



Indian Metropolitan Cities and the Anthropocene: Environmental Impacts, Challenges, and Sustainable Pathways

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Abstract

The urban Anthropocene is an epoch which though not officially recognised by the 'International Union of Geological Science'(IUGS), yet has been widely used in academic literature. It's an informal geologic chronological term that serves to mark the evidence and extent of human activities that have had a significant global impact on Earth's ecosystem. The rapid urbanisation has contributed to and for the Anthropocene epoch.

The present study looks at and investigates the representative Indian Metropolitan Cities and tries to establish the connection between rapidly urbanising metros and Anthropocene-related impacts. Pollution, excessive resource exploration resulting in its depletion, loss of bio-diversity, potable water crisis vulnerability to climate change etc, are a few notable impacts which are highlighted in the study.

The other half of the study talks about sustainable pathways and offers solutions like green urban planning, adoption of smart technologies and community-driven reform-oriented initiatives. It endeavours to strike a chord between urban planning and policy frameworks, to foster a balance between urban growth and ecological integrity, while offering scalable strategies.

Key Words: Anthropocene, Climate – change, Pathways, Metropolitan cities

INTRODUCTION

The Anthropocene is a proposed geological epoch which is characterised by the overwhelming dominance of human impact on earth's climate, ecosystem and geology. Humans have an indelible impact in significant magnitude and quantum, that have shaped the earth's system.

The advent of an 'Urbanized Anthropocene' comes with an all-pervasive sense that global change pressures such as climate- change, resource depletion, ecosystem breakdown and persistent poverty threaten the conditions of existence of human life as we know it (Crutzen 2002). In other words, the urban Anthropocene may be understood as the urbanised age of human-induced evolutionary changes. The term "**Anthropocene**" was first coined by **Paul J. Crutzen**, a Nobel Prize-winning atmospheric chemist, and **Eugene F. Stoermer**, an ecologist, in the early 2000s. Crutzen popularized the term through his research and publications, arguing that human activities have become a significant geological force shaping Earth's systems.

The Anthropocene as an epoch is not recognised by the **International Commission on Stratigraphy (ICS)** or the **International Union of Geological Sciences (IUGS)**, which are the governing bodies responsible for defining geological time scales. The current officially recognized epoch is the Holocene, which began approximately 11,700 years ago.

However, those advocating for the Anthropocene argue for starting the Anthropocene epoch from mid 20th century. The mid-twentieth century not only marked the great global upheaval in economics but also witnessed the nuking of two Japanese cities during World War 2. The rapid urbanisation and sudden surge in the emission of environment-polluting gases, precipitating global warming and climate change. The human impact has been so profound during the past many centuries, that it has a significant indelible impact on Earth's geology, ecosystem and climate. These changes are not natural or due to nature-induced processes, instead, human activities such as industrialisation and subsequent urbanisation, deforestation and fossil fuel burning induced climate change, have shaped the present era.

The human being in the centre of the activities shaping the present epoch adequately takes the prefix 'Anthro' to highlight the dominance of Homo sapiens. The dominance is so overwhelming that a section of earth scientists across the globe including geologists are advocating to rechristen and subdivide the present geological era into an epoch aptly named the Anthropocene.

In the geological time scale, the eras and epochs (from oldest to youngest) have certain characteristics or in other words, the major geological activities occurring during the period become its representatives. For example, the Cenozoic and the Permian are famous for mountain building and coal formation activities respectively.

The Anthropocene is a proposed era dominated by human activities to the extent that it becomes pronounced and relegates other geological/tectonic activities to play the second fiddle.

The pertinent question dealing with the period of the Anthropocene remains relevant.

Period / Time Scale of Anthropocene

The Anthropocene represents a period in Earth's history which is shaped largely by Anthropogenic activities.

Some enthusiasts point towards three important junctures of the recent past. The advent of agriculture or crop farming some 10000 years ago is generally referred to as a turning point. The Industrial Revolution in the latter half of the seventeenth century perhaps changed humanity and the way it affected the climate, ecosystem and geology of Mother Earth like never before. The third but not necessarily in the same order in terms of quantum of magnitude was the great global economic progress embedded with an overall uplift in the standard of living post-Second World War.

