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Impacts of Climate Change, Land Transformation and Advanced Technologies on Agriculture: A Microlevel Spatio-Temporal and Geo-Statistical Analysis of Four Mandals of Jangaon District in Telangana

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Abstract: ***Land Use/Land Cover (LULC) refers to the human modification of the Earth's surface, resulting in changes to the natural environment. LULC changes have significant impacts on ecosystems, biodiversity, climate, and human well-being. Some of the Key Aspects of LULC Clearance of forests for agriculture, urbanization, and other human activities. Expansion of urban areas, leading to changes in land use and cover. Conversion of natural habitats to agricultural land, affecting ecosystems and biodiversity. LULC changes contribute to climate change by releasing stored carbon and altering ecosystem processes. Importance of LULC is Monitored by Understanding LULC changes informs policies and practices for sustainable development, Monitoring LULC changes helps identify areas for conservation and restoration and thus Accurate LULC data supports climate change modeling and mitigation strategies. By analyzing and monitoring LULC changes, researchers and policymakers can develop effective strategies to mitigate the negative impacts of human activities on the environment.***

Keywords: Agriculture, Urbanization, Deforestation, Afforestation, Land Degradation, Soil Erosion, Water Resources Management, Landuse, landcover

1. Introduction

Land Cover is the major physical existence that occupy on the surface of earth while Landuse is the first activity that human does for his survival. As per Food and Agriculture Organization, Land cover refers to the observed physical and biological cover of the earth's land. Land is covered by various forms of vegetation, grasslands, scrubs, water bodies, bare soil etc. All the naturally occurring vegetation cover is called land cover. Food and Agricultural Organization, defines land use as “the total of arrangements, activities, and inputs that people undertake in a certain land cover type". According to Fox, “The land use is the actual and specific use to which a land surface is put in terms of inherent land use characteristics”. Therefore, land cover is a natural vegetation; land use is utilization of land by man as per his needs and choices. In other words, land use in general terms is human modifications of Earth’s terrestrial surface.

LL and cover is the observed (bio)physical cover on the earth's surface. Land use is characterized by the arrangements, activities and inputs people undertake in a certain land cover type to produce, change or maintain it 5(FAO).

However, Land is the utmost very important resource which provides us a area or place to stay or live on and use its extent for the collection and cultivation of food for our survival other than the food collected from the aquatic habitats. A Land cover and Landuse study of a region is necessary and it is very important reason to evaluate the per capita availability of the resources for its use in various purposes for a given period of time. Landuse is the result of exploitation of the Land cover and often is used either directly for Built-up purpose or indirectly by cultivating the crops for a temporary period on it. By any ways land has to be either utilized directly, designed, developed, modified for the utilization of some specific purpose. “When used together with the phrase Land Use / Land Cover (LULC) generally refers to the categorization or classification of human activities and natural elements on the landscape within a specific time frame based on established scientific and statistical methods of analysis of appropriate source materials. Identification of land cover establishes the baseline information for activities like thematic mapping and change detection analysis. Land use refers to the purpose the land serves, for example, recreation, wildlife habitat, or agriculture.” As time passes the quantity and quality of landuse and its efficiency frequently undergoes very remarkable changes. Such changes are the effect of various driving factors viz. Natural Forces, Demand, Availability, Time, Climate, Productivity and Management Efficiency etc.

Land cover and Landuse study tells us and plays an important role in the process of planning, designing and in the course of identifying the issues associated with the resource as well as in the course of developmental practices. The operation of Land cover and Landuse study is from the very begining stage of the foundation of human civilization when human was moving as a nomad and searching for a safe and suitable place to board either for a interim or a long term period of time. Since then, the land

resources obtainable nearby for the use of existence has compelled the human race to evaluate the resource by measuring it. Furthermost, mapping the Land cover and Landuse in different time period has made us to understand any changes which has happened to the resource either by natural forces or any artificial or anthropogenic effects. It provides very useful message about how much of single type of the resource was available in past and is available at present for every individual which are applicable to be the consumer of the certain land packet within the concerned region. This also tells to the question that what type of land is at more risk or vulnerable to several threats because of the modifications occurred in the past and permits us to forecast future of the resource. Land cover and Landuse mapping becomes very advantageous when it is associated and correlated with the other factors which have deep effect on it. It authorizes the users to understand both qualitative and quantitively type of land is more available for development, optimization and utilization best used for which purpose in different time period to give maximum benefit of its usage in the present generation by studying its formerly and present condition and it also gives a clear picture of the future consequences of over utilizing or ignoring the resource in its present state.

Here in this research the Land Cover and Landuse of the Study area has been studied for a period of 20 years from past 2001 to 2020 to understand the availability and utilization of the land for different purposes for every 5 years interval between the given time. Hence, here 5 sets of LULC maps are prepared to describe the past and present scenario which are given below in the Figure No. to Figure No. . The Landuse statistics is enlisted in the table (TABLE) and graphically illustrated in the graph (Graph) in which the area is given in hectares and the percentage of the Land cover and Landuse with reference to the total geographical extent of the Division is computed. A detailed evaluation of the lands under agricultural use with special reference to the areas under rainfed agricultural practice is discussed later in the next chapter where the agricultural statistics and the agricultural landuse is discussed.

Objectives

1) To study the landuse and land cover of study area.
2) To make a comparison of Landuse and Land cover of the Study area for last 20 years from Spatial, Resource and Economic point of view to identify the impact on agricultural lands.

2. Methodology

1) Base map for landuse and land cover studies have to be prepared from, 1980-85 SOI toposheets on 1:25000 scale.
2) For temporal Analysis and comparison of the Earlier LULC Satellite Scenes of EO Hyperion HySI for the year 2005 and Sentinel-2 HySI for the year 2017 have to be Classified and statistical calculation of the change detection will be carried out to find out the vulnerable agricultural lands.

