# Comparative Analysis of India, China, the United States, and the United Kingdom : Rising Leadership of India in Climate Change (1750 – 2020)

*Manoj Sinha* [1]
*Tripti Sangwan* [2]

## Abstract

**This paper is a comparative study of 270 years (1750 – 2020) highlighting the impact of India, China, the United States, and the United Kingdom on the environment by assessing these countries on six parameters of cumulative $CO_2$ emissions, production and consumption of $CO_2$ emissions, $CO_2$ emissions per unit, annual $CO_2$ emissions, energy intensity, and share of these countries in global $CO_2$ emissions. Further, the study showed, via empirical estimation of time series data by forming a linear regression model and using advanced statistical software, that even though India is developing at a fast pace, its income (GDP) elasticity of $CO_2$ emissions is significantly low compared to other developing Asian countries (China) and developed economies (the United States and the United Kingdom), which grew at the cost of the environment. Henceforth, this paper provided an in-depth analysis of the sustainable ancient practices followed in India and discussed modern India's pioneering policies, programs, and its transition from a linear to a circular economy to promote green economic growth and development, hence showing a path to the world to promote GDP without adverse impact on the climate and peaceful co-existence of humans and all other species on the planet.**

***Keywords :*** **sustainable development, environment-friendly practices, positive externalities**

**JEL Classification Codes : Q2, Q3, Q5**

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Since ancient times, human influence has played a dominant role in global warming, and the period from 1901– 2016 is reported to be the warmest in the history of modern civilization, where the global annual average surface air temperature rose by about 1.8°F (1.0°C) (Programme Climate Science Special Report, 2017). The advent of the Industrial Revolution in the UK in the 18th century led to a complete breakdown in the traditional practices of a sustainable atmosphere, which encouraged humans to live in harmony with nature as they required an enormous amount of fossil fuels, oil, and coal, which collectively released 40 times more carbon dioxide in the atmosphere (Global Change.gov, n.d.). As a by-product of growing industrialization, population, urbanization, and consumerism, there has been a rapid increase in global warming and adverse climate change. The last few years have witnessed record-breaking, climate-related weather extremes ranging from droughts, floods, cyclones, continuous decline of ice sheets and glaciers, which led to human suffering from

[1] *Principal,* Aryabhatta College, University of Delhi, Plot No. 5, Benito Juarez, Marg, South Campus, Anand Niketan, New Delhi - 110 021. (Email : msinhadu@gmail.com) ; ORCID iD : https://orcid.org/0000-0002-9945-2394
[2] *Assistant Professor (Corresponding Author),* Department of Business Economics, Aryabhatta College, University of Delhi, Plot No. 5, Benito Juarez, Marg, South Campus, Anand Niketan, New Delhi - 110 021. (Email : tripti.sangwan16@gmail.com) ; ORCID iD : https://orcid.org/0000-0003-4026-7917

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food insecurity, mass displacement, and loss of life and monetary loss. For instance, the threshold of $100 billion insured loss was crossed in 2021 (Kramer, 2021), and these trends are expected to increase in the future if no actions are undertaken.

The significant advances in the study of extreme weather events and their correlation to increasing global temperatures have led to the realization that the life and livelihood of humans depend on the sustainability of the Earth (Wuebbles et al., 2017). As the political will for climate action is visible with the rising protests around the world (Rathi, 2019), the entire world is getting united to frame policies and programs to reduce the carbon footprint and decrease the increasing temperatures.

Although the widespread consideration for the preservation of the environment and adopting sustainable practices for development were initiated at the United Nations Earth Summit (1992) and Stockholm Conference of Environment (1992), but these establishments are relatively new compared to ancient cultural environmental conservation practices in India ("World Environment Day: A look at the history, 2021"). Indian society is socialized eco-culturally as 'Environmentalism' is strongly rooted in Indian civilization due to its belief in the in-depth relationship between nature and society. Also, it recognizes that sustainability is due to forests and fields and not from the urban cities and factories (Singh, n.d.).

