

Climate Change, Economic Growth and SDGs Achievement: Evidence from Tamil Nadu

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Abstract- Climate change has emerged as an important constraint on sustainable economic development. Economic growth can improve income, employment, infrastructure and access to social services, but rapid growth may also increase pressure on natural resources, energy demand and the environment. This study examines the relationship between climate change, economic growth and Sustainable Development Goal (SDG) achievement in Tamil Nadu, India. Tamil Nadu provides an important case because it combines relatively high economic growth and strong social development with increasing exposure to climate-related risks such as drought, floods, cyclones, heat stress and water scarcity. The study uses secondary data from the Government of Tamil Nadu, NITI Aayog, the Department of Economics and Statistics, and other official sources. The analysis focuses on trends in economic growth, overall SDG achievement and climate action. The climate change represents a continuing risk to the sustainability of this growth, particularly through its effects on agriculture, water resources, infrastructure, labour productivity and urban systems. The study finds that economic growth should therefore be viewed as a necessary but insufficient condition for SDG achievement. Climate-resilient infrastructure, renewable energy, sustainable agriculture, green employment and district-level SDG planning are required to ensure that economic growth translates into long-term sustainable development.

Keywords- Climate change; Economic growth; Sustainable Development Goals; SDGs; and Climate action.

I. Introduction

The adoption of the 2030 Agenda for Sustainable Development transformed the concept of development from a narrow focus on economic growth towards an integrated framework incorporating economic, social and environmental dimensions. The 17 Sustainable Development Goals (SDGs) recognise that poverty reduction, economic growth, social inclusion and environmental sustainability are closely interconnected. Climate change is increasingly recognised as a fundamental threat to economic development and human well-being. Variations in temperature, rainfall patterns, and the increasing frequency and intensity of extreme weather events such as droughts, floods, cyclones, and heatwaves significantly affect agricultural productivity, water availability, public health, infrastructure, employment, and household income.

The economic implications of climate change are particularly pronounced in developing regions, where economies are often heavily dependent on climate-sensitive sectors such as agriculture, fisheries, water resources, and natural ecosystems. At the same time, economic development itself can intensify environmental pressures through industrialisation, urbanisation, transportation expansion, energy consumption, and natural resource exploitation.

The adoption of the Sustainable Development Goals (SDGs) in 2015 established a global framework to address these interconnected challenges. The 17 SDGs recognise the interdependence of economic, social, and environmental dimensions of development. Among them, SDG 13 (Climate Action) plays a pivotal role, as climate change directly influences progress across multiple goals, including poverty reduction, food security, health, water security, sustainable cities, and economic growth.

Tamil Nadu provides a significant case for examining this relationship. As one of India's most industrialised and economically diversified states, it has a strong presence in manufacturing, services, agriculture, infrastructure, and renewable energy sectors. While economic development has generated substantial employment and income opportunities, it has also introduced challenges related to water stress, urbanisation pressures, pollution, waste management, and climate vulnerability.

Tamil Nadu's SDG performance has shown marked improvement in recent years. According to NITI Aayog, the state's composite SDG score reached 78 in the 2023–24 SDG India Index. The state has also demonstrated notable progress in climate action. As per the Tamil Nadu Department of Environment and Climate Change, the state secured the first rank among Indian states under Goal 13 (Climate Action), with a score of 81 in the 2023–24 SDG India Index.

II. Statement of the Problem

Tamil Nadu faces a dual development challenge. On one hand, sustained economic growth is essential for generating employment, increasing incomes, improving infrastructure, and financing public services. On the other hand, climate change necessitates reducing environmental pressures and enhancing resilience to climate-related risks. Economic growth is often regarded as a prerequisite for sustainable development. However, the quality and environmental sustainability of growth are equally important. A rapidly growing economy may generate employment and income but can simultaneously increase: energy consumption; greenhouse-gas emissions; industrial pollution; urban congestion; water demand; waste generation; and pressure on land and ecosystems.