The Land cover and Landuse maps prepared in decade intervals are often considered as the average result of at least previous five years of practice and may go and have undergone some changes for further five years. Hence the statistics can be understood for a period of ±5 years from the mentioned year of mapping on the map. But in reality certain types of lands undergo very drastic changes every consecutive years. For this study particularly the primary types of Land cover and Landuse are mapped only to understand the overall distribution of the resources within spatial extent of the Division in different time periods. Only the arable lands are further subdivide into its subcategories such as area under only Spring Crop cultivation, area under only Autumn crop cultivation, area under crops cultivated in both seasons and fallowed croplands to address the impact of climate variability especially on Autumn Crops or Rainfed Crops. However, a brief of the overall changes in various major LULC categories over decadal interval with respect to the previous decadal year is given.

Percentage of LULC Change Of four mandals with respect to the past Years from 2001-02, 2005-06, 2010-11, 2014-15, 2020-21:

LULC IN 2001-02: The table appears to present land utilization data for different regions (Devaruppala, Palakurthy, Kodakandla, and Zaffargadh) for the year 2001-02. The data is sourced from the Chief Planning Office and includes various classifications of land use.

As given in the table above, agricultural lands were the dominating category of landuse of all other types of landuse and land cover around human civilization. During 1995, most of lands were under agricultural production which accounted up to more than 25% of the total land in the Division. It is noticed that the spread of Agricultural lands are mostly observed around the main water areas, streamlines or rivers passing diagonally and along the border of the Division. But more concentration can be seen in the southeast region rather than any other region as the area is apparently low and surrounded by the junction of two major rivers of the Division i.e. Musi, maneru which are tributaries of river Krishna. Together the Barren and the Built-up lands also occupied nearly the same extent of geographical area in the Division which accounted. Comparatively Barren lands are more in percentage i.e, 6.17% in zaffargadh than in other mandals of the Division. Most of the parts of palakurthy, kodakandla, zaffargadh mandals were covered by other fallow lands lately during 90's while zaffargadh is occupied in less percentage comparatively with other three mandals. While the croplands were dominating the regions of the mandals, the other major part was totally occupied by current fallow lands in the concerned Mandals during the same time. Followed by the other fallow lands and current fallow lands, Forest occupied the zero percentage of geographical extent in the Division as there is no forest area in my study area. Fallowed agricultural lands were ranked as the third largest landuse type followed by the croplands and other fallow lands in the Division. Nearly 34.4% of the Division were noticed as other fallowed agricultural lands of palakurthy mandal followed by devaruppla mandal of

26.3%, then 11.3% of kodakandla mandal and 4.92% of zaffargadh mandal which were spotted everywhere in the Division but maximum concentration was observed in the palakurthy. Similarly, Open Pasture lands and Culturable wastelands has occupied the next place of land cover type in the Division followed by the permanent pastures and land put to non agricultural uses. Open Pasture lands and Culturable Wastelands were well- distributed throughout the entire Division and were found everywhere.

The major Observations were Zaffargadh has the highest barren and uncultivable land (2529), whereas Devaruppala has the least (52). Kodakandla has a higher proportion of land put to non-agricultural uses (808) compared to the other regions. Permanent pastures and grazing lands are more prominent in Zaffargadh (2590). Total geographical area is largest for Palakurthy (63249) and smallest for Kodakandla (46792). Net Area Sown is highest in Palakurthy (31,434) and lowest in Devaruppala (25,033).

LULC IN 2005-06: Unlike the scenario of 90's, it was observed that the agricultural landuse was the primary type of landuse in late 2000's which suddenly decreased to nearly 40% of the total available lands in the Division which accounted to the lands as a sum. Similar to 2001, here the agriculture production is more when compared to other croplands. Next to that other fallow lands occupied second position with a 26.96% in devaruppla mandal, followed by palakurthy mandal with major part of 34.41%, whereas kodakandla covered11.36%. zaffargadh covered very less percentage 1.08%. then third position was occupied by current fallow lands with a Maximum spread with a more percentage in devaruppla mandal and very less comparatively in zaffargadh mandal. Kodakandla occupied more 7.67% percentage of culturable waste land, then devaruppla covers next position of it. Comparatively all the other categories occupied less percentage. Comparing with 2001, it is a negative sign that all the category land utilization has been decreased more than 50% in devaruppla mandal. Majorly Current fallow lands decreased to 73.3% in devaruppla. In palakurthy mandal total cropped area has increased 63.5%, but remaining all the categories decreased more than 50% of the land utilization. In Kodakandla mandal mainly current fallow lands decreased68.2%, whereas remaining all other categories was reduced to approximately 55%. In zaffargadh mandal land under misc.tree crops and groves was completely reduced to 100%, whereas current fallow lands was decreased to 99.8% 0f its area covered. Comparing the Landuse of 2001 with 2005 it can be said that there was a negative correlation between the extent of surface waterbodies with the agricultural lands.

LULC IN 2010-11: The following is a detailed breakdown of land utilization for the four regions: Devaruppula, Palakurthy, Kodakandla, and Zaffargadh, expressed as a percentage of their total geographical area. Forest Area is 0% in all four regions, indicating that no land is covered by forests. Barren and Uncultivable Land in Devaruppula is 0.54% of the total land is barren and unsuitable for cultivation. In Palakurthy 1.24% of the total land is barren and uncultivable. In Kodakandla 1.76% of the land falls under this category. In Zaffargadh 6.06% of the total land is barren, the highest among the four regions. Land Put to Non-Agricultural Uses Devaruppula 4.87% of the land is used for non-agricultural purposes such as buildings, roads, and other infrastructure. In Palakurthy 6.24% of the land is used for non-agricultural activities. Kodakandla 5.15% of the land is used for purposes other than agriculture. Zaffargadh 3.55% of the land is utilized for non-agricultural needs, the lowest among all. Culturable Waste Land in Devaruppula is 0.71% of the total land is classified as culturable waste, meaning it is currently not cultivated but has the potential for cultivation. Palakurthy 0.42% of the land falls under this category. Kodakandla 1.69% of the total area is culturable waste land. Zaffargadh 0.64% of the total land is culturable waste.