The United Nations World Commission on Environment and Development defined sustainable development as "meeting the needs of the present, without compromising the ability of future generations, to meet their own needs, especially concerning the use and waste of natural resources" (para 2). This is the reason that the world is adopting the concept of "green buildings." However, the notable point is that the idea of "green buildings" is not new to India, and literature suggests that specific natural resources indigenous to the location were efficiently used to maintain the houses warm or cool according to climatic conditions and thus no negative impact was created on the environment, unlike modern air conditioners and heaters.

## National Responsibilities : Historical Emissions

It is evident that the emissions are not uniform around the globe, and countries have different historic responsibilities for the emissions and varying abilities to cut these emissions. The UK tops the list in the historical emissions per person (Clark, 2011), and based on the population, it is the largest contributor to greenhouse gas emissions due to its historic use of coal in the process of the first industrial revolution (17th century), and thus it holds great responsibility for global warming. On May 1, 2019, Britain declared a Climate Emergency. Hence, Michael Gove (Secretary of State for Housing, UK) stated that due to its role in the Industrial Revolution, the UK has more moral responsibility to cut emissions ("Industrial revolution means UK has moral," 2020) and declared a

**Table 1.** ***Cumulative $CO_2$ Emissions (1850 – 2011) (% of World Total)***

| Country | Emission |
|---|---|
| United States | 27% |
| European Union | 25% |
| China | 11% |
| Russia | 8% |
| Japan | 4% |
| India | 3% |
| Canada | 2% |
| Rest of the World | 20% |

Source : Our World in Data. (n.d.a). $CO_2$ emissions. https://ourworldindata.org/co2-emissions

Climate Emergency on May 1, 2019. Thus, there is a requirement for action to cut the emissions and collectively come together for the security of both human life and Earth. Further, according to the World Resources Institute (Ge et al., 2014), the United States outdistanced all the nations of the European Union combined (25%) by contributing 27% to the total carbon dioxide emissions of the world (1850 – 2011), as shown in Table 1.

More recently (2000 – 2018), China has surpassed the United States in annual greenhouse gas emissions, becoming the largest emitter in the world (Mooney, 2015). The US has emitted much more $CO_2$ than any other country, and despite China's significant increase in emissions in the last decade, emissions per person are still less than half those of the US (Timperley, 2020). Although in 2019, the United States and European Union saw a decline in their emissions compared to 2018, but their greenhouse gas emissions are still greater than those of India. However, India has seen a growth in its greenhouse gas emissions, but these are way too less than those emitted by the US and EU (Netburn, 2019).

## Research Problem

After the preliminary trend analysis, it can be concluded that the US, the UK, and China have major roles in creating negative externalities for the environment via transboundary pollution; whereas, India still ranks very low compared to these countries in polluting the environment. Although previously, the United States and Britain used to produce and provide low-cost goods globally, but today, China is seen as the workshop of the world, producing significant quantities of low-price consumer goods at the cost of the environment.

This raises the need to understand how India's $CO_2$ emissions have been kept at such low levels since ancient times. There is growing recognition of the requirement for feasible ways, both practically and financially, to increase the perception and availability of environmentally friendly alternatives and the impact of people's decisions. Also, the need of the hour is to help them make less environmentally harmful and more advantageous environmental preferences (Coulson-Thomas, 2012). The directions and ways for adopting this include guidance and ancient insights from India.

Hence, this paper provides an in-depth analysis and comparison of the US, UK, China, and India. Additionally, it is a comprehensive study of ancient and modern practices and policies of the government and the private sector to encourage green development.

### *Identification of Research Gap*

- The in-depth literature review provides evidence that there is no study of such a lengthy time span of three centuries (1750 – 2020) in the field of the environment.
- There is no comparative analysis of India, the US, the UK, and China in $CO_2$ emissions, and that too over the span of 270 years.
- No research provides a holistic study of ancient and modern Indian-pioneering practices and policies that act as leading principles for the world, including government programs, lifestyle practices, and India's transition to a circular economy.

