

An Economic Analysis of the Impact of Climate Change on Women's Health in Tamil Nadu

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Abstract- Climate change is increasingly affecting women's health and economic well-being in Tamil Nadu through extreme heat, water scarcity, floods, droughts and changing weather patterns. This study examines the health and economic consequences of climate-related exposure among women, with particular emphasis on healthcare expenditure, productivity loss, income loss and household welfare. The study adopts a descriptive and analytical research design using secondary evidence and a primary-data framework. Percentage analysis, trend analysis and the Chi-square test are proposed to examine climate exposure, health outcomes and socioeconomic relationships. Recent evidence from Tamil Nadu demonstrates substantial heat exposure among women and a strong association between heat exposure and health-related and productivity outcomes. The study recommends gender-responsive climate policies, improved healthcare access, water security, occupational protection and climate-resilient livelihoods for women.

Keywords- Climate Change, Women's Health, Economic Impact, Heat Stress, Productivity, Healthcare Expenditure, Household Welfare, Tamil Nadu.

I. Introduction

Climate change has become a major challenge to human health, economic development and social welfare. Rising temperatures, extreme heat, irregular rainfall, droughts, floods, cyclones, water scarcity and environmental degradation increasingly influence the health and productive capacity of populations. However, the consequences of climate change are not experienced equally by all sections of society. Women may face distinctive vulnerabilities because of their biological characteristics, socioeconomic position, occupational conditions, household responsibilities and access to healthcare and economic resources.

The relationship between climate change and women's health is particularly important in developing economies where women frequently combine paid employment with substantial unpaid household responsibilities. Climate-related health problems can create both direct and indirect economic costs. Direct costs include expenditure on medical consultation, medicines, diagnostic tests, transportation and hospitalisation. Indirect costs include absenteeism, reduced productivity, loss of wages and additional unpaid caregiving responsibilities. Thus, the impact of climate change on women should be examined not merely as an environmental or health issue but also as an economic issue.

Research on India has established that climate change can affect women through extreme heat, poor air quality, extreme weather events, changes in vector-borne disease

transmission, reduced water quality and food insecurity. These effects may intensify existing gender-based health inequalities.

Tamil Nadu provides an important setting for examining this relationship. The state experiences diverse climate-related risks, including extreme heat, drought, floods, cyclones and water stress. The Tamil Nadu Climate Change Mission, led by the Tamil Nadu Green Climate Company, aims to reduce climate risks through adaptation and mitigation strategies and promote climate-resilient development. The official state framework also specifically identifies gender mainstreaming in climate action for women and children as a priority and adopts a One Health approach linking environmental, animal and human health.

Recent research provides particularly relevant evidence concerning women in Tamil Nadu. A study of adult women aged 40–79 years in rural Tamil Nadu found substantial differences in individual heat exposure, demonstrating that exposure can vary considerably even among people living in the same locality. The study also highlighted the limitations of relying solely on ambient monitoring stations to represent individual exposure.

More recent evidence is even more directly relevant. A 2026 study of 350 rural women in Tamil Nadu found that 85% experienced WBGT (Wet Bulb Globe Temperature) exposure at or above 28°C, while 75% reported heat-related illnesses. High heat exposure was associated with substantially greater odds of heat-related illness, and the study also identified significant psychological distress and reduced household functioning among exposed women.

From an economic perspective, heat exposure can reduce labour productivity. A recent study involving 1,560 outdoor workers across 11 districts of Tamil Nadu found that elevated WBGT exposure was associated with a 1.4-fold higher risk of productivity loss. These findings provide a strong basis for investigating the economic implications of climate-related health risks among women.

Statement of The Problem

Climate change is creating an increasing health burden for women in Tamil Nadu, but the economic consequences of this burden have received comparatively less attention. Women exposed to extreme heat may experience fatigue, dehydration, heat exhaustion, headaches, muscle cramps and other health problems. Climate-related water scarcity, flooding and changing environmental conditions can further increase health risks.

The economic consequences may be particularly severe for women working in agriculture, construction, brick-making, salt-pan activities, street vending and other informal occupations. A health problem can result in absence from work, reduced productivity and loss of wages. Even women who are not engaged in paid employment may experience economic consequences because illness can reduce their capacity to perform household production and caregiving activities.

Healthcare expenditure creates another economic burden. When women experience climate-sensitive illnesses, households may spend additional amounts on medicines, consultations, transportation and hospitalisation. For low-income households, these

additional costs can reduce expenditure on food, education and other essential requirements. The central problem addressed by this study is therefore the need to understand how climate change affects women's health and how those health effects translate into economic costs for women and their households in Tamil Nadu.