Permanent Pastures & Other Grazing Lands in Devaruppula is 1.64% of the land is used for permanent pastures and grazing. Palakurthy 0.95% of the total land is used for grazing. Kodakandla 3.39% of the land is dedicated to grazing, the highest percentage among the regions. Zaffargadh 0.57% of the land is used for grazing. Land Under Miscellaneous Tree Crops & Groves (Not Included in Net Area Sown) in Devaruppula 10.07% of the total land falls under this category, the highest among the four regions. In Palakurthy 7.75% of the total land is occupied by tree crops and groves. Kodakandla 5.06% of the land is used for tree crops and groves. Zaffargadh 0.74% of the total land is under tree crops and groves, the lowest among the four regions. Current Fallow Lands (Temporarily Unused for Cultivation) in Devaruppula is 4.80% of the land is temporarily fallow. In Palakurthy 1.84% of the land is fallow at present. Kodakandla 2.03% of the land is currently not in use. In Zaffargadh 0.04% of the total land is temporarily unused for cultivation. Other Fallow Lands (Long-Term Unused Land) in Devaruppula 34.22% of the land falls under this category, meaning a significant portion of the land has not been cultivated for an extended period. In Palakurthy 36.11% of the land is categorized as other fallow lands, the highest among the four regions. Kodakandla 28.45% of the land remains fallow. Zaffargadh Only 0.14% of the land is classified as other fallow lands, the lowest percentage among all regions.

Summary of Key Observations

Zaffargadh has the highest net area sown (87.67%), indicating extensive farming.Kodakandla has the highest percentage of land sown more than once (29.66%), which suggests multiple cropping cycles. Palakurthy has the highest proportion of long-term fallow land (36.11%), showing a significant portion of land remains uncultivated for extended periods. Devaruppula has the highest percentage of land under miscellaneous tree crops and groves (10.07%), meaning more land is used for permanent crops. Forest area is completely absent in all four regions.This detailed explanation provides insights into the land utilization patterns in the four regions, highlighting agricultural activity, wasteland proportions, and fallow land distribution.

When compare to 2005-06, Barren and Uncultivable Land have Significant reduction in barren land in Zaffargadh (-39.3%). A considerable increase in Devaruppala (+82.7%),

while Palakurthy and Kodakandla saw minor changes (+0.1%). In Land Put to Non-Agricultural Uses Devaruppala (+89%), Palakurthy (+87.5%), and Kodakandla (+66.5%) saw significant increases

And A decrease in Zaffargadh (-14.6%). Culturable Waste has a Sharp decline in Kodakandla (-78%) and Zaffargadh (-94.4%). Significant increase in Devaruppala (+88.8%) and Palakurthy (+91.1%). Permanent Pastures & Grazing Land were Decreased in Zaffargadh (-73.2%) and Increased in Kodakandla (+41.8%). Devaruppala saw a minor increase (+12.5%), whereas Palakurthy declined (-27.4%). Land Under Misc. Tree Crops & Groves Decreased significantly in Palakurthy (-100%) and Kodakandla (-100%). Increased significantly in Devaruppala (+96.6%) and Zaffargadh (+100%). Other Fallow Lands were Increased in Zaffargadh (+68.1%). Kodakandla (+65.2%) and Palakurthy (+77.2%) also showed a rise. A moderate increase in Devaruppala (+62.1%). Total Geographical Area is Remained stable across all regions with minor fluctuations (+0.1%). Area Sown More than Once is Increased in Devaruppala (+40.9%), Palakurthy (+38.4%), Kodakandla (+36%), and Zaffargadh (+38.6%). Total Cropped Area Growth in Devaruppala (+9.6%) and Palakurthy (+1.5%). Decline in Kodakandla (-7.4%) and Zaffargadh (-1.5%). Net Area Sown is Increased in Devaruppala (+16.5%) and Zaffargadh (+5.8%). Decreased in Palakurthy (-7.4%) and Kodakandla (-24.2%).

Summary

Positive Changes: Increased land utilization for agriculture in Devaruppala and Zaffargadh, with more land being cultivated. Negative Changes: Decline in net area sown in Palakurthy and Kodakandla, possibly due to urbanization or soil degradation. **Significant Variations:** Land put to non-agricultural uses rose in most regions, and pastures and fallow land showed inconsistent trends across different regions. Overall, while Devaruppala and Zaffargadh saw improvements in agricultural land use, Palakurthy and Kodakandla faced reductions in key cultivated areas.

LULC IN 2015-16: The given table presents land utilization data for different regions (Devaruppula, Palakurthy, Kodakandla, and Zaffargadh) for the year 2015-16. It is categorized based on different land utilization types.

Explanation of Different Utilization Types: No forest land recorded in any of the four regions. Barren and Uncultivable Land are highest in Zaffargadh (1004 hectares). Land used for infrastructure, settlements, etc is highest in Palakurthy (1598 hectares). Land that is not cultivated but has the potential; highest in Kodakandla (975 hectares). Permanent Pastures & Grazing Lands Used for animal grazing; Kodakandla has the highest (641 hectares). Land under Miscellaneous Tree Crops & Groves (Not Included in Net Area Sown), Areas covered by trees and groves, but not part of the net sown area. Land left fallow in the current year; highest in Palakurthy (3827 hectares). Land left uncultivated for a long time; highest in Palakurthy (4289 hectares). Land used for multiple crops in a year; highest in Palakurthy (4457 hectares). Total land where crops were cultivated; highest in Palakurthy (17687 hectares). Net Area Sown is highest in Palakurthy (13320 hectares).