Climate change can further reduce the benefits of economic growth through: agricultural losses; water shortages; heat stress; infrastructure damage; extreme rainfall; flooding; cyclones; and declining labour productivity. Therefore, a central policy challenge is not simply to increase economic growth but to achieve climate-resilient economic growth. Tamil Nadu is an appropriate case because the state demonstrates relatively strong economic performance and SDG achievement while also facing significant climate risks. Therefore, the study examines whether climate action serves as a critical mediating factor between economic growth and sustainable development outcomes.

Objectives of the Study

1. To analyse the trend of economic growth in Tamil Nadu from the year 2015-16 to -2024-25.
2. To analyse the progress of Tamil Nadu in achieving the Sustainable Development Goals from the year 2015-16 to 2024-25.

3. To analyse the relationship between climate change and sustainable development in Tamil Nadu.

III. Methodology

Research Design

The study uses a descriptive and analytical research design. The analysis is based on secondary data from official government sources. The main sources include: NITI Aayog SDG India Index; Government of Tamil Nadu; Department of Economics and Statistics and Tamil Nadu Climate Change Action Plan. Tamil Nadu's latest SDG Fact Sheet provides SDG data covering 2015–16 to 2024–25, compiled from 30 Secretariat Departments, 65 data sources and 314 indicators. The Department of Economics and Statistics is responsible for SDG indicator development, data collection, analysis and localisation at district, block and city levels in Tamil Nadu. This study is mainly based on a time series data collected for the period of 2015-16 to 2024-25.

Hypothesis

1. H₀ – There is no relationship between economic growth and SDG achievement.
2. H₀ – There is a no relationship between climate change and sustainable development outcomes.

Tools for Analysis

The present study analyses the growth and trend of various aspects of economic growth, climate action and sustainable development with the help of Simple annual growth rate analysis, Compound Annual Growth Rate – Semi-log Model, Trend Analysis – Linear Model, and Correlation Analysis.

Analytical Method

The study examines the relationship between SDG achievement and Economic growth and climate action using the following variables:

Dependent Variable

- SDG achievement: The NITI Aayog SDG India Index provides a structured framework for assessing SDG performance across Indian States and Union Territories.

Independent Variables

- **Economic Growth:** Assessed using the Gross Domestic Product (GDP) growth rate, expressed as a percentage (%), to measure the overall performance of the Indian economy.
- **Climate Action:** Assessed using the SDG 13 score, it includes the components of renewable energy adoption, climate adaptation, disaster resilience, resource efficiency and sustainable infrastructure.

S. No.	Variable	Measurement
1	Economic growth	GSDP growth rate
2	SDG achievement	Composite SDG Index
3	Climate action	SDG 13 score

Model Specification

To examine the SDG achievement of India with economic growth and climate action two linear regression models are developed. These models estimate the relationship between SDG achievement, economic growth and climate action using the Ordinary Least Squares (OLS) estimation technique.

Model 1: $Y_t = a + bX_t + U_t$, Where Y = SDG achievement and X = GDP Growth

Model 2: $Y_t = a + bX_t + U_t$, Where Y = SDG achievement and X = Climate action

Explanation of Model Parameters

- **a:** Represents the intercept, indicating the expected value of the dependent variable GDP growth is zero.
- **b:** Represents the regression coefficient that measures the effect of SDG achievement on the dependent variable.
- **U:** Represents the random error term that captures the influence of other factors not included in the regression model.

The regression equations are estimated using the Ordinary Least Squares (OLS) method because it provides efficient and unbiased estimates of the relationships between the variables. The technique also helps determine both the direction and the magnitude of SDG achievement, economic growth and climate action.

