STM JOURNALS

Journal of
Alternate Energy
Sources & Technologies

ISSN: 2230-7982 (Online)
ISSN: 2321-5186 (Print)
Volume 16, Issue 1, 2025
January–April
DOI (Journal): 10.37591/JoAEST

https://journals.stmjournals.com/joaest

Research JoAEST

Impact of Urbanization and Policy Interventions on Carbon Emissions Towards Achieving SDG 13

Prabavadhi J.[1,*], Devesh A.[2], Prashanth Arjun G.K.[2], Charumathy B.[2]

Abstract

Climate change remains a major threat to ecosystems and human society. This undermines efforts to achieve Sustainable Development Goal 13 (SDG 13), which aims to take immediate action to address climate change and its impacts. This study provides an overview of the wide-ranging impacts of climate change. It focuses on the increasing frequency, intensity and uncertainty of extreme weather events such as droughts, famines, landslides and heat waves, and impacts it has on unprotected populations and even diverse organisms. In this study, we assess the effectiveness of approaches such as integrating climate-resilient infrastructure, disaster risk reduction initiatives and renewable energy integration. Our analysis identifies key challenges that arise when relating these practices to SDG 13, such as lack of funding, issues with policy enforcement, limited access to technology and communal participation. Despite these limitations, we do have significant opportunities to increase climate resilience. Some notable actions include innovative solutions, such as nature-based solutions, climate finance mechanisms and stronger international cooperation. Findings of this research point out the need for comprehensive policy reforms, increased investments and innovations in sustainable technologies and empowering local communities via localized solutions. The study concludes with actionable recommendations for enhancing climate resilience and mitigating climate impacts, thereby advancing the goals of SDG 13.

Keywords: Climate Change, SDG 13, extreme weather, climate resilience, sustainable development, renewable energy, disaster risk reduction, policy enforcement, climate adaptation, community-based management

INTRODUCTION

One of the biggest threats to human civilizations and global ecosystems is climate change, which has a direct bearing on Sustainable Development Goal 13 (SDG 13), which calls for immediate action to mitigate the effects of climate change. This section explores the diverse impacts of climate change, the global trends driving these changes, and the pivotal role of SDG 13 in addressing these issues.

***Author for Correspondence**
Prabavadhi J.
E-mail: prabavadhiit@mvit.edu.in

[1]Assistant Professor, Department of Information Technology, Manakula Vinayagar Institute of Technology, Puducherry, India
[2]Student, Department of Information Technology, Manakula Vinayagar Institute of Technology, Puducherry, India

Received Date: January 10, 2025
Accepted Date: January 17, 2025
Published Date: January 25, 2025

Citation: Prabavadhi J., Devesh A., Prashanth Arjun G.K., Charumathy B. Impact of Urbanization and Policy Interventions on Carbon Emissions Towards Achieving SDG 13. Journal of Alternate Energy Sources & Technologies. 2025; 16(1): 18–29p.

Global Climate Change Trends: 1980s to 2024

Over the past four decades, climate change has increasingly manifested through more frequent and severe extreme weather events, rising global temperatures, and shifting climate patterns. The Intergovernmental Panel on Climate Change (IPCC) estimates that from the late 19th century, global temperatures have increased by around 1.1°C, with a notable acceleration during the 1980s. A series of natural impacts, such as melting glaciers,

increasing sea levels, and more powerful hurricanes and heatwaves, have been brought on by this warming trend [1].

During the 1980s, the impacts of climate change began to gain scientific and public attention. The decade was marked by increasing greenhouse gas emissions from industrial activities, deforestation, and agricultural expansion. International agreements like the Kyoto Protocol, which intended to reduce emissions, were the result of growing knowledge and concern by the 1990s. However, global emissions continued to rise, driven by economic development and energy consumption, particularly in emerging economies [2].

In the 2000s, the effects of climate change became more pronounced, with record-breaking heatwaves, widespread coral bleaching, and unprecedented polar ice melt. International initiatives to keep the rise in global temperatures far below 2°C, including the 2015 Paris Agreement, have not been enough. The IPCC's reports highlighted the urgency of drastic emission cuts to prevent catastrophic climate impacts [3].

By the 2010s, the focus shifted to adaptation and resilience, as communities worldwide began experiencing the tangible effects of climate change. Initiatives to advance energy efficiency, build climate-resilient infrastructure, and support renewable energy gathered steam. Yet, significant challenges remained, including financing, technology transfer, and policy implementation. As of 2023–2024, climate change continues to be a pressing issue, with the latest data showing that extreme weather events have become more frequent and severe, disproportionately affecting vulnerable regions such as small island states and low-lying coastal areas [4].