Key Insights:
Zaffargadh has the highest percentage of barren and uncultivable land (6.06%). Palakurthy and Zaffargadh utilize more than 50% of their land for cultivation. Other Fallow Lands are highest in Devaruppula (40.38%), indicating a significant amount of land left uncultivated. Total Cropped Area is highest in Zaffargadh (84.86%), showing a strong agricultural presence.

Here is a detailed comparison of land utilization between 2010-11 and 2015-16 based on the provided spreadsheet.

Barren and Un-Cultivable Land 2010-11: Increased significantly in Devaruppula (+82.7%) and Kodakandla (+39.3%) but remained almost unchanged in Palakurthy (+0.1%) and Zaffargadh. 2015-16: No further increase in Devaruppula, Palakurthy, and Kodakandla (+0%).

Observation: This indicates that previously un-cultivable land increased in 2010-11 but stabilized by 2015-16.

Land Put to Non-Agricultural Uses 2010-11: A major increase in Devaruppula (+89%) and Palakurthy (+87.5%), while Kodakandla and Zaffargadh had significant declines (-88.8% and -91.1%, respectively).

2015-16: No significant change in Devaruppula and Palakurthy (+0%), but Kodakandla and Zaffargadh saw a slight increase (+14.6% and +48.6%).

Observation: Land conversion for non-agricultural use grew significantly in some areas initially but stabilized later.

Cultivable Waste in 2010-11: Increased in Devaruppula (+12.5%) but declined in Palakurthy (-27.4%), Kodakandla (-41.8%), and Zaffargadh (-73.2%).
2015-16: No change in Devaruppula, Palakurthy, and Kodakandla (+0%), but a significant recovery in Zaffargadh (+48.6%).
Observation: Land categorized as "cultivable waste" was reduced significantly in 2010-11 but rebounded slightly in 2015-16. Permanent Pastures & Other Grazing Lands in 2010-11: A major decline in Devaruppula (-78%) but an increase in Palakurthy (+66.5%), Kodakandla (+94.4%), and Zaffargadh (+14.6%).

2015-16: No major changes in any area (+0%).

Observation: Grazing land saw a significant shift in 2010-11, but usage remained stable afterward.

Land Under Misc. Tree Crops & Groves in 2010-11: Sharp increases in Devaruppula (+96.6%) and Palakurthy (+94.3%), while Kodakandla and Zaffargadh saw significant gains (+100%). 2015-16: No additional changes in Devaruppula, Palakurthy, and Kodakandla (+0%),

indicating stabilization. Observation: The growth in tree crops peaked in 2010-11 and remained constant afterward.

Current Fallow Lands in 2010-11: A large increase in Devaruppula (+62.1%) and Palakurthy (+77.2%), while Kodakandla and Zaffargadh showed moderate increases (+60.1% and +68.1%). 2015-16: A decline in all areas except Zaffargadh, where it further increased (+99.9%). Observation: More land was left fallow in 2010-11, but by 2015-16, some areas had resumed cultivation.

Other Fallow Lands in 2010-11: Some increases in Devaruppula (+0.1%) and Palakurthy (+0.4%), while Kodakandla and Zaffargadh remained stable.2015-16: A slight decline in all areas except Zaffargadh.

Observation: There were only minimal changes in this category across both years.

Area Sown More Than Once in 2010-11: Showed growth in Devaruppula (+9.6%) but a decline in Palakurthy (-1.5%) and Kodakandla (-7.4%). In 2015-16 More noticeable declines in Kodakandla (-45.8%) and Zaffargadh (-27.2%). Observation: The practice of sowing multiple crops on the same land saw an overall decline over time.

Observation: The overall cropped area was shrinking, possibly due to urbanization, fallow land, or changing land use patterns.

Net Area Sown in 2010-11 was Declined significantly in Devaruppula (-16.5%) and Palakurthy (-7.4%), with slight changes in other regions. In 2015-16, Continued to decline in Devaruppula (-7.7%) and Zaffargadh (-24.2%).Observation: The decline in net sown area indicates reduced agricultural activity over time.

Final Summary

The most notable trend between 2010-11 and 2015-16 is the reduction in agricultural land and an increase in land for non-agricultural purposes in the early years, followed by stabilization. Current fallow lands and cultivable waste initially increased but later stabilized in some areas. Permanent pastures and grazing land saw a sharp decline, indicating less focus on livestock-based farming. Total cropped area and net area sown consistently declined, suggesting urbanization or land being repurposed.

LULC IN 2020-21:
The table presents land utilization data for different regions (Devaruppula, Palakurthy, Kodakandla, and Zaffargadh) for the year 2020-21. It categorizes the land based on different types of usage.

No forest land recorded in any of the four regions. Barren and Uncultivable Land are Highest in Palakurthy (3,002 hectares). Land put to Non-Agricultural Used for settlements, industries, roads, etc. Highest in Palakurthy (4,353 hectares). Culturable Waste is Highest in Kodakandla (369 hectares). Permanent Pastures & Grazing Lands are Highest in Devaruppula (2,514 hectares). Land under Miscellaneous Tree Crops & Groves is Highest in Kodakandla (1,214 hectares). Current Fallow Lands is Highest in Devaruppula (7,462 hectares).
Other Fallow Lands are Highest in Palakurthy (2,383 hectares). Area Sown More than Once is Highest in Zaffargadh (17,811 hectares). Total Cropped Area is Highest in Zaffargadh (52,481 hectares). Net Area Sown is Highest in Palakurthy (50,578 hectares.

Key Observations:
Zaffargadh has the highest Total Cropped Area (52,481 hectares) and Area Sown More than Once (17,811 hectares), indicating a strong agricultural presence. Palakurthy has the highest land under Non-Agricultural Uses (4,353 hectares), showing urbanization or infrastructure development. Devaruppula has the highest fallow lands (7,462 hectares), meaning a large portion of land was left uncultivated. Kodakandla has more land under tree crops (1,214 hectares) than other regions, possibly indicating fruit or timber plantations.

