

A Socio-Economic Analysis of Drought Vulnerability in the Rayalaseema Region of Andhra Pradesh

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Abstract

Rayalaseema, a semi-arid region in southern Andhra Pradesh, is one of India's most drought-prone areas. This study investigates the socio-economic impacts of recurrent droughts on the population of Rayalaseema, with a focus on livelihoods, agriculture, migration, and rural infrastructure. Using primary data collected through field surveys and secondary data from government reports, census data, and published literature, the study analyzes the vulnerability of communities and coping mechanisms. The results reveal that the persistent droughts in Anantapur, Chittoor, Kadapa, and Kurnool have led to agricultural distress, indebtedness, rural-to-urban migration, and socio-economic disparities. Policy suggestions include promoting drought-resilient livelihoods, improving irrigation infrastructure, and enhancing rural employment schemes.

1. Introduction

Drought is a significant environmental stressor that affects the economy, health, and overall development of arid and semi-arid regions. The Rayalaseema region of Andhra Pradesh, comprising the districts of Anantapur, Chittoor, Kadapa, and Kurnool, experiences frequent and severe droughts. Despite government interventions, the region continues to exhibit high levels of socio-economic vulnerability due to its dependency on agriculture and limited alternative employment opportunities.

2. Objectives of the Study

- To analyze the socio-economic conditions of drought-prone areas in Rayalaseema.
- To assess the impact of drought on agriculture, employment, migration, and quality of life.
- To recommend sustainable development strategies for drought mitigation and rural resilience.

3. Study Area

The Rayalaseema region is located in the southern part of the state of Andhra Pradesh in southern India. The region by its location extends approximately from 13°62' North Latitude and 79°42' East Longitude. It includes within its fold of four districts, Anantapur, Chittoor, Kadapa and Kurnool (Fig. 1). It is a historically and geographically important region known for its semi-arid climate and drought-prone conditions. Rayalaseema lies in the rain-shadow region of the Eastern Ghats. Annual rainfall varies from 400 mm to 900 mm, much of which is concentrated in the monsoon months. The terrain is largely undulating, with low soil fertility and poor irrigation facilities. Anantapur, in particular, ranks among the most drought-affected districts in India.