THE ROLE OF SDG 13: CLIMATE ACTION

This objective seeks to increase adaptability and resistance to climate-related risks and natural disasters, incorporate climate change mitigation strategies into national policy, and enhance climate education and awareness. SDG 13 has specific targets, including [5]:

- *Goal 13.1:* Increase each nation's ability to adapt and be resilient to climate-related risks and natural disasters.
- *Goal 13.2:* Include climate change mitigation in national planning, strategies, and policies.
- *Goal 13.3:* Enhance human and institutional capacity for adaptation of climate change, mitigation, impact reduction, and early warning, as well as education and awareness-raising [6].

Despite these targets, progress has been mixed. While some countries have made significant strides in renewable energy adoption and climate policy integration, global efforts have been hampered by challenges such as inadequate funding, insufficient policy enforcement, and competing economic interests. The continued rise in greenhouse gas emissions remains one of the most significant obstacles to achieving SDG 13, as it directly contributes to global warming and climate destabilization [7].

Impacts of Climate Change on Ecosystems and Human Societies

The environmental and societal impacts of climate change are profound and far-reaching. Ecosystems worldwide are experiencing shifts in species distribution, altered phenological events, and increased vulnerability to invasive species and diseases. For instance, coral reefs, which support a vast array of marine life, are severely threatened by ocean acidification and warming waters, leading to widespread coral bleaching and habitat loss [8].

Human societies are equally affected, with the most vulnerable populations bearing the brunt of climate impacts. Extreme weather events such as hurricanes, floods, and droughts have devastating effects on communities, causing loss of life, displacement, and economic hardship [8]. Agriculture, a critical sector for food security and livelihoods, faces significant challenges due to changing rainfall patterns, prolonged droughts, and increased pest and disease pressure. In regions like Sub-Saharan

Africa and South Asia, climate change exacerbates existing vulnerabilities, leading to food shortages and heightened conflict over scarce resources [9].

Moreover, climate change disrupts essential ecosystem services, such as water filtration, soil stabilization, and carbon sequestration. Forests, which play a crucial role in absorbing carbon dioxide and regulating the climate, are threatened by increased instances of wildfires, pests, and diseases. The degradation of these services further compounds the challenges faced by communities and ecosystems, highlighting the urgent need for effective climate action [10].

Challenges and Opportunities in Aligning Climate Action with SDG 13

Despite the promise of various climate action practices, several challenges prevent full alignment with the goals of SDG 13. Insufficient funding, limited technological infrastructure, and weak policy enforcement hinder efforts to mitigate climate change and enhance resilience. Additionally, socio-economic factors, such as poverty and lack of education, limit the capacity of vulnerable communities to adapt to climate impacts [11].

However, opportunities exist to overcome these challenges through innovative solutions and stronger collaboration. Technological advancements, such as satellite monitoring for real-time climate data and renewable energy technologies, offer new avenues for effective climate action. Financial mechanisms, such as green bonds and climate funds, provide critical resources for climate mitigation and adaptation projects. International cooperation, bolstered by local engagement and inclusive policy-making, can drive the successful implementation of climate initiatives and the attainment of SDG 13 goals [12].

PURPOSE OF THE STUDY

This study explores the effectiveness of current climate action practices across regions, analyzing their alignment with SDG 13. By examining diverse approaches from countries like the United States, India, and the Pacific Island nations, this study provides insights into successful strategies, barriers to implementation, and the potential for innovative solutions [13]. The goal is to offer practical recommendations that policymakers, conservationists, and communities can use to advance climate resilience and achieve SDG 13, ensuring that ecosystems and human societies can adapt to and mitigate the impacts of climate change for future generations [14].

Countries Experiencing Gains and Losses Due to Climate Change

Recent data highlights contrasting trends in climate impacts among various countries, reflecting their differing capacities to adapt and mitigate climate-related challenges [15].

1. Countries experiencing positive outcomes include:
    i. *China:* Through extensive investments in renewable energy and policies promoting energy efficiency, China has significantly reduced its carbon emissions in recent years. This transition has led to improvements in air quality and a commitment to achieving carbon neutrality by 2060.
    ii. *India:* Initiatives such as the National Action Plan on Climate Change have supported India in advancing its renewable energy capacity, with a notable increase in solar power generation contributing to a cleaner energy mix and a decrease in reliance on fossil fuels.
2. Conversely, countries facing significant climate challenges include:
    i. *Brazil:* Despite past achievements in reducing emissions, recent policy shifts have exacerbated environmental degradation, leading to increased greenhouse gas emissions, particularly due to deforestation in the Amazon rainforest. In 2021, Brazil faced a surge in emissions attributed to changes in land use and agricultural practices.
    ii. *Indonesia:* Driven by economic pressures from palm oil production and logging, Indonesia has seen substantial increases in carbon emissions. The ongoing deforestation and land conversion for agriculture have raised concerns about the country's long-term climate resilience, with significant implications for biodiversity and local communities [16].