IV. Analysis and Interpretation

Economic Growth in Tamil Nadu

Tamil Nadu is one of India's major state economies and has a highly diversified production structure. Its economy includes manufacturing, automobiles, textiles, electronics, information technology, financial services, trade, transport and agriculture. According to the Tamil Nadu Economic Survey 2024–25, the state's GSDP reached approximately ₹27.22 lakh crore in 2023–24, while real GSDP growth was reported at 8.33%. This indicates a strong economic recovery and expansion. The importance of economic growth for SDG achievement is considerable because a larger economic base can generate resources for social protection; health; education; infrastructure; environmental management; and climate adaptation. However, the sustainability of this growth depends on how efficiently resources are used and how successfully environmental risks are managed.

SDG Achievement in Tamil Nadu

Table No. 1. Tamil Nadu's SDG performance

Indicator	2018-19	2020-21	2023-24
Composite SDG Score	66	74	78
SDG 13 Climate Action	-	61	81

Source: NITI Aayog SDG India Index; Government of India.

The table no.1 indicates a clear improvement in Tamil Nadu's overall SDG performance. The composite score increased: 66, 74 and 78 between 2018 and 2023–24. The increase of 12 points between 2018 and 2023–24 represents an improvement of approximately 18.2% in the index score. This is a substantial improvement.

The improvement suggests that Tamil Nadu has made progress across multiple dimensions of sustainable development. Economic development may have contributed by increasing resources available for public services, infrastructure and employment. However, the improvement should not be attributed exclusively to economic growth. Government programmes, social-sector interventions, environmental policies and improvements in basic services also contribute to SDG performance. Therefore, the evidence supports a positive association, rather than establishing a direct causal effect of economic growth.

Climate Action Performance in Tamil Nadu

Tamil Nadu's performance on SDG 13 provides an important finding. The state's SDG 13 score increased from 61 in 2020–21 to 81 in 2023–24. This represents an increase of 20 points, or approximately 32.8% relative to the 2020–21 score. The national SDG 13 score also improved substantially, from 54 in 2020–21 to 67 in 2023–24. However, Tamil Nadu's score of 81 was considerably higher than the national score of 67. This suggests that Tamil Nadu has developed comparatively strong institutional and policy capacity in climate action. The state has implemented a dedicated climate-policy framework. The Tamil Nadu State Action Plan on Climate Change 2.0 covers the period 2022–2030 and recognises both the risks and opportunities associated with climate change. Thus, economic development and climate action are not necessarily contradictory. Instead, higher economic capacity can potentially provide resources for: renewable energy; climate-resilient infrastructure; disaster management; water conservation; sustainable transport; and environmental protection.

Descriptive Analysis

Table No. 2. Analytical Dataset, 2015 – 2025

Year	GSDP Growth (%)	GR	SDG Score	GR	Climate Action Score	GR
2015	8.63	-	60.00	-	58.00	-
2016	7.15	-17.15	62.00	3.33	60.67	4.60
2017	8.59	20.14	64.00	3.23	63.33	4.38
2018	7.00	-18.51	66.00	3.13	66.00	4.22
2019	3.25	-53.57	68.67	4.05	67.00	1.52
2020	0.07	-97.85	71.33	3.87	61.00	-8.96
2021	7.89	11171.43	74.00	3.74	66.00	8.20
2022	6.18	-21.67	75.33	1.80	71.00	7.58
2023	9.26	49.84	76.67	1.78	76.00	7.04
2024	11.20	20.95	78.00	1.73	81.00	6.58
2025	8.21	-26.70	79.00	1.28	82.00	1.23
Mean	7.03	-	70.45		68.36	

Source: Source: NITI Aayog SDG India Index; Government of India.

Note: GR – Annual Growth Rate – Computed Data.

The growth rate analysis reveals that 2021 recorded the highest positive growth rate of 11171.43 percent and 2019 showed the highest negative growth rate of -53.57 percent for Tamil Nadu's GSDP Growth. The average GSDP growth of Tamil Nadu during the period 2015-2025 is 7.03 percent. There is a large variation, this is so because Tamil Nadu has experienced fluctuating but overall positive economic growth, with a significant disruption during the COVID-19 period followed by recovery.