## Research Aim and Methodology

To enhance the achievement of sustainability goals and reduce emissions, a multi-level approach is required in which academicians and researchers have a huge role to play by investigating, analyzing, and providing suggestions for policymakers and institutions to develop the most effective and efficient policies and programs.

**Table 2.** ***Objectives, Source, and Research Methodology***

| Objective | Source and Methodology |
|---|---|
| **Objective 1 : To conduct a comparative trend analysis of India, China, the US, and the UK (1750 – 2020).** | |
| a Cumulative $CO_2$ emissions (1750 – 2020) | Our World in Data |
| b Production and consumption-based $CO_2$ emissions (1990 – 2020) | |
| c Per capita $CO_2$ emissions (1750 – 2020) | |
| d Energy intensity (1965 – 2020) | |
| e Annual $CO_2$ emissions (1750 – 2020) | |
| f Share of Global $CO_2$ emissions, 2020 | |
| **Objective 2 : Empirical estimation of income (GDP) elasticity of $CO_2$ emissions of India, China, the US, and the UK (1970 – 2019).** | |
| Mendeley Data Repository | |
| The ordinary least square method is used to analyze the linear regression model using advanced statistical software. | |
| **log *CO*$_2$ = *a* + *b* log *GDP*** | |
| where, *CO*$_2$ is the carbon dioxide emissions, *GDP* is the gross domestic product, *a* is the intercept, *b* is the slope, and hence, *GDP* elasticity of $CO_2$ emissions is calculated. | |
| **Objective 3 : To shed light on the sustainable environmental practices of ancient India.** | |
| a Sustainable ancient Indian architecture. | Literary sources, ancient texts, scriptures, and evidence of architecture are studied. |
| b Importance of environment conservation in ancient Indian scriptures. | |
| **Objective 4 : Listing the sustainable environmental practices in modern India.** | |
| a. Sustainable lifestyle practices. | Literary sources, texts, new policies and programs from international journals and articles were studied. |
| b. The role of the government: Indian climate change and environmental policies. | |
| c. Role of the private sector and transition of India from linear to circular economy : India's model of corporate sustainability for the world. | |

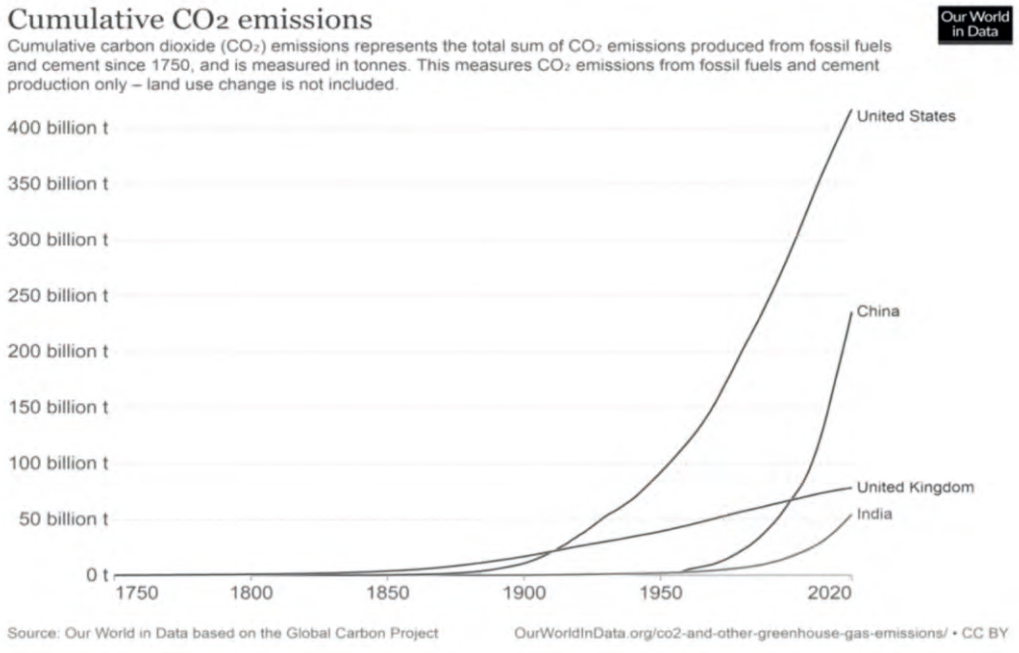
This secondary data-based empirical study is one such significant contribution to the field of climate change and sustainable development with the following objectives (Table 2).