This analysis emphasizes the importance of understanding regional trends in climate resilience and vulnerability, illustrating the need for tailored policies that address both mitigation and adaptation strategies in the face of climate change.

How Much Carbon Emissions Result from Human Activities Each Year? Philosophical Approaches

Each year, human activities emit approximately 40 billion metric tons of CO_2 globally, significantly contributing to climate change. This figure has remained alarmingly high, with carbon emissions primarily driven by fossil fuel combustion, industrial processes, deforestation, and land-use changes [17]. Fossil fuel emissions from the energy sector alone account for around 75% of global CO_2 emissions, while deforestation in tropical regions like the Amazon, Southeast Asia, and Africa further exacerbates the climate crisis by reducing carbon sequestration capacity. The deforestation related emissions are a result of agricultural expansion, logging, and infrastructure development, particularly in high biodiversity areas where forests play a crucial role in mitigating climate impacts. Immediate and sustained action is required to reduce carbon emissions and accelerate efforts toward carbon-neutral practices and forest restoration, in line with SDG 13, which aims to combat climate change and limit its impacts [18].

Can We Bring Global Carbon Emissions to an End? Philosophical Approaches

Global carbon emissions have been steadily increasing over the past few centuries, significantly contributing to global climate change. Since the beginning of the industrial revolution, humanity has emitted approximately 2.5 trillion tons of CO_2 into the atmosphere, leading to rising global temperatures and shifting climate patterns. The primary sources of these emissions have been fossil fuel use in the energy sector, industrial activities, and land-use changes such as deforestation [19].

As of recent estimates, global CO_2 emissions reached about 40 billion metric tons in 2020, a year marked by the COVID-19 pandemic, which temporarily reduced emissions due to economic slowdowns. However, this drop is considered temporary, with emissions rebounding quickly as economies recover. Over the past 30 years, global CO_2 emissions increased by more than 60%, largely driven by economic growth in developing countries and the continued reliance on fossil fuels. A study by the International Energy Agency (IEA) found that while there have been some declines in developed countries, such as the European Union, emissions from countries like China and India have increased due to industrialization and growing energy demands [20].

Research indicates that a large portion of global emissions comes from fossil fuel combustion (about 75%), particularly from the energy and transportation sectors, while deforestation and other land-use changes contribute approximately 20% to total emissions. Forests play a crucial role in absorbing CO_2 from the atmosphere, and deforestation not only reduces this capacity but also releases stored carbon back into the atmosphere. According to the Global Carbon Project, deforestation in tropical regions, including the Amazon and Southeast Asia, is responsible for significant carbon emissions. In Brazil, for example, over 9,000 km^2 of forest was lost in 2021, leading to the release of billions of tons of CO_2. To reduce carbon emissions and bring them to zero include transitioning to renewable energy sources, enhancing energy efficiency, adopting carbon capture technologies, and restoring forests through afforestation and reforestation projects. The Paris Agreement, signed by nearly every nation in 2015, sets the target of limiting global warming to below 2°C, ideally 1.5°C, above pre-industrial levels by reducing global emissions [21].

Countries have committed to net-zero emissions by 2050, which involves cutting down emissions and offsetting remaining emissions through carbon sequestration practices such as planting trees or using carbon capture technologies.

Numerous reports show that the world can significantly reduce emissions by adopting green technologies and shifting away from fossil fuel dependency. For instance, the International Renewable

Energy Agency (IRENA) reports that transitioning to renewable energy could cut global emissions by 70% by 2050. In parallel, large-scale afforestation and reforestation projects, such as China's "Green Great Wall", which has seen the planting of over 66 billion trees since the 1980s, could help sequester large amounts of carbon, helping to offset emissions.

However, achieving emissions is a monumental task. According to the United Nations Environment Program (UNEP), current pledges under the Paris Agreement are not sufficient to meet the 1.5°C target. Much stronger and more immediate action is needed in all sectors, particularly in energy, transportation, and land-use. Additionally, policies and financial support for sustainable development, such as the Green Climate Fund, will be vital in enabling developing countries to transition to a low-carbon economy.

Regions Where Carbon Emissions Remain High and the Reasons: Philosophical Approaches

Certain regions around the world continue to experience high carbon emissions, driven by a mix of industrialization, energy use, and land-use practices.