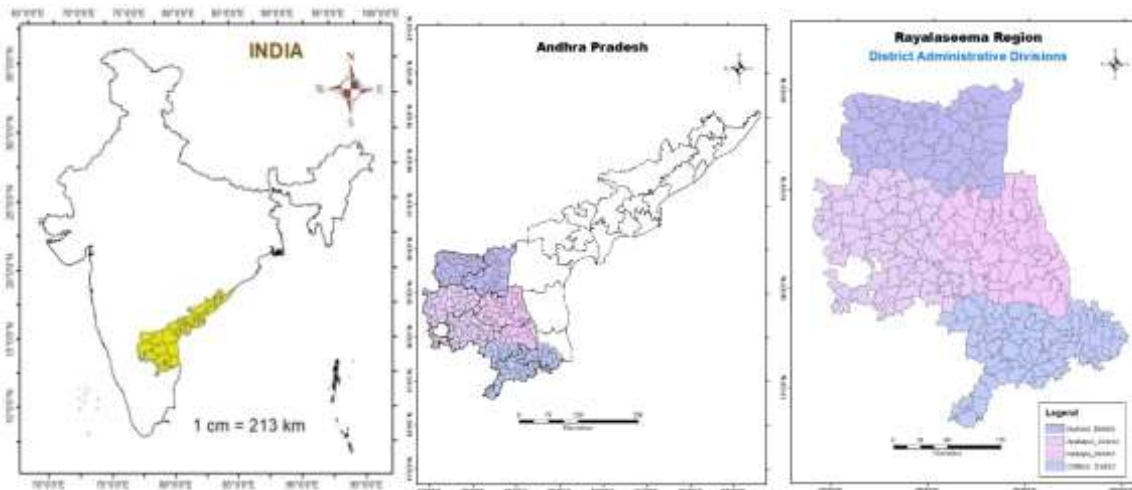


Fig. 1

3.1 Literature Review

Several studies have highlighted the increasing vulnerability of semi-arid regions in India to recurrent droughts and climate variability. Previous research on the Rayalaseema region emphasized the dependence of rural livelihoods on rain-fed agriculture and the resulting agricultural distress during drought years. Studies by Rao (2016) and Singh (2021) indicate that repeated crop failures, groundwater depletion, and unstable agricultural income have significantly increased seasonal migration and rural indebtedness. Research conducted by UNDP (2008) on livelihood vulnerability also identified irrigation access, landholding size, and employment diversification as major determinants of resilience. However, limited studies have comprehensively examined the combined socio-economic impacts of drought across all districts of the Rayalaseema region. Therefore, the present study attempts to fill this gap through a comparative district-level analysis.

4. Methodology

4.1 Data Collection

Primary data for this study was collected through a combination of household surveys, interviews, and focus group discussions (FGDs) conducted across the drought-prone districts of Rayalaseema. A total of 400 households were surveyed using a structured questionnaire, covering aspects such as income levels, agricultural practices, access to irrigation, migration patterns, and the impact of drought on livelihoods. In addition, in-depth interviews were conducted with local farmers, agricultural laborers, and community leaders to gain qualitative insights into their experiences and coping strategies. Furthermore, village-level FGDs were organized in selected communities to understand collective responses to drought, local perceptions of government interventions, and suggestions for improving resilience. This mixed-method approach provided a comprehensive understanding of the socio-economic impacts of drought in the region.

Secondary data was sourced from a variety of official and published records to support and contextualize the primary findings. Key sources included the Census of India 2011 for demographic and household-level information, NSSO (National Sample Survey Office) reports for data on consumption, employment, and agricultural patterns, and publications from the Andhra Pradesh Drought Monitoring Cell for historical drought records and classifications. Additionally, District Statistical Handbooks (2010–2024) were utilized to gather district-level statistics on rainfall, crop production, irrigation coverage, and socio-economic indicators relevant to the Rayalaseema region.

4.2 Parameters Studied

The study examines income levels and employment patterns, focusing on sources of livelihood, wage disparities, and seasonal employment trends. It analyzes agricultural productivity and cropping patterns by assessing crop yields, land use changes, and input usage. Migration trends are explored to understand the scale, reasons, and impacts of both seasonal and permanent migration. The availability of water resources and irrigation access is evaluated to gauge

agricultural sustainability and household water security. Lastly, the study assesses government scheme utilization, measuring awareness, enrollment, and the effectiveness of key welfare programs.

4.3 Analytical Tools

The study applies a simple multiple regression framework to analyze the relationship between agricultural yield reduction and major drought-related variables. The model is expressed as:

$$Y = a + b_1X_1 + b_2X_2 + b_3X_3 + b_4X_4 + e$$

Where:

Y = Agricultural Yield Reduction

X1 = Rainfall Deficit

X2 = Irrigation Coverage

X3 = Migration

X4 = Landholding Size

e = Error Term

The expected relationship indicates that rainfall deficit and migration positively influence yield reduction, whereas irrigation and larger landholdings negatively influence agricultural vulnerability.

4.4 Regression Model

The study employs descriptive statistics and regression analysis to identify patterns, relationships, and key determinants across socio-economic and agricultural variables.

5 Results

5.1 Overall Output of the Survey

Output for Household Survey Analysis – Rayalaseema Region

The household survey analysis of the Rayalaseema region reveals significant spatial variations in rainfall deficit, irrigation facilities, migration patterns, landholding size, and agricultural yield reduction across the four districts of Anantapur, Kurnool, Kadapa, and Chittoor. The results clearly indicate that climatic stress and drought conditions have had varying impacts on agricultural livelihoods and socio-economic conditions in the region.