The period of Anthropocene, hence, is considered to have commenced around 10000 years BC. The wide-scale farming in a commune significantly started to affect the present ecosystem. Similarly, the Industrial Revolution marked an unprecedented surge in fossil fuel burning and the release of greenhouse gases in the atmosphere, which many years later became the prime cause of climate change.

The period of Renaissance coupled with resurgence and rapid economic progress, witnessed large-scale urbanisation both in developed and developing countries. The enormity of and scale of urbanisation put severe pressure on the available resources. The consumption pattern and resource exploitation underwent a clear paradigm shift. The voracity and quest for an urban place rose in a gigantic manner. The result was accelerated carbon emissions and a spreading ecological footprint. A city like London has an ecological footprint 140 times its size. The whole world fast turning urban, with big cities growing bigger and bigger to the extent of getting unmanaged. The burgeoning big cities though are home to millions of inhabitants and are also sources of a plethora of social economic and microclimatic issues. The vulnerability to climate change has risen and so is the frequency of hazardous events.

Indian Metropolitan cities are also struggling with challenges like micro-climatic alteration, depletion of the underground water table, heavy and sporadic rainfalls, Urban Heat Islands (UHI) etc. Approximately 31 per cent of the Indian population resides in the Indian urban system (Census 2011) divided into six category towns. Every third urban dweller resides in slums. Moreover, two-thirds of the Indian population is concentrated in category one (one lakh and above population) towns. Out of the total population concentrated in category one town, a significantly large number is in the metropolitan cities (Million cities or cities with a population of 10 lacs or more). The statistics clearly show a top-heavy lop-sided urbanisation of the country, as per the census 2011 reports. The enumeration which is still on for census 2021, trends show will not be a significant alteration in terms of the pattern of urbanisation in India. Recent estimates and agencies (other than the Census of India) estimate the population of Delhi somewhere near 33 million which is roughly equal to the total population of the State of Jharkhand.

Urban Anthropocene is the current age which is arguably shaped by the urbanisation and forces affecting the process of urbanisation. Even the conserves seem to agree regarding the profound and unmistakable impact of rapid urbanisation and its process upon the new age or period. There is no denying that the footprints of urbanisation across the developing as well as the developed world have outstretched their limit which augmented the effects of the Anthropocene. However, the sub-division among the Anthropocene as urban is not been widely used. The dual term is usually used whenever the devastating impact of unbridled rapid urbanisation is highlighted.

The present paper endeavours to investigate the Indian metropolitan cities and their roles in the Anthropocene as well as their impacts towards the effects of the Anthropocene.

The Anthropocene is a proposed age/epoch marked by or shaped by human activities and their impact on the geology, climate and ecosystem of the Earth.

The Anthropocene refers to a proposed geological epoch marking significant human impact on Earth's geology, ecosystems, and climate. The term implies a shift from the Holocene, highlighting that humans have become the dominant force shaping the Earth's systems. It is a period in Earth's history shaped largely by anthropogenic activities.

On the other hand, the Anthropocene effect suggests the immediate and cumulative impression of anthropogenic activities during the Anthropocene epoch. It is a manifestation of human dominance that includes environmental degradation, Global warming, Soil infertility, oceanic acidification, nuclear hazards etc. The focus here is the outcomes and phenomena resulting from indiscriminate and non-judicious exploitation of nature by anthropogenic activities to cater to the consumption-oriented society.

Increased frequency of extreme weather events, imbalanced ecosystems, emergence of heat islands and resulting bouts of heavy and torrential rainfalls (incidence of cloud bursts), are some of the good examples.

Research Gap

Indian cities particularly metropolitan cities are portrayed by Western academics teaming with all sorts of problems and issues. Existing literature often examines urbanization in India as a developmental or demographic phenomenon but fails to situate these studies within the broader framework of the Anthropocene epoch. The global context of urbanization as a geological force remains underexplored in Indian cities.

Most of the studies brazenly lack systematic and comprehensive study of Metropolitan cities in terms of their ecological footprints. Fragmented Research on Metropolitan Carbon Footprint, resource depletion and loss of disequilibrium in urban ecology. There is a need to have empirical and quantifiable data on the contribution of Indian metropolitan cities towards carbon emission and subsequent microclimatic alterations over a time and space dimension.

The coping mechanism and the resilience of the marginalised and deprived communities to the challenges of Anthropocene urbanisation, also remain less probed and investigated.

