, together with trees intentionally grown on the farm, can help create shade, decrease wind flow, and reduce temperatures on the farm while providing additional products as well.

## Role of urban planners

Agriculture experts and farmers cannot solely account for land-use changes. Urban planners need to take into consideration the agricultural and climatic significance of peri-urban areas.

Some of the possible actions can entail:

- Preserving active agricultural land from unnecessary conversion.
- Maintaining green belts around growing cities.
- Preserving wetlands and water bodies.
- Preserving vegetation corridors.

- Promoting green infrastructure.
- Incorporating agriculture into city and country long-term planning.
- Utilizing satellite LULC and LST observation to determine which areas are vulnerable to land-use changes.

These actions can help Bhubaneswar grow, while still preserving the ecological and agricultural functions of the areas surrounding it.

## Climate-smart approach in Bhubaneswar

The concept of climate-smart development must integrate elements of urban planning, agronomy, agricultural meteorology, remote sensing, and water management. The goal is not to choose between development and agriculture, but to create a place where cities can grow while taking care of fertile agricultural land and surrounding green areas and water.

## Conclusion

It is evident that land changes occurring in the areas surrounding Bhubaneswar do not just affect the appearance of the landscape but also result in a change in land's interaction with sunlight, water, and atmosphere. Remote sensing shows rapid growth of built-up areas near Bhubaneswar and changes in land surface temperature. From an agricultural perspective, these changes pose many challenges for soil moisture, heat stress for crops, water needs, and the future of peri-urban agriculture. Consequently, the existing agricultural areas need special attention as an essential part of the region's environmental infrastructure. Safeguarding them is significant not only for preserving farmland but also for ensuring food production, conserving water, securing community livelihoods and creating a climate-resilient environment. As the city continues to grow, the question of how much land should be utilized for Bhubaneswar should be followed by a question of how much productive and environmentally valuable land the city can afford to lose.

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