Table 1: Output for Household Survey Analysis – Rayalaseema Region

District	Rainfall Deficit (%)	Irrigation (%)	Migration (%)	Landholding (acres)	Yield Reduction (%)
Anantapur	42	18	38	3.2	55
Kurnool	30	42	20	4.8	35
Kadapa	36	28	27	3.9	44
Chittoor	22	55	14	5.5	26

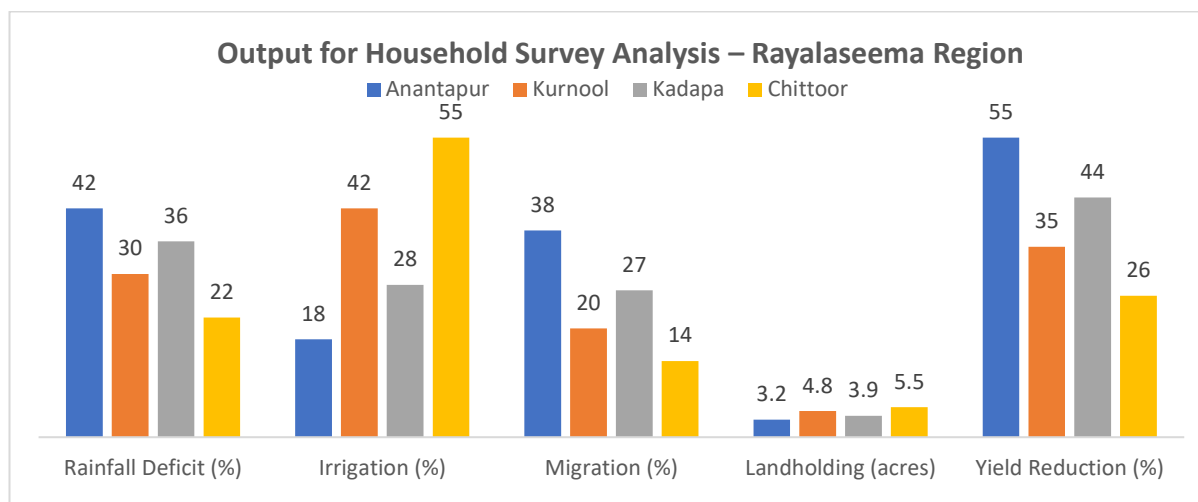


Fig. 2

Anantapur recorded the highest rainfall deficit (42%) and the lowest irrigation coverage (18%). Due to severe drought conditions and poor water availability, the district experienced the highest migration rate (38%) and maximum yield reduction (55%). The average landholding size is also relatively small at 3.2 acres, making farmers highly vulnerable to climatic stress.

Kurnool shows comparatively better agricultural conditions with a moderate rainfall deficit of 30% and irrigation coverage of 42%. Migration is lower at 20%, while agricultural yield reduction is limited to 35%. Farmers possess relatively larger landholdings averaging 4.8 acres, which supports better agricultural stability.

Kadapa experienced a rainfall deficit of 36% with irrigation coverage of only 28%. The district recorded a migration rate of 27% and a significant yield reduction of 44%, indicating moderate to severe drought impact. The average landholding size is 3.9 acres, which provides limited resilience against crop losses.

Chittoor district performed better than the other districts with the lowest rainfall deficit (22%) and the highest irrigation coverage (55%). As a result, migration levels are the lowest at 14%, and agricultural yield reduction is limited to 26%. The district also has the largest average landholding size of 5.5 acres, contributing to greater agricultural security.

Overall Observation

The analysis clearly shows that districts with better irrigation facilities and larger landholdings, such as Chittoor and Kurnool, experienced lower migration and reduced crop losses. In contrast, drought-prone districts like Anantapur and Kadapa faced higher agricultural distress, greater migration, and severe yield reduction due to inadequate rainfall and poor irrigation support.