The challenges of the urban Anthropocene in general and the effects of the Anthropocene in particular differentially affect the urban communities. A chilly night in the cosy comfort of a house might be pleasant, but for the homeless, it's an unending nightmare.

The policy interventions in general address the problems plaguing the Indian urban system, however, the issues on the contribution towards the effects of the Anthropocene, have not been adequately and widely taken up by the academics in a systematic manner.

Urban resilience and adaptability to climate change and other extreme events are the cornerstones of urban and regional planning schemes across the globe. However, the spatiotemporal pattern of anthropogenic activities induced impact in the Anthropocene, particularly in the context of Indian metropolitan cities.

Following are the objectives of the present study

1. To Explore the Role of Indian Cities in the Anthropocene and identify urban challenges
2. To Evaluate Policy and Technological Interventions
3. To Propose Strategies for Resilient Urban Development

The research questions emanating from the objectives listed here are the following for the study.

1. How are Indian cities contributing to and affected by the Anthropocene epoch?
2. What are the key environmental, social, and economic challenges faced by Indian cities in the Anthropocene?
3. How can urban planning and policy in India be reimaged to address Anthropocene challenges effectively?
4. What could be the sustainable pathways?

Keeping in mind the above-stated objectives and research questions, it was found relevant and pertinent to discuss issues faced by the representative metropolitan cities of India spatially located in four distinct regions of the country.

Indian metropolitan cities have outgrown their size and are now swelling. Although almost 31 per cent population in India is urban as per the census 2011, two-thirds of our urban population dwells in category one towns including metropolitan cities. One-third or in other words every third of urban India lives in a slum. Indian urban system is divided into six category/class towns, based on the population or size. The top-heavy distribution of the Indian urban system is glaring with almost 70 per cent of the urban population concentrated in class one or cities having a population of more than 1 lakh. Ironically out of the total population concentrated in category one towns more than two-thirds are confined to the 53 metropolitans (population having more than a million. Leading the tally is Delhi with little over 3.3 crores, which is roughly equal to the total population of the state of Jharkhand.

The enormity of the population is reflected in the large ecological footprints of these cities.

Indian Metropolitan cities have significantly added to the Anthropocene and have a multiplier effect in precipitating the urban Anthropocene and its effects.

The rapid urbanization of Indian metropolitan cities has led to several environmental and socio-economic challenges, contributing significantly to the effects of the Anthropocene.

Some of the impacts and contributions towards the effects of the Anthropocene by the Indian metropolitan cities are listed below.

1. Water Resource Depletion and Pollution
2. Urban Heat Islands
3. Biodiversity Loss
4. Air Pollution:
5. Soil degradation
6. Solid waste disposal

7. Socio-economic chasm growing
8. Pockets/enclaves of prosperity and depression.
9. Growing inequality
10. Severe loss in biodiversity in urban ecology/ landscape
11. The frequency of the incidences of urban deluge and flooding increasing rapidly
12. High vulnerability to Climate change and extreme events
13. Lowering the city's resilience
14. Marginalised communities being pushed to the wall
15. The stings of coercive carbon emission checks will affect the deprived, the most.

Water Resource Depletion and Pollution

Depletion

Cities like Chennai have faced severe water shortages due to over-extraction of groundwater and inadequate rainfall. While Yamuna River in Delhi remains heavily polluted and its water is not fit for domestic purposes as untreated sewerage and industrial effluents continue draining in the river unchecked. (Central Pollution Control Board, 2002)

Pollution

The Yamuna River in Delhi is heavily polluted due to the discharge of untreated sewage and industrial effluents, making the water unfit for consumption and harming aquatic life. Rivers crisscross the big cities be it The Ganges, Sabarmati, Yamuna or the Musa, all are highly polluted and are akin to biological deserts.