1. The following regions have notably high levels of carbon emissions:
    i. *China:* China is the world's largest emitter of carbon dioxide, responsible for over 28% of global emissions, according to data from the International Energy Agency (IEA) and the Global Carbon Project. This is largely due to the country's heavy reliance on coal for energy, as well as its rapid industrialization and urbanization. In addition, China's transportation sector has been growing rapidly, contributing to emissions. Though China is making significant strides in renewable energy, such as wind and solar power, the country still faces a large gap between its fossil fuel consumption and cleaner alternatives.
    ii. *The United States:* The second-largest emitter globally, has seen significant emissions from its transportation sector, which alone is responsible for about 28% of its total emissions. The US also remains heavily reliant on fossil fuels, particularly natural gas and petroleum, despite growing efforts to transition to renewable energy sources. The industrial sector and energy production are major contributors, although the country has made some progress in reducing emissions in recent years through technological innovation and a shift toward cleaner energy sources.
    iii. *India:* The third-largest emitter of carbon emissions, contributing about 7% of global CO_2 emissions. The reasons for high emissions in India include rapid industrial growth, increased energy demands, and a significant reliance on coal for electricity generation. India's growing population and urbanization also lead to increased transportation emissions. While renewable energy development, particularly solar, is expanding, India's economic dependence on coal and oil poses a challenge to reducing emissions in the short term.
    iv. *European Union (EU):* While historically a leader in emissions reductions, still faces high emissions, especially in countries with energy-intensive industries. Germany and Poland, for example, rely heavily on coal for electricity generation, contributing significantly to emissions in the region. However, the EU has made substantial progress in shifting towards renewable energy, with investments in solar, wind, and other clean technologies, though these efforts are not yet fully sufficient to bring emissions to net-zero levels.
    v. *Southeast Asia (Indonesia, Malaysia, and in Southeast Asia):* Countries like Indonesia and Malaysia are major contributors to carbon emissions, driven by deforestation and the expansion of palm oil plantations, along with fossil fuel consumption. Indonesia, for example, is one of the largest emitters in the region due to forest degradation, which releases large amounts of CO_2. Additionally, the growing industrialization in countries like Thailand and Vietnam contributes to rising emissions. Agricultural practices, such as rice cultivation, are also significant sources of methane, another potent greenhouse gas.
    vi. *Russia:* Russia remains one of the top carbon emitters contributing about 5% of global emissions. The country's emissions are primarily driven by its energy sector, which relies heavily on oil and natural gas extraction, production, and export. Russia's industrial activities, such as heavy manufacturing, also contribute to high emissions, although the country has been making some strides in renewable energy development.

vii. *Brazil and the Amazon:* Brazil's deforestation, particularly in the Amazon, has led to an increase in carbon emissions. The Amazon serves as a critical carbon sink, and deforestation, driven by logging, agricultural expansion (especially soy and cattle ranching), and illegal activities, results in the release of large amounts of stored carbon into the atmosphere. While Brazil has made efforts to curb deforestation, recent political changes have led to weaker enforcement of environmental policies, contributing to higher emissions.

2. *Reasons for high emissions*
   i. *Fossil fuel dependence:* Countries like China, India, United States are heavily reliant on coal, oil, and natural gas for energy, leading to high emissions.
   ii. *Industrialization:* Rapid industrialization in countries such as India and Southeast Asia leads to higher energy consumption and emissions from manufacturing processes.
   iii. *Land-use changes:* Deforestation in countries like Brazil and Indonesia releases stored carbon from forests, significantly contributing to emissions.
   iv. *Transportation sector:* The growing demand for transportation, particularly in urbanizing regions, results in increased emissions from vehicles that rely on fossil fuels.
   v. *Economic development:* Emerging economies tend to rely on fossil fuels for industrial and infrastructure development, contributing to higher emission levels.

Improvements Shown by These Countries Over the Years with Data: Philosophical Approaches

Over the years, many countries have made notable improvements in reducing carbon emissions and increasing their commitments to sustainable development. These improvements have been driven by changes in policy, technological advancements, and a shift toward cleaner energy sources. Below are examples of countries that have shown progress in reducing emissions or improving their environmental footprint, backed by relevant data:

Economic Development

Emerging economies tend to rely on fossil fuels for industrial and infrastructure development, contributing to higher emissions levels:

1. *China:* China has made significant progress in reducing its carbon intensity (emissions per unit of GDP). According to the International Energy Agency (IEA), China reduced its carbon intensity by about 50% between 2005 and 2020, despite the rapid expansion of its economy.
   i. China leads the world in renewable energy production, particularly in solar and wind. In 2020, China was responsible for nearly 40% of the global wind power capacity and 32% of global solar capacity *(Source: REN21)*.
   ii. *Dataset:* China's CO_2 emissions per capita grew from 3.6 Mt in 2000 to 7.6 Mt in 2019, but the carbon intensity of the economy has decreased, as shown in the Global Carbon Project's data.
2. *United States:* The US has seen a reduction in total emissions by around 12% between 2005 and 2019. This was largely due to a shift from coal to natural gas and renewables, as well as increased energy efficiency. The US Environmental Protection Agency (EPA) reports that carbon emissions from the US power sector dropped by nearly 33% from 2005 to 2019.
   i. In 2020, renewables, particularly wind and solar, accounted for around 20% of total electricity generation in the US, up from 5.2% in 2005 *(Source: US Energy Information Administration (EIA)).*
   ii. *Dataset:* EIA data indicates that US carbon emissions dropped from 6,138 Mt CO_2 in 2007 to 5,130 Mt CO_2 in 2019, showing steady emission reductions despite a growing economy.
3. *India:* India has seen impressive growth in renewable energy capacity, with a focus on solar energy. As of 2020, India had a total of 94.4 GW of renewable energy capacity, and its solar capacity has increased by nearly 10 times since 2014 *(Source: Ministry of New and Renewable Energy, Government of India)*.
   i. India's carbon intensity decreased by 21% between 2005 and 2019, according to Global Carbon Project data, reflecting a shift toward cleaner energy.

   ii. *Dataset:* India's CO_2 emissions per capita were 1.8 Mt in 2000, increasing to 2.6 Mt in 2019, but the growth in emissions is slower compared to its economic expansion *(Source: World Bank)*.
4. *European Union (EU):* The EU has made significant progress in reducing carbon emissions by approximately 24% from 1990 levels by 2019, driven by energy efficiency improvements and a shift to renewable energy sources *(Source: EEA)*.
   i. The EU's share of renewables in total energy consumption increased from 8.5% in 2005 to 19.7% in 2020 *(Source: Eurostat).*
   ii. *Dataset:* EU carbon emissions dropped from 5,493 Mt CO_2 in 1990 to 4,174 Mt CO_2 in 2019, despite a growing population and industrial activity, according to EEA data.
5. *Brazil:* Brazil has made notable progress in reducing deforestation rates, particularly in the Amazon. Between 2004 and 2012, Brazil managed to reduce deforestation by 80%, thanks to stricter policies, monitoring, and enforcement. However, recent policy shifts have led to an increase in deforestation in the following years.
   i. Brazil's deforestation reduction led to a significant drop in its carbon emissions. Between 2005 and 2010, Brazil's emissions from land use change fell by over 70% *(Source: Global Carbon Atlas).*
   ii. *Dataset:* Brazil's total CO_2 emissions were 1.4 Gt CO_2 in 2005, and they decreased to 1.1 Gt CO_2 by 2012, but they have since started to rise again as deforestation pressures increase *(Source: World Resources Institute)*.
6. *Indonesia:* Indonesia has been working to control deforestation and has set goals for net-zero deforestation by 2030. The country has seen a decrease in the rate of deforestation, but it remains one of the highest emitters due to land-use changes, including palm oil expansion.
   i. Between 2010 and 2019, Indonesia's emissions decreased by around 10% due to better forest management and reforestation initiatives *(Source: Global Carbon Atlas).*
   ii. *Dataset:* Indonesia's emissions from land-use change were about 1.5 Gt CO_2 in 2015, but they have since fluctuated based on deforestation rates *(Source: World Bank)*.

Emerging economies tend to rely on fossil fuels for industrial and infrastructure development, contributing to higher emissions levels.

THE CONTRAST IN CARBON EMISSIONS BETWEEN DEVELOPED CITIES (TIER-1) AND DEVELOPING CITIES (TIER-2 AND TIER-3) WITHIN COUNTRIES

Developed Cities (Tier-1)

Developed cities, typically classified as Tier-1 cities (e.g., New York, London, Tokyo), tend to have high carbon emissions per capita due to dense populations, high industrial activity, and reliance on fossil fuels, even as these cities often have better access to renewable energy and more advanced environmental regulations. However, they also tend to have more sustainable energy practices.

United States (New York)

- *Energy usage:* New York, for example, is a major urban center with high energy demand, but it has made substantial investments in renewable energy, energy-efficient buildings, and carbon reduction programs.
- *Carbon emissions:* New York's carbon emissions per capita are relatively lower than the US national average due to its high concentration of services, reduced industrial activity, and effective public transport systems. The US Environmental Protection Agency (EPA) reports that New York's carbon emissions from energy consumption dropped by about 16% from 2005 to 2017, but its urban sprawl and reliance on fossil-fuel-based heating and transportation still contribute significantly to its carbon footprint.

European Union (London)

- *Emissions and policy:* London is part of the EU, where emissions are lower in comparison to many other industrialized regions. The EU's push towards sustainable urban development has

driven down carbon emissions in cities like London. According to Eurostat, carbon emissions per capita in the EU have decreased significantly, from 9.5 Mt in 1990 to around 6.6 Mt in 2020.