5.2 Descriptive Analysis - Mean Values

Table 2: Mean Values of Selected Variables Related to Drought Vulnerability

Variable	Mean
Rainfall Deficit	32.50%
Irrigation	35.75%
Migration	24.75%
Landholding	4.35 acres
Yield Reduction	40%

The mean values derived from the household survey analysis provide an overall understanding of the drought and agricultural conditions prevailing in the Rayalaseema region. These averages reflect the combined impact of rainfall variability, irrigation availability, migration, landholding size, and crop productivity across the selected districts.

The average rainfall deficit in the region is 32.50 percent, indicating that Rayalaseema experiences a considerable shortage of rainfall compared to normal conditions. This reflects the drought-prone nature of the region and highlights the dependence of agriculture on uncertain monsoon rainfall. Reduced rainfall directly affects soil moisture, groundwater recharge, and crop cultivation.

The mean irrigation coverage is 35.75 percent, showing that only about one-third of the agricultural land has access to irrigation facilities. This indicates inadequate irrigation infrastructure in many parts of the region, forcing farmers to rely heavily on rainfall. Limited irrigation availability increases agricultural vulnerability during drought years.

The average migration rate is 24.75 percent, suggesting that nearly one-fourth of rural households are compelled to migrate in search of employment and livelihood opportunities. Migration is mainly influenced by recurring droughts, crop failures, declining agricultural income, and lack of alternative employment in rural areas.

The mean landholding size is 4.35 acres, indicating that most farmers in the region belong to the small and medium farmer category. Smaller landholdings reduce farmers' economic capacity to withstand climatic stress and invest in irrigation, modern farming techniques, and drought mitigation measures.

The average agricultural yield reduction is 40 percent, which reflects the severe impact of drought and rainfall deficit on crop production in the Rayalaseema region. Significant yield loss affects food security, farmer income, and the overall rural economy.

Pattern Identification

Rainfall Deficit vs Yield Reduction

The data shows a strong positive relationship between rainfall deficit and crop yield reduction.

- Anantapur has the highest rainfall deficit (42%) and also the highest yield reduction (55%).
- Chittoor has the lowest rainfall deficit (22%) and the lowest yield reduction (26%).

Interpretation : Higher drought intensity leads to severe agricultural losses.

5.3 Irrigation and Agricultural Resilience

Table 3: The districts with higher irrigation percentages experienced lower crop loss.

District	Irrigation (%)	Yield Reduction (%)
Chittoor	55	26
Kurnool	42	35
Kadapa	28	44
Anantapur	18	55

Interpretation: Irrigation acts as a protective factor against drought impacts.

The table 3 shows the relationship between irrigation availability and agricultural yield reduction in the Rayalaseema region. Districts with higher irrigation coverage experienced lower crop losses, while districts with poor irrigation facilities recorded greater yield reduction.

Chittoor has the highest irrigation coverage (55%) and the lowest yield reduction (26%). Better irrigation facilities helped farmers reduce the impact of drought and maintain agricultural productivity. Kurnool recorded 42% irrigation coverage with a yield reduction of 35%. Moderate irrigation support helped limit crop losses compared to more drought-prone districts. Kadapa has lower irrigation coverage at 28%, resulting in a higher yield reduction of 44%. Limited irrigation increased farmers' dependence on rainfall and affected crop production. Anantapur shows the lowest irrigation coverage (18%) and the highest yield reduction (55%). Severe water scarcity and dependence on rainfall caused major agricultural losses in the district.

The analysis clearly indicates an inverse relationship between irrigation and yield reduction. Districts with better irrigation infrastructure experienced lower agricultural losses, while areas with inadequate irrigation faced severe crop reduction during drought conditions.

Migration Pattern

Table 4: Migration increases in districts facing severe drought conditions.

District	Migration (%)	Yield Reduction (%)
Anantapur	38	55
Kadapa	27	44
Kurnool	20	35
Chittoor	14	26

Interpretation : Crop failure and water scarcity force rural households to migrate seasonally for employment.

