


Chapter 9


Evaluating the Environmental and Health Impacts of 6G Deployment in India: Challenges and Opportunities for Sustainable Digital Infrastructure

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ABSTRACT

India's ambitious digital transformation efforts, spearheaded by initiatives like Digital India and Smart Cities Mission, are set to be reshaped by 6G technology. While 6G promises ultra-fast connectivity and economic transformation, it also introduces environmental and public health risks. This study critically evaluates the impact of high-frequency electromagnetic radiation on biodiversity, particularly in the Western Ghats, Sundarbans, and Himalayan regions, and assesses health risks in urban areas. Additionally, it highlights the socioeconomic divide in 6G accessibility

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and proposes a sustainability framework integrating renewable energy and green policies. The findings provide actionable insights for policymakers, technologists, and environmentalists in India's 6G rollout.

1. INTRODUCTION

1.1 Background

The advent of 6G technology marks the next phase in wireless communication evolution, promising transformative changes in connectivity, speed, and real-time data processing. With expected commercial deployment by 2030, 6G is anticipated to deliver terahertz (THz) frequency communication, ultra-low latency, and artificial intelligence-driven automation (Tera et al., 2024). Unlike its predecessors, 6G networks will incorporate intelligent surfaces, quantum communication, and edge computing, enabling advancements in augmented reality (AR), virtual reality (VR), and Internet of Everything (IoE) (Banafaa et al., 2023). However, as with any major technological shift, the environmental and health implications of 6G remain a critical area of concern.

In India, where digital transformation initiatives such as Digital India and the Smart Cities Mission aim to enhance urban infrastructure, governance, and citizen engagement through digital solutions, 6G is expected to play a pivotal role (Prajapati et al., 2025). With India projected to be one of the largest consumers of wireless communication technology, the rollout of 6G will involve extensive infrastructure deployment, including high-frequency base stations, satellite connectivity, and dense small-cell networks. These infrastructural advancements will be crucial in addressing urban-rural digital disparities, improving telemedicine, and enhancing Industry 4.0 capabilities (Sharma et al., 2024). However, the environmental footprint and potential health risks of 6G deployment remain understudied.

One of the key concerns is the electromagnetic radiation exposure due to the anticipated use of THz frequencies in 6G. While 5G operates primarily in the sub-6 GHz and mmWave (24–100 GHz) spectrum, 6G will utilize frequencies beyond 100 GHz, raising concerns about potential biological effects (Al-Falahy & Alani, 2024). Studies on millimeter-wave radiation (used in 5G) have suggested possible links to thermal effects on human tissues, oxidative stress, and cellular damage, although conclusive evidence remains limited (Khalil & Hassan, 2024). With 6G operating at even higher frequencies, there is a need for extensive research on the long-term biological impact of prolonged exposure to these frequencies.

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