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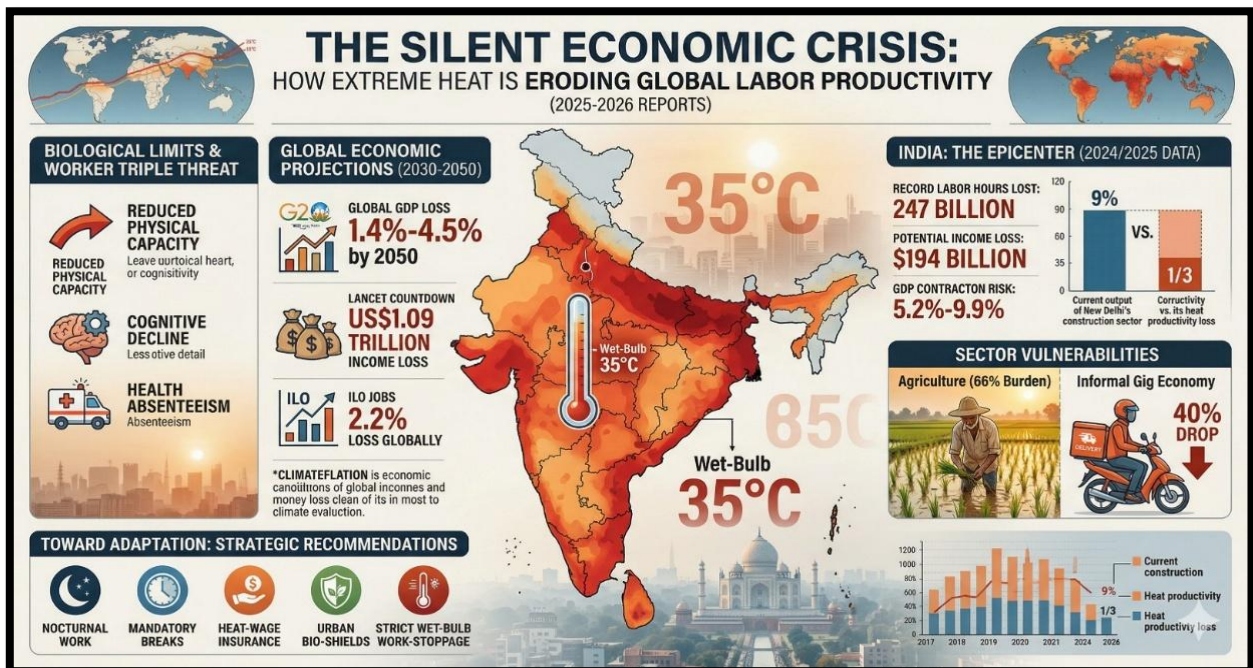


Climate Change, Heat Stress, and the Emerging Productivity Crisis

1. Introduction

Climate change is no longer solely an environmental concern; it has evolved into a systemic economic risk. Among its many impacts, extreme heat is emerging as a silent yet powerful force that is reducing global labour productivity and weakening economic output.

While public attention often focuses on visible disasters such as floods and cyclones, a more pervasive and less visible crisis is unfolding—the gradual erosion of human work capacity due to rising temperatures. This phenomenon is increasingly recognised as a “negative supply shock,” directly affecting GDP, employment, and income levels, particularly in tropical regions such as India.



2. The Biological Limits of Human Productivity

Human productivity is intrinsically linked to environmental conditions. There exists a narrow temperature range within which the human body performs optimally. Beyond this range, both physical and cognitive capacities begin to decline.

- Optimal performance: 20°C–25°C
- Productivity decline begins: Above 30°C
- Severe risk threshold: Above 35°C (especially under high humidity)

At elevated temperatures, the human body prioritises thermoregulation over work. As a result, productivity declines through multiple pathways:

- Reduced physical capacity due to faster fatigue and lower endurance
- Cognitive decline affecting decision-making and reaction time
- Increased health risks, including heat exhaustion, heatstroke, and aggravation of existing illnesses

In humid regions such as South India, these effects are intensified because high moisture levels reduce the effectiveness of sweating, thereby increasing thermal stress and dehydration risk.

3. The Global Economic Impact of Heat Stress

Extreme heat is no longer just a climatic variable; it has become a measurable economic factor. Rising temperatures are already translating into substantial losses in labour productivity and economic output.

By 2030, it is estimated that 2.2% of global working hours could be lost due to heat stress, which is equivalent to nearly 80 million full-time jobs. This could result in an economic loss of approximately USD 2.4 trillion.

Looking further ahead, global GDP losses are projected to range between 1.4% and 4.5% annually by 2050. Asia alone could face economic losses between \$2.8 trillion and \$4.7 trillion each year. In addition, heat stress is contributing to “climate inflation” by increasing energy demand, cooling costs, and disruptions in supply chains.

4. India: The Epicentre of the Workability Crisis

India stands out as one of the most vulnerable countries due to its climatic conditions and labour structure. A large proportion of its workforce is engaged in outdoor and informal occupations, making it highly sensitive to rising temperatures.