The table 4 highlights the relationship between migration and agricultural yield reduction in the Rayalaseema region. Districts with higher crop losses experienced greater migration, while districts with lower yield reduction showed reduced migration levels.

Anantapur recorded the highest migration rate (38%) along with the highest yield reduction (55%). Severe drought conditions and major crop failures forced many rural households to migrate in search of employment and livelihood opportunities. Kadapa experienced a migration rate of 27% and a yield reduction of 44%. Significant agricultural losses increased economic stress on farming families, leading to moderate levels of migration. Kurnool showed comparatively lower migration (20%) and yield reduction (35%). Better irrigation facilities and moderate agricultural stability helped reduce distress migration. Chittoor recorded the lowest migration rate (14%) and the lowest yield reduction (26%). Improved irrigation support and better agricultural productivity provided more stable livelihoods within the district.

The analysis indicates a direct relationship between yield reduction and migration. Districts facing severe agricultural losses experienced higher migration, whereas districts with better agricultural performance showed lower migration levels. This reflects the strong influence of drought and crop failure on rural livelihood patterns in the Rayalaseema region.

5.4 Landholding and Vulnerability

Table 5: Smaller landholdings are associated with greater drought vulnerability.

District	Landholding (acres)	Yield Reduction (%)
Anantapur	3.2	55
Kadapa	3.9	44
Kurnool	4.8	35
Chittoor	5.5	26

Interpretation: Farmers with larger landholdings are relatively more resilient due to better economic capacity and resource availability.

The table 5 presents the relationship between landholding size and agricultural yield reduction in the Rayalaseema region. It shows that districts with smaller landholdings experienced higher crop losses, while districts with larger landholdings recorded lower yield reduction.

Anantapur has the smallest average landholding size of 3.2 acres and the highest yield reduction of 55%. Small farmers are more vulnerable to drought conditions due to limited financial resources and poor irrigation access. Kadapa recorded an average landholding size of 3.9 acres with a yield reduction of 44%. Moderate land size and inadequate irrigation contributed to significant agricultural losses. Kurnool has comparatively larger landholdings averaging 4.8 acres and a lower yield reduction of 35%. Better agricultural resources and irrigation support helped reduce crop losses. Chittoor

recorded the largest average landholding size of 5.5 acres and the lowest yield reduction of 26%. Larger farms and improved irrigation facilities increased agricultural resilience and productivity.

The analysis indicates that districts with larger landholdings experienced lower yield reduction, while districts dominated by small farmers faced greater agricultural losses. Larger landholdings generally provide better economic stability and capacity to manage drought conditions effectively.

Table 6: Expected Signs of Coefficients

Variable	Expected Sign	Meaning
Rainfall Deficit	Positive (+)	More drought increases crop loss
Irrigation	Negative (−)	Irrigation reduces vulnerability
Migration	Positive (+)	Distress migration rises with drought
Landholding	Negative (−)	Larger farms reduce vulnerability

The above table 6 explains the expected relationship between different variables and agricultural vulnerability in drought-prone regions.

Rainfall deficit has a positive relationship with crop loss. This means that as drought conditions increase and rainfall decreases, agricultural yield reduction also increases. Higher rainfall deficit directly affects soil moisture, water availability, and crop growth. Irrigation shows a negative relationship with vulnerability. Increased irrigation facilities help farmers reduce dependence on rainfall, protect crops during dry periods, and improve agricultural productivity. Therefore, better irrigation decreases crop loss and drought vulnerability. Migration has a positive relationship with drought impact. When drought severity and agricultural losses increase, rural households are more likely to migrate in search of employment and income opportunities. Thus, higher drought stress leads to increased migration. Landholding size has a negative relationship with vulnerability. Farmers with larger landholdings generally possess better economic capacity, more resources, and improved resilience to drought conditions. As landholding size increases, agricultural vulnerability and crop loss tend to decrease.

