# Chapter 3
# Long-Term Impacts of Environmental and Economic Growth on GHG With Temperature, Rainfall, Energy Usage, GDP, and Employment Variations in India:
## A VECM Analysis (1980–2023)

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## ABSTRACT

*This paper examines the dynamic relationship among CO2 emissions and some significant economic and environmental variables in India in a VECM approach during the period from 1980 to 2023. In the analyses performed, carbon dioxide (CO2) emissions have been considered as the dependent variable, while the independent variables are temperature and rainfall, energy use, employment, and GDP. Using unit root tests and Johansen's cointegration analysis, the long-run relationships among these variables are identified, detecting five cointegrating equations at a 5*

DOI: 10.4018/979-8-3373-0174-7.ch003

*percent significance level. The results indicated that temperature, rainfall, energy use, employment, and GDP growth are significantly impacting CO2 emission with impacts appearing after one period lag. Some variables associate positively with CO2 emissions, including temperature, energy use, and employment but rainfall is inversely related to CO2 emissions. This postulates that as the economic activities and energy use increase, causes emit more CO2, the result is an unstable environment characterized by reduced rainfall.*

## 1. INTRODUCTION

Global warming and climate change are significant challenges that countries worldwide are grappling with. Temperature and economic and environmental factors have a complicated and diverse interaction (Dubash et al., 2018). Elevated temperatures in India are correlated with rising CO2 emissions, a consequence of activities like burning fossil fuels, industry, and more automobile transportation (Ahmed et al., 2020). As the Indian economy has grown, so too has its reliance on energy, especially in forms such as coal, oil, and natural gas. (Tripathi et al, 2016).

### Energy usage

The use of energy measured in kilograms of oil equivalent per capita is an indicator and proxy for industrial activities and consumerism. The dependency of environmental health on both of these aforementioned factors is quite strong in the country. Moreover, gross domestic product is a very valuable indicator of economic activity, wherein energy usage and emissions from fuels are closely tagged to it (Ramesh, 2015). That is, it consumes more energy the more it produces—basically at the cost of environmental degradation. Besides, population increase complicates the temperature dynamics in India because a bigger population fully accrues with increased demand for housing, transportation, food, and energy—all of which contribute to environmental stress. Specific urbanization led to the growth of cities, the deforestation of areas, and changes in natural topography that could favour the increment of the urban heat island effect, where cities record a higher temperature compared to their surrounding rural areas. In many cases, a growing population puts added pressure on resources like water and land and increases vulnerability to climate change impacts.

# The Influence of Green Knowledge Management on Digital Transformation, Green Innovation, Energy Efficiency, and Firm Sustainable Development: A Case of the Manufacturing Industry of Pakistan

Adnan Ahmed Sheikh, Muhammad Wisal, Bilal Hassan, Nadir Munir Hassanand Sajjad Khan (2025). *Innovation and Sustainability Through Circular Economy in Businesses (pp. 1-24).*

www.irma-international.org/chapter/the-influence-of-green-knowledge-management-on-digital-transformation-green-innovation-energy-efficiency-and-firm-sustainable-development/364055