This data helps in agricultural planning, resource allocation, and policy-making for better land utilization.
Comparison of Land Utilization Between 2015-16 and 2020-21:
The above table compares land utilization changes in four regions (Devaruppula, Palakurthy, Kodakandla, and Zaffargadh) between 2015-16 and 2020-21. The values represent percentage changes over the years. A positive percentage indicates an increase, while a negative percentage indicates a decrease in land usage.

Barren and Uncultivable Land: Significant Increase in Devaruppula (+92.8%), Palakurthy (+89.5%), Kodakandla (+37.6%), Zaffargadh (+17.2%). This increase indicates that more land has become non-arable, possibly due to soil degradation, urbanization, or deforestation. Land Put to Non-Agricultural Uses Increase Across All Regions. In Devaruppula (+14.6%), in Palakurthy (+53.4%), in Kodakandla (+63.3%), Zaffargadh (+53.8%). This increase suggests more land is being used for construction, industries, roads, and urban expansion. Culturable Waste has been also increase. In Devaruppula (+48.6%), in Palakurthy (+67.2%) in Kodakandla (+51.6%), Zaffargadh (+77.2%) increased. This rise could indicate land degradation, lack of irrigation, or farmers leaving land fallow due to economic challenges.

Permanent Pastures and Grazing Lands are also Increased, in Devaruppula (+85.4%), in Palakurthy (+58.1%), in Kodakandla (+23%), in Zaffargadh (+78.2%). This suggests an increased focus on livestock farming and animal husbandry.

Land Under Miscellaneous Tree Crops & Groves: Major Increase in Kodakandla (+1,214 hectares in 2020-21 vs. 958 hectares in 2015-16). Zaffargadh recorded no tree crop land in 2020-21, unlike other regions. Overall, tree crop farming has increased in Palakurthy and Kodakandla, indicating a shift towards horticulture or timber plantations. Current Fallow Lands has been also increased. Major Increase in Devaruppula (+99.9%) and Kodakandla (+99.6%), Decrease in Palakurthy (-74.3%) and Zaffargadh

(-25.6%). A sharp rise in Devaruppula and Kodakandla suggests that more land is temporarily left uncultivated, possibly due to soil infertility, labor shortages, or economic factors. Other Fallow Lands Increased in Devaruppula (+89.3%), Palakurthy (+74.1%), and Zaffargadh (+65%), Kodakandla saw an enormous rise (+97.7%). More land is being left uncultivated for long durations, indicating declining agricultural activity or land abandonment.

Area Sown More than Once Increased in all regions, especially in Kodakandla (+74.1%), Zaffargadh (+83%). It Indicates intensification of agriculture, with farmers adopting multi-cropping practices.

Total Cropped Area has been seen a Major Increase in all regions. In Devaruppula (+24.8%), Palakurthy (+74%), Kodakandla (+62.9%),

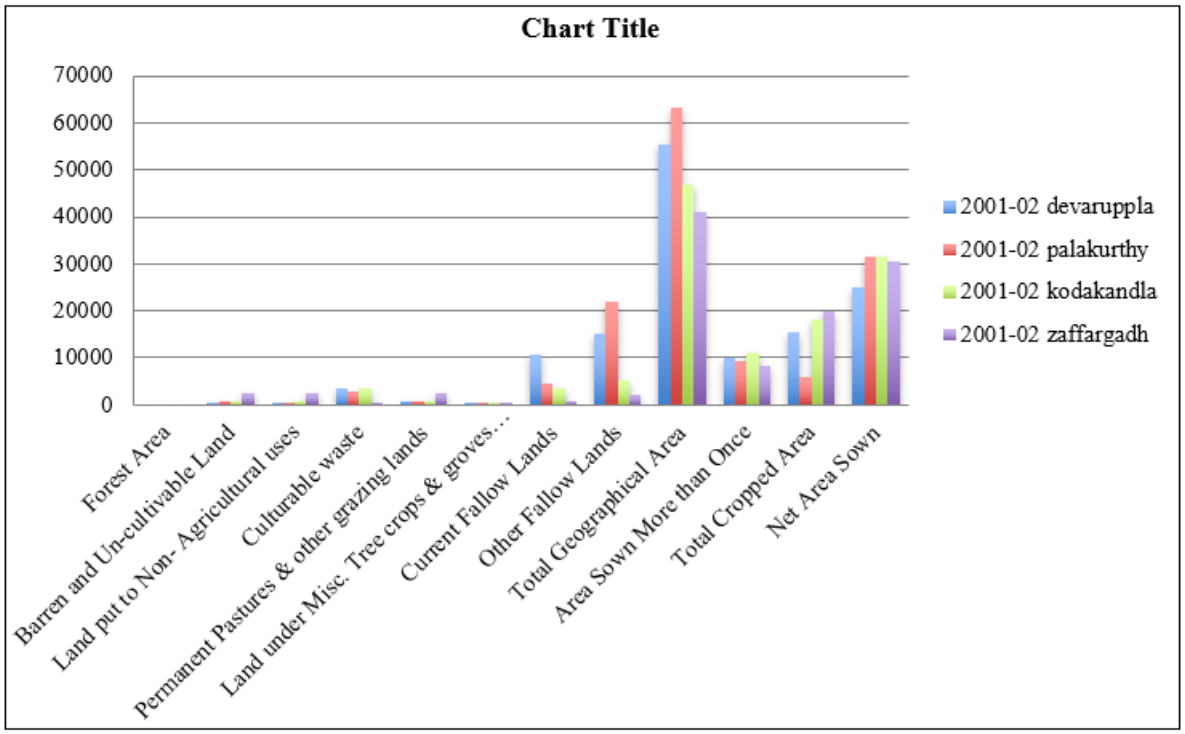
Zaffargadh (+74%). This shows an overall expansion in agricultural activity.