Objectives of The Study

The Major objectives of the study is

1. To examine the impact of climate change on women's health in Tamil Nadu.
2. To identify the major climate-related health problems experienced by women and examine the relationship between climate exposure and health outcomes.
3. To analyse the economic consequences of climate-related illness in terms of healthcare expenditure, loss of working days, productivity and income.
4. To examine whether selected socioeconomic characteristics are significantly associated with climate-related health problems among women.

Research Hypotheses

The study proposes the null hypothesis that there is no significant association between occupation and climate-related health problems among women in Tamil Nadu. The second null hypothesis states that there is no significant association between climate exposure and loss of working days. The third null hypothesis states that there is no significant association between household income and climate-related healthcare expenditure.

Theoretical Framework

The study is based on an integrated Climate Exposure–Health–Productivity–Household Welfare Framework. The framework combines human capital theory, household production theory and the cost-of-illness approach.

Human capital theory considers health to be an important component of productive capacity. A healthy individual possesses greater capacity to participate in economic activities, whereas illness can reduce working capacity and earnings. Therefore, climate-related illness can be interpreted as a reduction in productive human capital.

Household production theory provides an additional perspective. Household welfare is generated not only through market income but also through unpaid activities such as childcare, cooking, cleaning and caregiving. Women frequently undertake a significant share of these activities. Consequently, climate-related illness among women may reduce household production even when no direct wage loss occurs.

The cost-of-illness approach distinguishes between direct and indirect costs. Direct costs include expenditure on healthcare, while indirect costs arise through absenteeism, productivity loss and income reduction. Climate change can therefore create a chain of economic effects beginning with environmental exposure and ending with reduced household welfare.

The conceptual relationship can be expressed as:

Climate Exposure → Health Impact → Healthcare Expenditure → Productivity Loss
→ Income Loss → Household Welfare

The framework also recognises that socioeconomic characteristics such as education, occupation, income, access to water, healthcare availability and cooling facilities can influence the degree of vulnerability.

II. Review of Literature

Sorensen et al. examined climate change and women's health in India and identified heat, air pollution, extreme weather, water quality, food security and infectious diseases as important pathways through which climate change affects women. The authors argued that biological, socioeconomic and cultural factors can produce gender differences in climate-related health vulnerability. They recommended incorporating gender-sensitive approaches into climate, health and disaster-risk policies.

Sorensen et al. further highlighted that climate change can amplify existing gender inequalities. Their policy analysis emphasised the importance of integrating women's health into climate adaptation and mitigation strategies rather than treating climate, health and gender as separate policy areas.

Research specifically examining women in rural Tamil Nadu has demonstrated the importance of personal heat exposure. A study of women aged 40–79 found that individual temperatures could differ substantially between people in the same locality, suggesting that household characteristics, daily activities and indoor environments influence exposure.

A recent 2026 study involving 350 rural women in Tamil Nadu provides further evidence of gender-specific vulnerability. The study reported high levels of heat exposure and heat-related illness and found associations between extreme heat and psychological distress. It also identified an association between heat exposure and impaired household functioning, including reduced caregiving capacity.

Research concerning labour productivity provides an important economic dimension. A study covering 1,560 outdoor workers across 11 districts of Tamil Nadu found that WBGT exposure above critical levels was associated with an increased risk of productivity loss. The study identified heat exposure and workload as important predictors of productivity decline.

Another Tamil Nadu study examined future heat-induced labour-capacity loss and projected increases in seasonal WBGT under future climate scenarios. It found that productivity risks associated with heat exposure could increase under both moderate and high-emission scenarios.

The literature therefore demonstrates that climate change affects women through multiple health pathways and that heat exposure can have economic consequences through productivity loss. However, there remains a need for an integrated economic analysis connecting women's climate exposure, health expenditure, productivity, income and household welfare. The present study addresses this research gap.

III. Methodology

The study adopts a descriptive and analytical research design. Tamil Nadu is selected as the study area because of its exposure to diverse climate-related hazards and its importance as a major industrial, agricultural and service-sector state.

The population of the study comprises women aged 18 years and above residing in selected districts of Tamil Nadu. For an empirical journal article, primary data may be collected from approximately 400 respondents through a structured questionnaire. A multistage sampling procedure may be adopted to include rural and urban women and women from different occupational and socioeconomic backgrounds.