The relationships indicate that drought-related factors such as rainfall deficit and migration increase agricultural vulnerability, whereas supportive factors like irrigation and larger landholdings help reduce the adverse impacts of drought on farming communities.

5.5 Statistical Interpretation

The statistical analysis indicates a strong positive relationship between rainfall deficit and agricultural yield reduction. Districts experiencing severe rainfall shortages recorded higher crop losses and increased migration. Irrigation coverage shows a negative association with agricultural vulnerability, suggesting that improved irrigation infrastructure reduces the adverse impacts of drought. Similarly, larger landholding size contributes to greater economic resilience and lower vulnerability among farming households. The overall findings confirm that climatic stress, limited irrigation, and small landholdings collectively intensify socio-economic distress in the Rayalaseema region.

6. Discussion

6.1 Demographic and Economic Profile:

The study found that over 65% of farmers are small and marginal landholders, with 70% of households relying on agriculture as their primary income source, followed by 20% on labor and 10% on remittances. The literacy rate stands at approximately 60%, which is below the state average, indicating educational challenges in the region.

6.2 Agricultural Distress:

Agriculture in the region is predominantly rain-fed (~80%), making it highly vulnerable to monsoon variability. Frequent crop failures—especially in groundnut and paddy—are reported due to delayed rains, while rising input costs and

unstable output prices further exacerbate farmer distress. Only about 20% of agricultural land has access to assured irrigation, highlighting infrastructural gaps.

6.3 Migration Patterns:

Seasonal migration to urban centers such as Bengaluru, Hyderabad, and Chennai is common, with 45% of surveyed households reporting at least one member migrating for work. Migration is largely distress-driven, temporary in nature, and linked to the lack of local employment opportunities.

6.4 Impact on Women and Children:

Water scarcity and livelihood stress disproportionately affect women, who are often responsible for managing household needs. Girls frequently drop out of school to assist with domestic chores, and malnutrition rates among children are notably high, particularly during drought years.

6.5 Government Schemes and Interventions:

While MGNREGA is widely accessed, wage disbursements are irregular and often delayed. Awareness and coverage of PM-KISAN and crop insurance schemes remain low. Major irrigation projects like Handri-Neeva are either underutilized or delayed, limiting their intended benefits to the farming community.

The discussion reveals that the cumulative impact of ecological vulnerability and economic dependence on climate-sensitive livelihoods creates a vicious cycle of poverty, indebtedness, and forced migration. Drought emerges as a multidimensional threat, affecting not only agricultural productivity but also food security, education, health, and overall social stability. The absence of diversified livelihood opportunities further deepens household vulnerability, limiting resilience and adaptive capacity. This interlinked nature of environmental and socio-economic stressors highlights the urgent need for integrated, climate-resilient development interventions.

7. Recommendations

- To enhance resilience and reduce vulnerability, the study recommends diversifying livelihoods by promoting agroforestry, livestock farming, and horticulture. Providing skill training for youth in non-farm employment can create alternative income sources and reduce migration pressures.
- Strengthening irrigation infrastructure is crucial, with emphasis on expanding micro-irrigation systems like drip and sprinkler irrigation, and completing long-pending canal and tank restoration projects.
- Social safety nets should be improved by ensuring timely MGNREGA wage payments and increasing the number of available workdays, while also expanding the reach and effectiveness of crop insurance and welfare schemes.
- Community participation must be encouraged by involving local self-help groups (SHGs) and panchayats in drought preparedness planning, and by promoting water user associations for more efficient and participatory water resource management.
- Finally, early warning and monitoring systems should be enhanced by using GIS and satellite data for proactive drought response, along with establishing dedicated drought monitoring units at the district level.

8. Conclusion

Rayalaseema's socio-economic vulnerabilities are deeply intertwined with its environmental conditions. Combating drought impacts requires a multi-sectoral approach—combining infrastructure development, livelihood support, institutional reform, and community engagement. With focused and inclusive policies, it is possible to build a resilient and equitable future for the drought-prone populations of the region.

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