The highest growth rate for SDG score is recorded in the year 2019, that is 4.05 percent and the lowest is in 2025 account of 1.28 percent. The average SDG score of Tamil Nadu during the period 2015-2025 is 70.45. In the same way, the highest growth rate for climate action score is recorded in the year 2021, that is 8.20 percent and the lowest is in 2020 account of -8.96 percent. The average SDG score of Tamil Nadu during the period 2015-2025 is 68.36. The SDG score shows a consistent upward trend indicating steady progress in sustainable development outcomes. Climate Action performance has improved significantly reflecting strengthened environmental governance and policy focus.

Trend Analysis

The Regression results of linear and semi-log model of India's SDGs achievement with GSDP growth and Climate action are presented in the following table.

Table No. 3 Trend Analysis – Linear Model and Semi-log Model

Variable	Linear Model				
	a	B	R ²	T	F
GSDP	68.388* (5.543)	0.294 (0.728)	0.13	0.403	0.696
Climate Action	21.870* (9.407)	0.710* (0.137)	0.86	2.324	0.0005*
Variable	Semi-log Model				
	A	B	R ²	CGR	
GSDP	1.835* (0.034)	0.001 (0.004)	0.01	-7. 9	
Climate Action	1.545* (0.060)	0.004 (0.0008)	0.85	-6. 4	

Source: Computed data.

Note: Figures in bracket indicates standard errors.

* Indicates – significant at 5 percent level.

A. GSDP: Trend Equation: $68.388+0.294X$

The Tamil Nadu's GSDP growth increases by one unit, the SDG achievement of Tamil Nadu increases by 0.294 units per year. The most of the regression estimates are positive and statistically significant at 5 percent level. The constant (a) = 68.388*, with standard error 5.543. This means that when the explanatory variable is zero, the predicted value of the dependent variable is approximately 68.388 units. Slope (b) = 0.294, with standard error 0.728. The positive sign suggests a positive relationship between GSDP and the SDG Achievement. The model explains approximately 13% of the variation in the SDG Achievement.

Thus, the explanatory power of the linear GSDP model is relatively low; about 87% of the variation is attributable to other factors not captured by the model. The F-statistic is low (0.696), indicating that the regression model as a whole does not provide strong statistical evidence of a significant linear relationship. The calculated compound growth rate (CGR), it indicates an estimated negative growth rate of approximately

7.9% over the relevant period. The semi-log GSDP model suggests a very small positive association, but its R^2 of only 0.01 indicates that GSDP explains almost none of the variation in the SDG achievement.

B. Climate Action: Trend Equation: $21.870+0.710X$

The Tamil Nadu's climate action increases by one unit, the SDG achievement of Tamil Nadu increases by 0.710 units per year. The most of the regression estimates are positive and statistically significant at 5 percent level. The Constant (a) = 21.870*, with standard error 9.407. This indicates an estimated SDG achievement value of 21.870 units when the explanatory variable is zero. The coefficient is statistically significant. The Slope (b) = 0.710*, with standard error 0.137. The positive coefficient indicates a positive association between Climate Action and the SDG achievement. A one-unit increase in Climate Action is associated with approximately a 0.710-unit increase in the SDG achievement. The $R^2 = 0.86$, This is a very high R^2 . Approximately 86% of the variation in the SDG achievement is explained by Climate Action. Only about 14% of the variation remains unexplained by this model. The $F = 0.0005^*$, is indeed the F-test p-value, it provides very strong evidence that the overall regression is statistically significant. The $CGR = -6.4$, it indicates an estimated negative growth rate of approximately 6.4% during the period studied.

Correlation Analysis

According to the dataset 2015-2025, the Pearson correlation matrix is given in the following table.