Net Area Sown also seen Sharp Increase in all regions, in Devaruppula (+78.3%), Palakurthy (+73.9%), Kodakandla (+62%), Zaffargadh (+68.2%). A positive trend showing more land is being cultivated, which is beneficial for food security and economy.

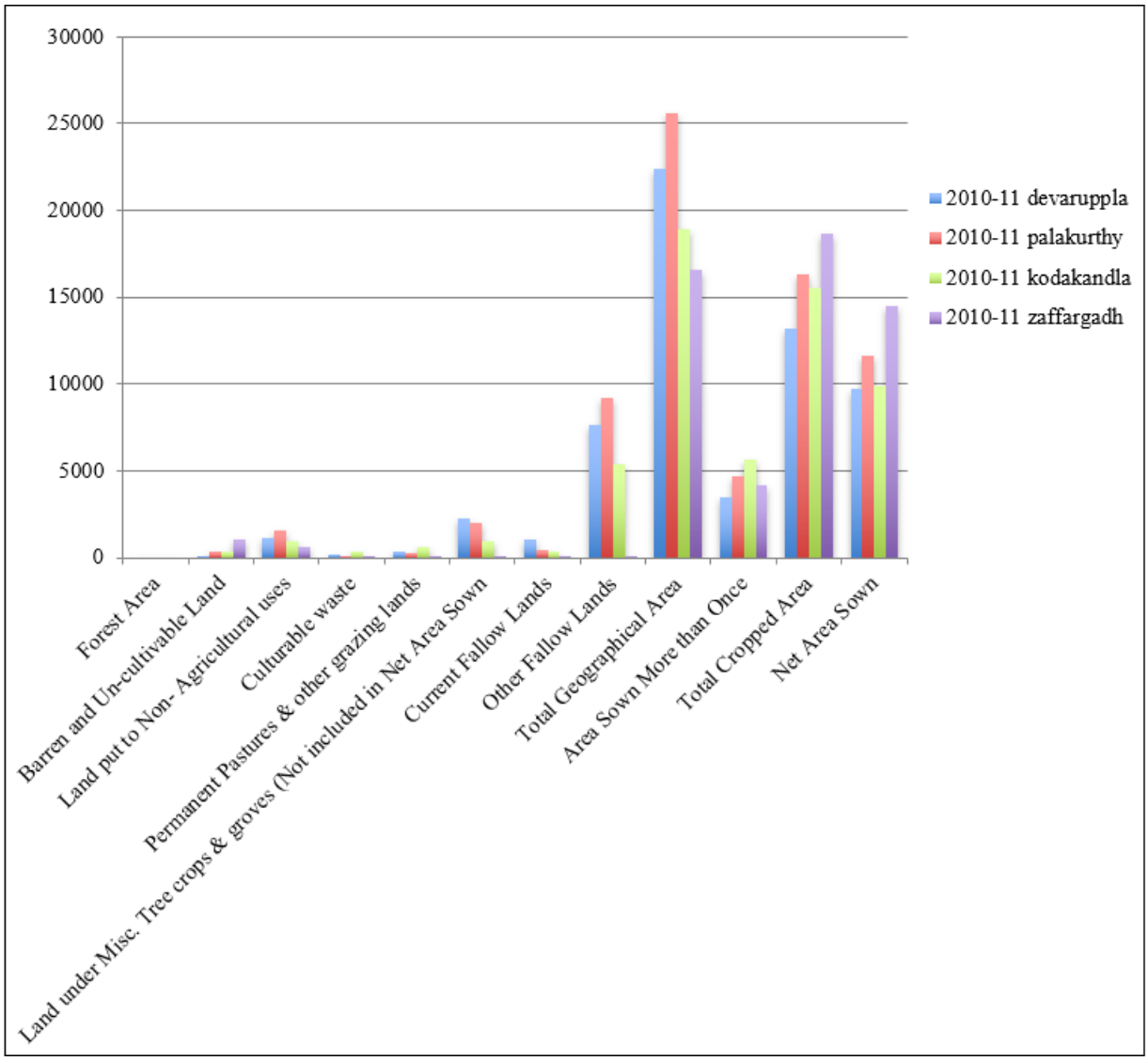
Key Take aways:

1) More land is becoming barren (+92.8% in Devaruppula, +89.5% in Palakurthy).
2) Urbanization is increasing (+53.4% in Palakurthy, +63.3% in Kodakandla).
3) Fallow land is rising, especially in Devaruppula and Kodakandla, indicating under-utilization of farmland.
4) Agriculture is expanding, with increased cropped area and multi-cropping, especially in Palakurthy and Zaffargadh.
5) Livestock farming is gaining importance, as seen in the rise of grazing land.

This data can help in better land management and planning agricultural policies for sustainability and productivity.