Urban Heat Islands (UHIs)

Rapid urbanization has led to the replacement of natural landscapes with concrete structures, increasing temperatures in cities. Delhi, for instance, has recorded temperatures significantly higher than its rural surroundings, exacerbating heat-related health issues. Delhi often experiences heat intensities of 7-9 degrees Celsius higher than the rural surroundings. (IMD, 2021)

Biodiversity Loss

Urban expansion has led to the destruction of natural habitats. In Bengaluru, the conversion of wetlands and green spaces into urban infrastructure has resulted in a significant decline in local biodiversity (Indian Institute of Science, 2020)

Air Pollution

Cities like Mumbai and Delhi frequently experience hazardous air quality levels due to vehicular emissions, industrial activities, and construction dust. This has led to increased respiratory ailments among residents. New Delhi had the dubious distinction for many years of being the most polluted city in the world. Delhi's ambient air quality shooting to a 'hazardous' level with Particulate Matter (PM) levels exceeding the WHO limit by 400 per cent (IQAir, 2023)

Soil Degradation

Construction activities and industrial waste disposal in cities like Kolkata have led to soil contamination and loss of fertility, affecting urban, agriculture and open green spaces.

Solid Waste Disposal

Indian cities in general and Metros, in particular, generate thousands of tonnes of solid waste daily, with inadequate waste management systems leading to overflowing landfills and erecting mountains (heaps) of garbage as in the case of Ghaziabad adjacent to Delhi, creating a major threat to the environment and the resident population. Indian cities collectively generate 62 million tonnes of waste annually, with only 25 per cent treated (Ministry of Environment, Forest and Climate Change, 2022).

Socio-economic Chasm Growing:

Rapid urbanization has widened the gap between the rich and the poor. In cities like Delhi, affluent neighbourhoods have access to better amenities, while slum areas lack basic services. The Metropolitan Cities in India are the glaring examples of cities within a city. The enclaves and pockets of prosperity in a big city surrounded by areas of gloom and despair mark the widespread inequality in Indian urban centres. Forty per cent of the Mumbai population lives in informal settlements (UN-Habitat, 2022).

Pockets/Enclaves of Prosperity and Depression

Bengaluru's IT hubs are juxtaposed with underdeveloped areas lacking infrastructure, highlighting stark economic disparities within the city.

Severe Loss in Biodiversity in Urban Ecology/Landscape

Chennai's rapid urbanization has led to the loss of its wetlands, affecting migratory bird populations and disrupting local ecosystems.

Increasing Frequency of Urban Deluge and Flooding

Mumbai faces frequent flooding during monsoons due to inadequate drainage systems and unplanned urban growth, disrupting daily life and causing economic losses. World Bank estimates an annual loss exceeding 10 billion \$ due to monsoonal flooding in cities like Mumbai and Chennai (World Bank, 2023).

High Vulnerability to Climate Change and Extreme Events

Kolkata is highly susceptible to cyclones and rising sea levels, posing significant risks to its infrastructure and population. By 2050 an estimation by the Intergovernmental Panel on Climate Change (IPCC) presents a gloomy picture of 13 million Indians expected to be displaced due to climate-related extreme events. (IPCC, 2022)

Lowering the City's Resilience

The lack of sustainable urban planning in cities like Hyderabad has reduced their ability to withstand and recover from environmental and economic shocks.

Marginalized Communities Being Pushed to the Wall:

In Delhi, slum dwellers are often displaced without adequate rehabilitation to make way for urban development projects, exacerbating their vulnerabilities.

The Stings of Coercive Carbon Emission Checks, affect the deprived and disadvantaged the maximum.

Regulations aimed at reducing emissions can disproportionately impact low-income groups in cities like Mumbai, who may rely on older vehicles and lack the means to transition to cleaner technologies. Similarly, the less efficient means of cooking method used by the communities who are at the last rung of the societal ladder, do not gel well with the grand narrative of emission cut. The raging debate between the Global South and the North on environmental conservation in general and modus operandi for carbon emission cuts underscores the difference between emissions in the consumption of luxurious items and emissions related to livelihood sustenance.

Addressing the complex challenges requires a multipronged strategy. Below are some key pathways to sustainability that Metropolitan cities in India can adopt.

1. **Green Infrastructure**
2. **Urban Forestry**
3. **Rejuvenating Urban Wetlands**
4. **Sustainable Water Management**

5. **Energy-Efficient Infrastructure**
6. **IoT and AI for Resource Management**
7. **Resilient Urban Planning**
8. **Reducing Air and Soil Pollution**
9. **Solid Waste Segregation and Recycling**
10. **Affordable Housing Projects**
11. **Decentralized Governance**
12. **Community Engagement**

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