The questionnaire should collect information concerning age, education, occupation, income, family characteristics, climate exposure, health conditions, healthcare expenditure, working days lost, productivity loss, income loss and adaptation strategies. Secondary information may be obtained from the Government of Tamil Nadu, Tamil Nadu Green Climate Company, India Meteorological Department, Ministry of Health and Family Welfare, National Family Health Survey, World Health Organization and peer-reviewed research publications.

The study uses percentage analysis to describe the characteristics of respondents and the prevalence of climate-related health problems. Trend analysis is used to examine changes in selected climate indicators over time. The Chi-square test is used to examine associations between categorical socioeconomic and health variables. Where sufficient primary data are available, regression analysis may be used to examine the determinants of health expenditure and productivity loss.

Analysis of Data

The analysis should examine four interconnected dimensions: climate exposure, health outcomes, economic consequences and household welfare. The socioeconomic profile of respondents provides the foundation for understanding differences in vulnerability. Climate exposure should be measured through indicators such as frequency of extreme heat, water scarcity, floods, droughts, cyclones and irregular rainfall. Occupational exposure should be analysed separately because women engaged in outdoor work may experience greater exposure than women primarily engaged in indoor activities.

The health analysis should examine symptoms such as fatigue, dehydration, heat exhaustion, headache, muscle cramps, skin problems, respiratory problems and other climate-sensitive illnesses. Mental-health impacts and climate-related psychological distress should also be considered because recent Tamil Nadu evidence indicates significant psychological effects among rural women exposed to high heat.

The economic analysis should examine direct healthcare expenditure and indirect economic losses. Direct costs include consultation, medicines, diagnostic tests, transportation and hospitalisation. Indirect costs include income loss due to absence from work and productivity reduction.

The household-welfare component should consider whether climate-related illness affects household consumption, savings, education expenditure, food expenditure and

caregiving arrangements. This broader perspective is necessary because climate-related health effects can influence household welfare even when a woman does not receive a formal wage.

- **Percentage Analysis**

Percentage analysis is used to identify the distribution of respondents according to socioeconomic characteristics, climate exposure and health outcomes. The percentage is calculated using the following expression:

$$\text{Percentage} = (\text{Number of respondents in a category} / \text{Total number of respondents}) \times 100$$

The analysis should present the proportion of women exposed to extreme heat, water scarcity, floods and other climate hazards. It should then identify the percentage experiencing different health outcomes and the percentage reporting additional medical expenditure, working-day loss and income loss.

Published evidence provides useful comparative information. The recent Tamil Nadu study of 350 rural women reported that 85% were exposed to WBGT levels of at least 28°C and 75% reported heat-related illnesses. Fatigue, heat rash and muscle cramps were among the commonly reported health problems. (Springer)

These published percentages should be treated as findings of that particular study and not as results of the present research. For an international-journal submission, the percentage analysis of the present study should be calculated from the researcher's own dataset.

- **Trend Analysis**

Trend analysis can be used to examine changes in temperature, heatwave occurrence, rainfall variability and other climate indicators over a selected period. Annual observations may be obtained from official meteorological and government sources.

A linear trend model may be expressed as: $Y_t = a + bt + e_t$

where Y_t represents the value of the climate or health indicator in year t , a represents the constant, b represents the trend coefficient and e_t represents the error term.

A positive trend coefficient indicates an increasing trend, while a negative coefficient indicates a declining trend. Where the data permit, climate trends can be compared with health-related indicators to examine whether changes occur in the same direction.

The interpretation should remain cautious because health outcomes are influenced by several factors other than climate, including healthcare access, income, nutrition, population structure and public-health interventions.

Tamil Nadu's Climate Change Mission provides an official institutional source for climate-related reports, data and policy information.

- **Chi-Square Test**

The Chi-square test is used to determine whether there is a statistically significant association between two categorical variables. In this study, the test can be applied to variables such as occupation and climate-related health problems, climate exposure and

working-day loss, or income category and healthcare expenditure. The formula is: $\chi^2 = \sum (O - E)^2 / E$; where O represents the observed frequency and E represents the expected frequency.

The null hypothesis assumes that the two categorical variables are independent. If the calculated p-value is less than 0.05, the null hypothesis is rejected and a statistically significant association is concluded. For publication, the result should be reported in a format such as: $\chi^2(df, N = \text{sample size}) = \text{value}$, $p = \text{value}$. The actual Chi-square value must be calculated from the collected primary data. A numerical result should not be invented merely to complete the research paper.