- *London's progress:* London has made strides in reducing emissions through the Ultra Low Emission Zone (ULEZ) and heavy investment in public transportation. London has also moved to phase out coal and is increasingly shifting to renewable energy. Still, emissions in Tier-1 cities remain high due to the continued dependence on cars, air travel, and heavy industries.

Developing Cities (Tier-2 and Tier-3)

In contrast, cities in developing countries, typically classified as Tier-2 or Tier-3 (e.g., Mumbai, Jakarta, São Paulo), generally have lower carbon emissions per capita but are experiencing rapid urbanization and increased industrialization, leading to higher overall emissions in the aggregate. These cities are also more likely to rely on coal, biomass, and other non-renewable energy sources due to limited access to clean energy infrastructure.

India (Mumbai)

- *Carbon emissions growth:* Mumbai is one of India's largest cities, where emissions have risen rapidly with urbanization and industrialization. India's per capita emissions were 2.6 Mt in 2019 (source: Global Carbon Atlas), but urban areas like Mumbai see much higher emissions due to transport, construction, and industrial sectors. Mumbai has also seen a rise in air pollution due to vehicle emissions and limited use of clean energy.
- *Challenges:* Mumbai's transportation system is heavily reliant on fossil fuels. However, there has been a push for more sustainable solutions, including electrifying buses and improving public transport. India has pledged to reduce its carbon intensity by 33–35% by 2030 compared to 2005 levels (source: India's Nationally Determined Contributions, UNFCCC).

Brazil (São Paulo)

- *Carbon emissions in São Paulo:* São Paulo, Brazil's financial hub, faces significant emissions from transportation, deforestation, and industrial activity. São Paulo has a population of over 12 million people and an expanding urban footprint, leading to greater emissions per capita, though these emissions are lower than those seen in Tier-1 cities.
- *Recent trends:* While Brazil has made efforts to reduce deforestation in the Amazon, São Paulo still struggles with high urban emissions due to a car-dependent culture, deforestation for urban expansion, and a reliance on coal for industrial activities. According to the Global Carbon Project, Brazil's emissions have fluctuated due to deforestation patterns but are steadily rising in urban centers.

Indonesia (Jakarta)

Deforestation and Urbanization

Jakarta, one of the most populous cities in Southeast Asia, has high emissions from both industrial activities and deforestation, exacerbating climate challenges. The World Bank notes that Jakarta's carbon emissions have grown by 25% from 2000 to 2018, primarily driven by transportation (mostly private cars), coal-based power plants, and deforestation. Jakarta's emissions are much lower per capita than cities in developed countries, but the rapid growth of the city presents a significant challenge for managing its carbon footprint.

Energy Transition

While Indonesia has started to invest in renewable energy sources, the shift is slow, and much of the energy demand is still met by coal, which significantly contributes to emissions.

Emission Intensity

Developed cities tend to have lower emissions per capita compared to developing cities because of more advanced technologies, better public transport systems, and energy policies aimed at sustainability. However, overall emissions are higher in Tier-1 cities due to their larger populations and high economic activity.

Energy Sources

Developing cities often rely on fossil fuels, including coal and biomass, for energy production, contributing to higher emissions. Developed cities, while still reliant on fossil fuels, have made greater investments in renewables and energy efficiency, leading to gradual emission reductions.

Transportation

Tier-1 cities generally have better public transportation systems that help reduce emissions, whereas developing cities are experiencing rapid motorization, with many cities in the Global South seeing an increase in vehicle emissions due to a lack of public transport infrastructure and urban sprawl.

Economic Growth and Industrialization

Developing cities are witnessing rapid industrialization and urbanization, which drives up emissions, particularly from sectors like construction, agriculture, and manufacturing. Tier-1 cities are moving toward post-industrial economies, with greater service sector involvement, which typically has lower carbon footprints.

WHERE ARE COUNTRIES IN THE TRANSITION TODAY?

Countries around the world are in varying stages of transition when it comes to reducing carbon emissions and moving toward sustainable development. While many developed nations have made significant strides, others, especially in the Global South, face greater challenges. Developed countries like the EU and United States have been transitioning toward greener economies, with substantial investments in renewable energy, energy efficiency, and emission reduction policies. The EU aims to become carbon neutral by 2050 under its European Green Deal, with notable progress in shifting to renewable sources such as wind and solar. Similarly, the US has seen a decline in emissions over the last decade, especially from the power sector, but faces challenges in transportation and industry. In developing nations, the transition is more complex. Countries like China and India are making progress but face significant barriers due to high industrial growth, rapid urbanization, and reliance on coal for energy. China has become a leader in renewable energy production, particularly solar, but its emissions continue to rise due to its heavy reliance on coal-fired power plants. India, while setting ambitious targets to cut emissions by 33–35% by 2030 (relative to 2005 levels), still struggles with energy poverty and the need for affordable, low-carbon energy solutions.