Recent estimates highlight the scale of the crisis:

- 247 billion labour hours lost in 2024
- Income loss of approximately \$194 billion
- Nearly 75% of the workforce (about 380 million people) exposed to heat
- Potential GDP loss of 5.2%–9.9% by 2050

This combination of high exposure and economic dependence on labour-intensive sectors places India at the centre of the global workability crisis.

5. Regional Focus: South India and Puducherry

South India faces a particularly acute form of heat stress due to the combination of high temperatures and high humidity. Typical conditions include temperatures ranging from 35°C to 40°C and humidity levels between 60% and 90%. Additionally, urban heat island effects and persistently warm nights limit the body's ability to recover from daytime heat exposure.

These climatic conditions have direct implications for labour productivity. Workers experience reduced working hours, particularly during the afternoon, increased fatigue, and a higher incidence of heat-related illnesses. This leads to a decline in efficiency across multiple sectors.

Case Study: Heat Stress and Productivity Loss in Chennai

Chennai, a major coastal city, demonstrates how extreme heat combined with high humidity affects labour productivity. Summer temperatures often exceed 38°C, with humidity between 60% and 80%, leading to severe thermal stress.

Humid conditions reduce the body's ability to cool itself, increasing heat stress among outdoor workers. This impacts sectors such as construction, street vending, transport, and fisheries. Construction workers often adjust schedules to avoid peak heat, resulting in productivity losses of 20%–30% due to fatigue, dehydration, and heat-related illnesses.

The informal sector is highly vulnerable, with income losses of 25%–40% during heatwaves due to reduced working hours and lower demand. Urban heat island effects further worsen conditions by raising nighttime temperatures and limiting recovery.

Coastal livelihoods are also affected, as fisherfolk modify activities due to heat and changing sea conditions. While Chennai has introduced Heat Action Plans and early warning systems, challenges remain in protecting informal workers.

These conditions closely resemble those in Puducherry, making Chennai a useful proxy for understanding similar heat-related economic risks and the need for targeted adaptation strategies.

6. Sector-Wise Economic Impacts

The impact of heat stress varies across sectors but is universally significant.

In agriculture and fisheries, rising temperatures directly affect crop yields, with declines of 5–10% observed for every 1°C increase. Farmers also face reduced working hours and increased irrigation costs.

In construction and manufacturing, productivity drops during peak heat periods, while workplace risks increase. Employers are also forced to invest more in cooling systems and safety measures.

The informal sector is the most vulnerable. With over 80% of India's workforce engaged in informal employment, workers face income losses due to reduced working hours, often without any form of social protection or safety net.

7. The Informal Economy Challenge

The informal sector is trapped in a self-reinforcing cycle:

Extreme heat → Reduced productivity → Income loss → Increased vulnerability

Workers such as street vendors, delivery personnel, and daily wage labourers are often forced to choose between protecting their health and sustaining their livelihoods. In the absence of insurance, labour rights, or institutional support, this cycle deepens socio-economic inequality and vulnerability.

8. Urban Heat and Infrastructure Stress

Urban environments significantly amplify heat stress through the heat island effect, where built-up areas retain heat and remain warmer even during the night. This reduces the body's ability to recover, leading to cumulative fatigue and reduced productivity the following day.

In many cities, informal workers experience income declines of up to 40% during extreme heat events. Sectors such as construction, despite contributing modestly to economic output, account for disproportionately high productivity losses due to direct exposure and lack of protective infrastructure.

9. Policy and Adaptation Strategies

Addressing heat stress requires a shift from infrastructure-centric approaches to human-centric adaptation strategies.

Key interventions include:

- **Workplace measures:** Flexible working hours, mandatory rest breaks, and provision of hydration and shaded workspaces
- **Urban planning:** Cool roofs, reflective materials, increased green cover, and heat-resilient city design
- **Technological solutions:** Development of heat-resistant crops, mechanisation of labour-intensive tasks, and real-time heat monitoring systems
- **Policy reforms:** Strengthening labour protection laws, expanding Heat Action Plans, and providing social protection for informal workers

10. Strategic Recommendations

To effectively bridge the adaptation gap, targeted interventions are necessary:

- Heat-wage insurance to compensate workers for income loss during extreme heat
- Shifting work schedules to early morning or night hours
- Large-scale urban greening initiatives as “bio-shields”

- Implementation of mandatory work-stoppage protocols during dangerous heat conditions

11. Conclusion

Extreme heat has emerged as a systemic economic risk, directly undermining labour productivity, public health, and economic stability. Regions such as South India and Puducherry are particularly vulnerable due to their climatic conditions and workforce exposure.

Without immediate and targeted interventions, productivity losses will continue to rise, and socio-economic inequalities will deepen. Protecting workers from heat is no longer just a health or environmental priority—it is essential for sustaining economic growth in a warming world.

Reference Links & Sources (2025–2026)

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