Economic Analysis

The economic burden of climate-related health problems can be divided into direct and indirect costs. Direct costs include medical consultation, medicines, diagnostic procedures, hospitalisation and transportation. Indirect costs include loss of working days, reduced productivity and income loss. For women in paid employment, income loss may be estimated by multiplying the number of working days lost by average daily earnings. For informal workers, this measure can provide a relatively direct estimate of economic loss because income is often closely related to daily work participation.

For women engaged primarily in unpaid household work, the economic consequences are more difficult to measure. Illness may reduce the amount of household production undertaken by the woman and increase the caregiving responsibilities of other household members. Therefore, the study should consider the opportunity cost of unpaid labour wherever adequate information is available. The economic importance of heat exposure is supported by recent Tamil Nadu research. The study of 1,560 outdoor workers found that elevated WBGT was significantly associated with productivity loss and that high workload further increased the risk of productivity decline. This evidence suggests that investment in climate adaptation can generate economic returns by protecting productive capacity and reducing health-related losses.

Findings

The available evidence indicates that climate change presents a significant health concern for women in Tamil Nadu, particularly through extreme heat. Research among rural women demonstrates substantial personal heat exposure and a high prevalence of heat-related health problems. The evidence also indicates that climate-related heat exposure is associated with psychological and household consequences. Recent research among rural women in Tamil Nadu found significant relationships between extreme heat, heat-related illness, psychological distress and reduced household functioning. From an economic perspective, heat exposure is associated with productivity loss. Evidence from 11 districts demonstrates that elevated WBGT exposure increases the risk of productivity loss among outdoor workers.

The combined evidence indicates that climate change can generate a chain of consequences beginning with environmental exposure and extending to health problems, healthcare expenditure, reduced productivity, income loss and household-welfare effects. The proposed primary survey would provide additional evidence regarding the magnitude of these effects specifically among women and the relationship between socioeconomic characteristics and climate-related health outcomes.

Suggestions

Tamil Nadu should strengthen gender-responsive climate-health policies by explicitly incorporating women's health and economic vulnerability into climate adaptation programmes. Heat action plans should pay particular attention to women engaged in outdoor and informal occupations. Appropriate working hours, shaded rest areas, drinking-water facilities, heat-health warnings and access to healthcare can reduce occupational heat risks. Healthcare services should be strengthened in climate-vulnerable areas so that women can obtain affordable treatment without experiencing excessive financial burden. Primary healthcare centres should be equipped to respond to heat-related illnesses and other climate-sensitive conditions.

Water security should receive greater attention because water scarcity can influence women's health, household labour and time allocation. Improved access to safe and reliable water can reduce both health risks and unpaid household burdens. Climate-resilient livelihood programmes should be expanded for women working in climate-sensitive sectors. Skill development, entrepreneurship, green employment and income diversification can strengthen women's adaptive capacity.

Government agencies should also collect gender-disaggregated data on climate exposure, illness, healthcare expenditure, absenteeism, productivity and income loss. Such data would enable more effective monitoring of climate-health inequalities. Tamil Nadu's existing Climate Change Mission provides an appropriate policy platform for these measures. Its stated objectives include climate-resilient development, community adaptation, climate-smart governance and green employment. The official framework also identifies gender mainstreaming for women and children as a key priority.

IV. Conclusion

Climate change is increasingly becoming an important determinant of women's health and economic welfare in Tamil Nadu. Extreme heat, water scarcity, floods, droughts and other climate-related hazards can affect women's physical and psychological health while simultaneously influencing productivity, healthcare expenditure and household income. The economic consequences of climate-related illness are particularly important because health expenditure and income loss may occur simultaneously. A woman who becomes ill may require additional medical treatment while losing working days or experiencing reduced productivity. For women in informal employment, these losses can immediately affect household income. For women engaged in unpaid household work, illness can reduce household production and increase the caregiving burden on other family members.

Recent evidence from Tamil Nadu demonstrates that women experience substantial personal heat exposure and associated health consequences. Evidence among outdoor workers further demonstrates that high heat exposure is associated with productivity loss, confirming the economic significance of climate-related heat stress. The study therefore concludes that women's health should be treated as an important component of climate-resilient economic development. Investment in healthcare, water security, occupational protection, social protection and climate-resilient livelihoods can reduce both health risks and economic losses.

Tamil Nadu has already established an institutional framework through the Tamil Nadu Climate Change Mission, including a specific emphasis on gender mainstreaming and a One Health approach. Strengthening gender-disaggregated climate-health data and incorporating economic indicators into climate policy can help the state develop more effective and inclusive adaptation strategies. Protecting women's health from climate change is therefore not only a public-health responsibility but also an economic investment in human capital, productivity, household welfare and sustainable development.

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