Emerging economies like Brazil and Indonesia are also experiencing growth in emissions, driven by deforestation and industrial expansion, though efforts to address climate change are slowly increasing. Brazil’s deforestation rates have spiked in recent years, threatening its transition goals, while Indonesia continues to rely heavily on coal and palm oil production.

The carbon emissions in Tier-2 and Tier-3 cities in developing countries are substantial but present a significant opportunity for reduction through targeted efforts. For context, emissions from these cities are often driven by industrial growth, transportation, and energy production, with significant room for improvement in each sector.

Current Emissions in Developing Countries and Room for Improvement

- *Current emissions:* Tier-2 Cities (e.g., cities in India, Brazil, and China) contribute significantly to global emissions. According to the International Energy Agency (IEA), India’s overall carbon dioxide emissions in 2020 reached 2.65 billion tons, with a large portion stemming from cities. Emissions from these cities are primarily due to coal-based power generation and the transportation sector, which remains heavily dependent on fossil fuels.
- Tier-3 Cities (e.g., smaller cities in Africa, Southeast Asia, and Latin America) contribute less individually but collectively form a larger share of regional emissions. For instance, Southeast Asia's urban carbon emissions have increased by approximately 4.6% annually between 2000 and 2019, driven largely by rapid urbanization and a growing dependence on cars.

- *Room for Improvement:* The potential for emission reductions is considerable. Studies show that Tier-2 and Tier 3 cities can reduce their emissions by up to 40–60% with targeted strategies.

Key areas of improvement include:

1. *Energy efficiency and renewable energy:* Transitioning from coal and oil to renewable sources (wind, solar, and hydropower) can reduce energy-related emissions by up to 70%. A study by CDP indicates that sub-Saharan Africa, where many Tier-3 cities are located, could reduce its emissions by 50% through improved energy access and renewables.
2. *Transportation:* Implementing cleaner transportation policies, such as expanding electric vehicles (EVs) and public transport networks, could reduce emissions from this sector by up to 40%. India's National Action Plan on Climate Change (NAPCC) suggests that transitioning to EVs in urban centers could cut 6 million tons of CO_2 per year by 2030.
3. *Urban planning and waste management:* Improving waste management, increasing recycling, and reducing emissions from construction and industrial activities could yield reductions of up to 20–30% in cities.

Well-known Policies Introduced by Countries After 2020: Philosophical Approaches

Some of the well-known policies introduced by major carbon-emitting countries after 2020, each contributing to climate action and carbon reduction includes:

1. *European Union Green Deal (2020):* The EU's Green Deal aims to make Europe the first carbon neutral continent by 2050. It includes a carbon border adjustment mechanism and strengthens carbon pricing with the EU Emissions Trading System (ETS). By focusing on clean energy, energy efficiency, and circular economy models, the deal targets a 55% reduction in emissions by 2030 from 1990 levels (Source: European Commission).
2. *China's Carbon Neutrality Goal (2020):* In 2020, China pledged to achieve carbon neutrality by 2060. The country aims to peak carbon emissions before 2030 and rapidly increase the share of non-fossil fuels in its energy mix. A key component is the establishment of a national carbon trading market, focusing initially on power generation (Source: Reuters).
3. *United States Rejoining the Paris Agreement (2021):* Under President Biden, the US recommitted to the Paris Agreement in 2021 and set an ambitious target to reduce emissions by 50–52% by 2030 from 2005 levels. The country also introduced clean energy incentives through the Infrastructure Investment and Jobs Act, 2021 (Source: The White House).
4. *India's National Green Hydrogen Mission (2021):* India launched this mission to accelerate the production of green hydrogen, aiming for 5 million tons of green hydrogen by 2030. This is expected to reduce dependence on fossil fuels and help decarbonize industries (Source: Press Information Bureau, Government of India).
5. *Canada's Net-Zero Emissions Accountability Act (2021):* Canada passed the Net-Zero Emissions Accountability Act, which enshrines the country's 2050 carbon neutrality target into law. The act requires the government to set emission reduction targets every 5 years, with clear strategies to meet them (Source: Government of Canada).
6. *Japan's Green Growth Strategy (2020):* Japan announced a green growth strategy to promote clean energy technology, aiming to become carbon-neutral by 2050. The strategy includes a focus on renewable energy, hydrogen technology, and energy efficiency across key sectors like steel and transportation (Source: Japan Ministry of the Environment).
7. *South Korea's Green New Deal (2020):* South Korea's Green New Deal aims to transition the country to a low-carbon economy, promoting renewable energy, energy-efficient buildings, and electric vehicles. It includes a substantial investment in green jobs and technologies, and the country aims for carbon neutrality by 2050 (Source: Korea Herald).