## Comparative Analysis of India, China, United States, and United Kingdom (1750 – 2020)

The history of development is also the history of national $CO_2$ emissions. Over the last three centuries, there are various examples in which the largest emitters have cut down their temperate forests to meet agricultural and fuel requirements. For instance, in the United States, the majority of forests were cut down when migrations happened from East to West to settle in the US. Similar deforestation happened in the UK, where large areas of land were cleared for farming purposes. Even though there have been significant reductions in the emissions of these countries lately, but they are the most responsible for the historical global warming today.

The US ranks top in cumulative $CO_2$ emissions with more than 509Gt$CO_2$ emissions (1850–2021), which is 20.3% of the total global emissions leading to 0.2 degree celsius global warming due to the high usage of coal and motor cars. The second rank is of China, which contributed 11.4% to cumulative $CO_2$ emissions, leading to 0.1

**Figure 1.** ***Cumulative $CO_2$ Emissions of India, China, US, and UK (1750 – 2020)***




Source : Our World in Data. (n.d.a). $CO_2$ emissions. https://ourworldindata.org/co2-emissions

degree celsius of global warming, majorly because of the coal-fired economic boom since 2000. Thus, China surpassed the US and is the world's largest annual emitter, with China's $CO_2$ output having tripled since 2000 (Evans, 2021).

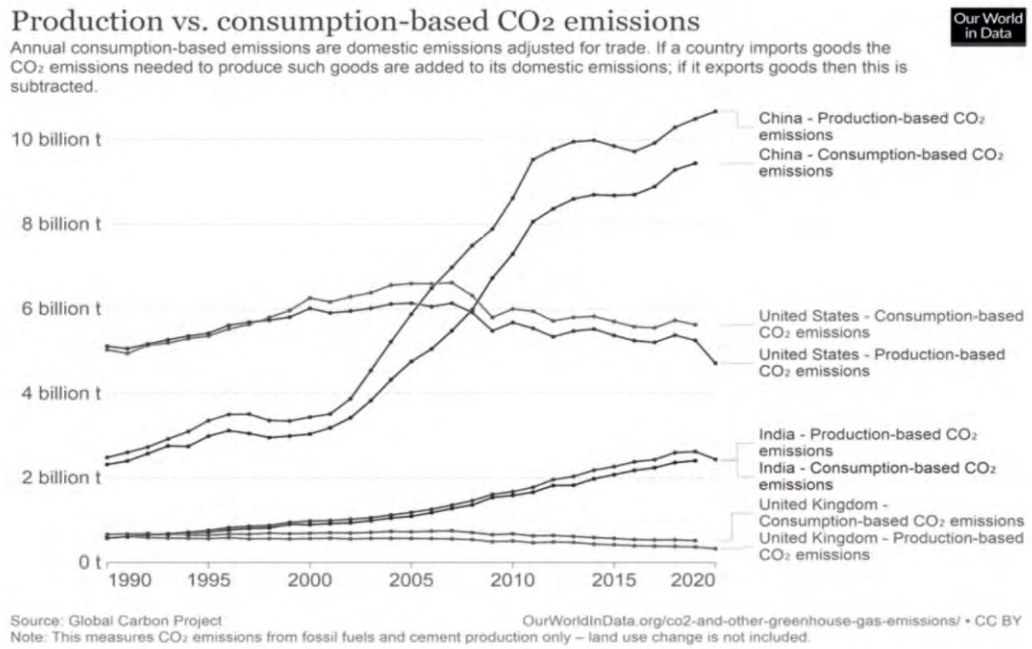
Figure 1 shows the steep growth in global $CO_2$ emissions in the last 270 years and provides a comparative analysis of cumulative $CO_2$ emissions in India, the US, the UK, and China (1750 – 2020). India's emissions have been significantly less compared to those of the United States. Figure 1 also displays that the contribution to emissions was initiated by the UK as the industrialization process started there since the early 18th century. Although, in China's case, the emissions started at a later stage (the 1950s), but the emissions increased at a fast pace, as displayed by the steep curve in the figure. As India has adopted nature-friendly techniques since ancient times, thus its contribution to environmental destruction is significantly low compared to other developed Western countries like the US, the UK, and even Asian countries like China.