LULC IN 2001-02



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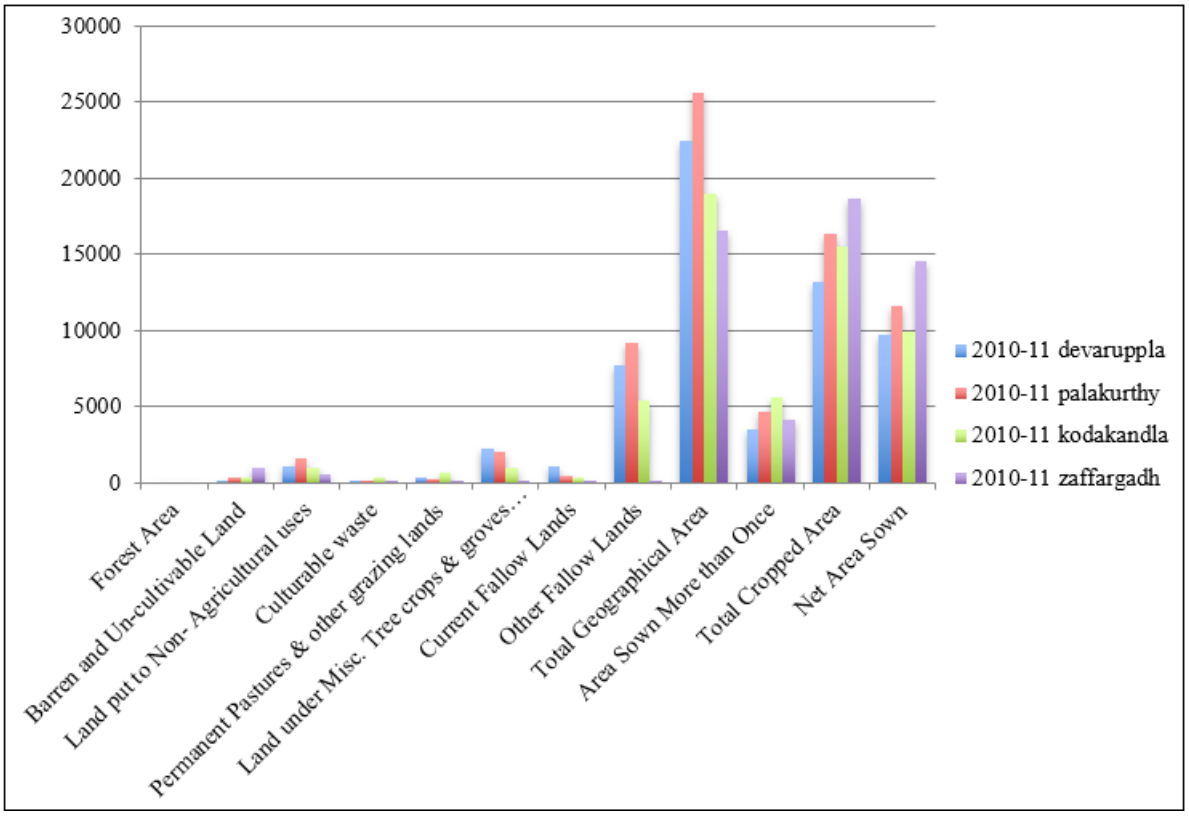

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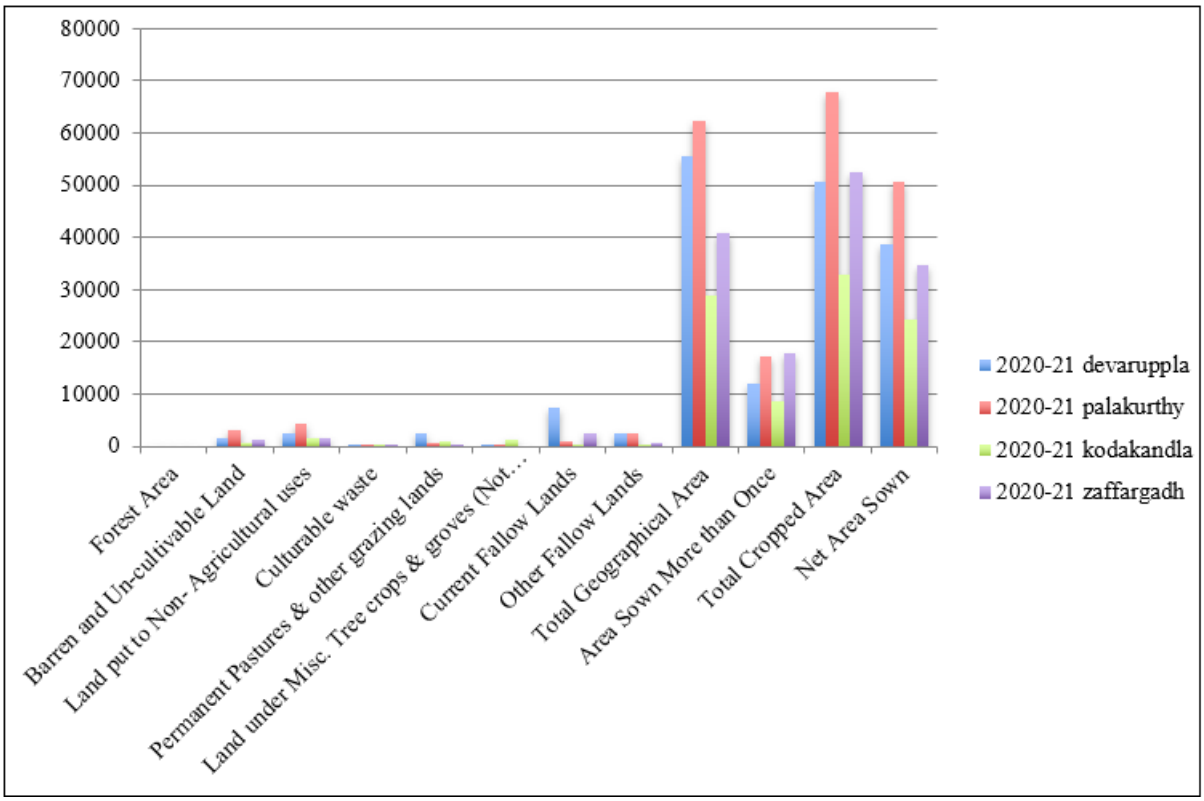
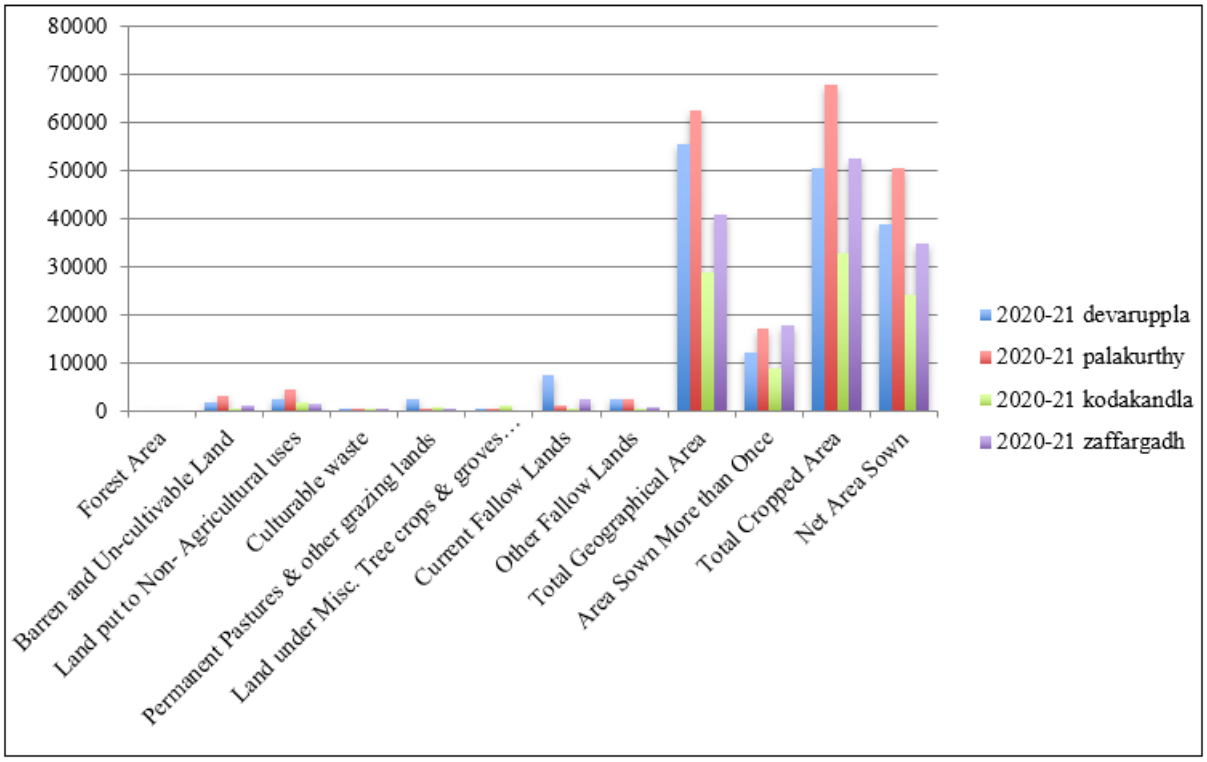