CONCLUSION

The continued rise in global carbon emissions, exacerbated by industrial activities, transportation, and deforestation, remains a critical environmental challenge that demands urgent attention. The

accelerated increase in emissions over the past century has contributed significantly to climate change, threatening ecosystems, economies, and human well-being. To address this, it is essential that global efforts align with Sustainable Development Goal 13 (SDG 13), which aims to combat climate change and its impacts. This can be achieved by strengthening international cooperation, setting more ambitious emission reduction targets, and fostering the transition to a low-carbon economy.

Key strategies for reducing emissions include the promotion of clean energy technologies, energy efficiency, and the adoption of sustainable practices across sectors like agriculture, forestry, and transportation. Further, improving data transparency and implementing robust monitoring systems will enable better tracking of emissions progress. Enhanced financial support and technology transfers to developing countries are critical for supporting their efforts to transition towards low-carbon pathways. By taking immediate and comprehensive action to reduce emissions, we can mitigate the worst impacts of climate change and ensure a sustainable and resilient future. As the scientific community and policymakers emphasize, tackling carbon emissions requires global cooperation and commitment to both current and future generations. Through focused climate policies, technological innovation, and community engagement, the shift towards a more sustainable world is achievable.

REFERENCES

1. SDGS. SDG 13. [Online]. https://sdgs.un.org/goals/goal13
2. Intergovernmental Panel on Climate Change (IPCC). (2021). Sixth Assessment Report (AR6). [Online]. Retrieved from https://www.ipcc.ch
3. UNFCCC (United Nations Framework Convention on Climate Change). (2020). The Paris Agreement. [Online]. Retrieved from https://unfccc.int
4. Global Carbon Project. (2022). Global Carbon Budget 2022. [Online]. Retrieved from https://www.globalcarbonproject.org
5. United Nations (UN). (2022). SDG 13: Climate Action. [Online]. Retrieved from https://sdgs.un.org/goals/goal13
6. World Bank. (2021). Carbon Pricing Dashboard. [Online]. Retrieved from https://carbonpricingdashboard.worldbank.org
7. International Energy Agency (IEA). (2021). World Energy Outlook 2021. [Online]. Retrieved from https://www.iea.org
8. Carbon Disclosure Project (CDP). (2021). Climate Change Report 2021. [Online]. Retrieved from https://www.cdp.net
9. The World Resources Institute (WRI). (2021). Climate Data Explorer. [Online]. Retrieved from https://www.wri.org
10. United Nations Environment Programme (UNEP). (2022). Emissions Gap Report 2022. [Online]. Retrieved from https://www.unep.org
11. European Environment Agency (EEA). (2020). Greenhouse Gas Emissions Trends and Projections in Europe. [Online]. Retrieved from https://www.eea.europa.eu
12. OECD (Organisation for Economic Co-operation and Development). (2020). Carbon Dioxide Emissions from Fuel Combustion. [Online]. Retrieved from https://www.oecd.org
13. National Aeronautics and Space Administration (NASA). (2021). Global Climate Change: Vital Signs of the Planet. [Online]. Retrieved from https://climate.nasa.gov
14. International Renewable Energy Agency (IRENA). (2021). Renewable Energy and Carbon Emissions Reduction. [Online]. Retrieved from https://www.irena.org
15. International Transport Forum (ITF). (2021). Carbon Emissions in Transportation: Trends and Future Outlooks. [Online]. Retrieved from https://www.itf-oecd.org
16. Climate Action Tracker (CAT). (2022). Global Carbon Budget and National Emission Reductions. [Online]. Retrieved from https://climateactiontracker.org
17. World Health Organization (WHO). (2020). Health and Climate Change: A Review of the Latest Evidence. [Online]. Retrieved from https://www.who.int

18. The Lancet Countdown. (2021). Tracking Progress on Health and Climate Change. [Online]. Retrieved from https://www.lancetcountdown.org
19. Carbon Brief. (2021). How the Carbon Budget Works and What it Means for Emission. [Online]. Retrieved from https://www.carbonbrief.org Reductions.
20. National Oceanic and Atmospheric Administration (NOAA). (2021). Carbon Dioxide Concentrations and Trends. [Online]. Retrieved from https://www.noaa.gov
21. Global Environment Facility (GEF). (2020). GEF's Contribution to Global Climate Action. [Online]. Retrieved from https://www.thegef.org