It is important to provide a comparison of production and consumption-based $CO_2$ emissions (1990 – 2020), as shown in Figure 2, because with growing environmental accountability, few countries have reduced domestic production of goods with high emissions, but they continue to satisfy their demand from imports, leading to low production of $CO_2$ emissions, but the high consumption of $CO_2$ emissions.

Figure 2 shows that both India's production and consumption emissions are low compared with those of China and the US. Moreover, for India and China, production emissions are greater than consumption emissions, and for the US and UK, consumption emissions are greater than production emissions. By tracking the trend of the empirical data in Figure 1 and Figure 2, it can be concluded that India ranks relatively low in polluting the environment compared to China, the US, and the UK, in both production and consumption emissions.

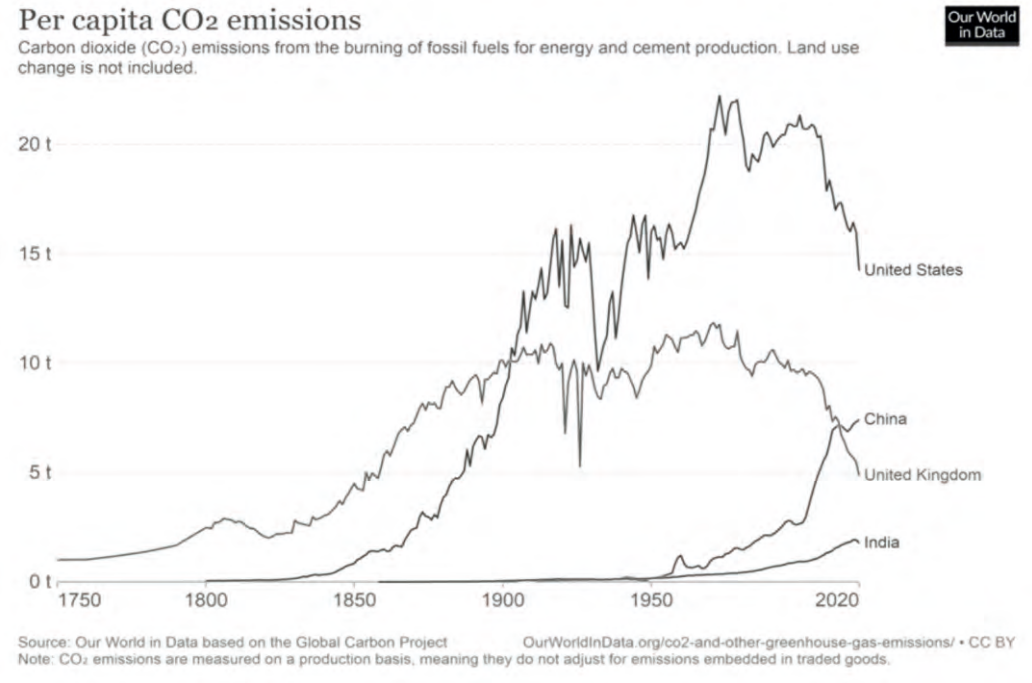
The third parameter of comparison is per capita $CO_2$ emissions (1750 – 2020), as shown in Figure 3. It shows that per capita $CO_2$ emissions have been low in India since the 18th century and are the lowest till date. The credit for this is that India has always adopted environment-friendly lifestyle practices of production and consumption.