LULC IN 2015-16



LULC IN 2020-21

3. Review of Literature

Michael Mortimore and Beryl Turner (2006): Drylands are considered to be more fragile in much literature as they have low biological productivity and high temporal variability, in particular in rainfall. They therefore offer a test case of the landuse sustainability.

Padmaja S and Kaushalya R. (2015): Land fragmentation has been a traditional cause of agricultural crisis. There is a need to stop fragmentation through law as field or land holdings are becoming unviable and unfit for agricultural operation.

NIEMAND (2011): A joint UN, UN habitat and World Bank report reveals that most of the land development policies are inefficient in poor and developing countries. For instance in India the rapid urbanization and inefficiency in urban development policies have led to creation of slums and densely populated areas where sustainability fades away. The study suggests government intervention in providing enough land access and housing for poor also provision of public facilities by reforming those land policies which are solely based on business activities and revenues generation for the Government and private sector. its also believed that the transformation of agriculture land which is in some cases inevitable should be taken first on low quality agro land.

Dowall & Clarke (2018): Developing countries like Jordan experience the land use change due to poor land use planning laws. land use change especially change of agricultural land to residential built area has caused an urban sprawl and serious environment degradation in Jordan, shehan, which is considered a waste of agro land and costly servicing the sprawled areas . another example could be India with vast green and agriculture land experiences severe land use change due to new development and rapid urbanization process.

Manickam Valli, Radhika R. and Krishna Iyyanki V. Murali (2012): have attempted to study the impact of Climate variables on crop productivity in Warangal District of Andhra Pradesh (present Telangana). They concluded that continuous droughts and unassured rainfall with irrigation has affected the soil health to its extreme level so that the diversification of crops and the gross production has declined to its maximum extent. However, the yield of cash crops has somehow managed in balancing the economic stability of some Big land holders. This also has shown a negative impact on the SDP with respect to the Food Crop production.

Song *et al* (2010): Basically the climatic changes impact on agricultural productivity is essentially both an ecological development and food security issue. For the majority of developing countries, agricultural production is not only related to farmers livelihood but also closely associated with long term necessities of all mankind for nutrition and food. Currently, there are several studies focusing on the impact of climate change on agricultural production. An extensive literature focuses on the climate changes effects on crop yield, but there is no unified study available on the climate change impact on agricultural productivity.

4. Summary and Conclusion

The land use and land cover patterns in Devaruppula, Zaffergadh, Palakurthy, and Kodakandla mandals of Jangaon district are influenced by various factors, including agriculture, urbanization, and environmental concerns.

Key Observations:

1) Agricultural Dominance: Agriculture is the primary land use in these mandals, with a significant portion of the land dedicated to crops such as paddy, maize, and cotton.
2) Urbanization and Infrastructure: The region is experiencing urbanization, with the growth of towns and villages, leading to an increase in built-up areas and infrastructure development.
3) Environmental Concerns: The mandals are prone to environmental issues such as soil erosion, water scarcity, and climate change, which impact agricultural productivity and ecosystem balance.
4) Land Use Changes: Changes in land use patterns, such as the conversion of agricultural land to non-agricultural purposes, are observed in these mandals, affecting the local ecosystem and biodiversity

The land use and land cover patterns in Devaruppula, Zaffergadh, Palakurthy, and Kodakandla mandals of Jangaon district are shaped by a complex interplay of factors. Understanding these patterns is crucial for sustainable development, environmental conservation, and agricultural productivity in the region. Effective planning and management strategies are necessary to balance the competing demands on land resources and ensure a sustainable future for the region [3].

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