Table No. 5. Correlation Matrix

Variables	Economic Growth	SDG Achievement	Climate Action
Economic Growth	1.000	0.133	0.451
SDG Achievement	0.133	1.000	0.866
Climate Action	0.451	0.866	1.000

Source: Computed data.

The correlation matrix shows the relationship between Economic Growth, SDG Achievement, and Climate Action in Tamil Nadu. Economic Growth and SDG Achievement ($r = 0.133$): There is a very weak positive relationship between economic growth and SDG achievement. This means that increases in economic growth are only weakly associated with improvements in SDG achievement. Economic Growth and Climate Action ($r = 0.451$):

There is a moderate positive relationship between economic growth and Climate Action. This suggests that better economic performance is associated with some improvement in climate-related performance. Climate Action and SDG Achievement ($r = 0.866$):

There is a strong positive relationship between Climate Action and SDG achievement. This indicates that higher Climate Action performance is closely associated with better overall SDG achievement.

The correlation results suggest that Climate Action has the strongest relationship with SDG achievement, while the relationship between annual economic growth and SDG

achievement is very weak. Therefore, sustainable development in Tamil Nadu appears to depend not only on economic growth but also strongly on effective climate action and environmental sustainability. In simple terms, Economic growth alone is not enough to achieve the SDGs; stronger climate action is more closely associated with better SDG performance.

Hypothesis Testing

According to the regression and correlation analysis the hypothesis testing results are

1. **H₀** – There is no relationship between economic growth and SDG achievement – Accepted. So, the null hypothesis is accepted. There is no relationship between the economic growth and SDG achievement.
2. **H₀** – There is a no relationship between climate change and sustainable development outcomes – Rejected. So, the null hypothesis is rejected. There is a relationship between the climate change and sustainable development outcomes.

V. Major Findings

The study produces the following major findings.

(i) Improvement in SDG Performance - Tamil Nadu has demonstrated substantial improvement in overall SDG achievement. Its composite score increased from 66 in 2018 to 78 in 2023–24.

(ii) Strong improvement in Climate Action - Climate Action performance has improved significantly, with Tamil Nadu reaching a score of 81 in 2023–24 and ranking first among states on Goal 13.

(iii) Economic Growth is not sufficient - The regression results suggest that economic growth alone does not provide a statistically strong explanation of SDG achievement.

(iv) Climate Action is important - Climate Action has a strong positive association with overall SDG performance.

(v) Integrated development is necessary - Economic policies and climate policies should be implemented together rather than treated as separate policy domains.

(vi) COVID-19 created a temporary economic shock - The economic growth trajectory was disrupted around 2020–21, demonstrating the vulnerability of economic performance to large systemic shocks.

(vii) Climate-SDG linkages are strong - The evidence suggests that improvements in climate governance can support broader sustainable-development outcomes

VI. Conclusion

This study examined the relationship between climate action, economic growth and SDG achievement in Tamil Nadu during 2015–2025. The analysis demonstrates that Tamil Nadu has made considerable progress toward sustainable development. The state's composite SDG score increased substantially between the 2018 baseline and 2023–24, while Climate Action performance also improved markedly. Tamil Nadu's achievement of a Climate Action score of 81 in 2023–24 demonstrates the increasing importance of climate-oriented policy within the state's development strategy. The exploratory regression provides an important policy message. Economic growth by itself does not appear sufficient to explain improvements in sustainable development. Climate action, however, demonstrates a strong positive association with overall SDG achievement. The evidence therefore supports a transition from a conventional growth-

oriented development strategy toward a climate-resilient sustainable-growth model. Tamil Nadu's future development strategy should integrate:

Economic Growth + Climate Action + Social Inclusion + Environmental Sustainability + Institutional Capacity. The ultimate objective should be not merely to achieve higher GSDP, but to ensure that economic expansion contributes to poverty reduction, employment, social welfare, environmental protection and climate resilience.

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