**Figure 2.** ***Production vs. Consumption-based $CO_2$ Emissions of India, China, US, and UK (1990 – 2020)***



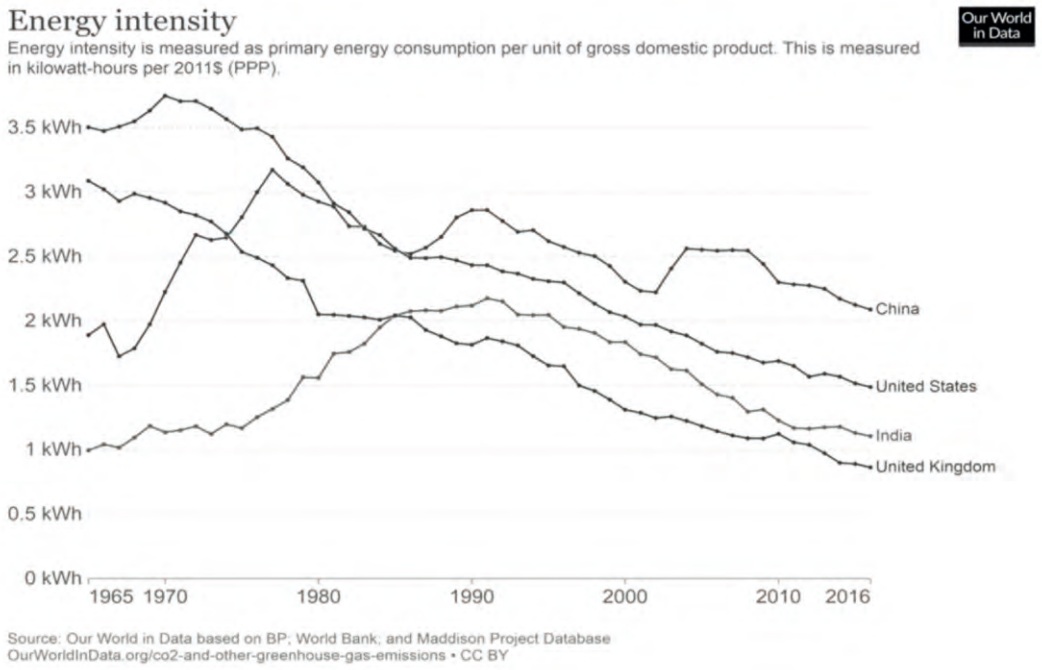

Source : Our World in Data. (n.d.a). $CO_2$ emissions. https://ourworldindata.org/co2-emissions

**Figure 3.** ***Per Capita $CO_2$ Emissions in India, China, US, and UK (1750 – 2020)***




Source : Our World in Data. (n.d.a). $CO_2$ emissions. https://ourworldindata.org/co2-emissions

**Figure 4.** ***Energy Intensity Comparison of India, China, US, and UK (1965 – 2016)***




Source : Our World in Data. (n.d.b). Energy intensity. https://ourworldindata.org/grapher/energy-intensity

However, the noteworthy point is that for the US and UK, although the emissions are high, they are on a declining trend, but for India and China, the emissions are significantly less than those of the US, but they are on a rising trend. In addition to $CO_2$ emissions, energy intensity is also an important indicator. It is a measurement of efficient production, that is, how much energy is used to produce economic output. Low energy intensity means it requires low energy per unit of GDP.

Figure 4 provides a comparative analysis of India, China, the US, and the UK on the metric of energy intensity (1965 – 2016). The reduction in energy consumption greatly reduces emissions. But it is impossible to avoid energy consumption as the consumption of some energy is vital for human existence and to meet the increasing living standards. Energy intensity displays how much cost the country pays to convert energy into GDP. Thus, high-energy intensity means a higher price of producing GDP.

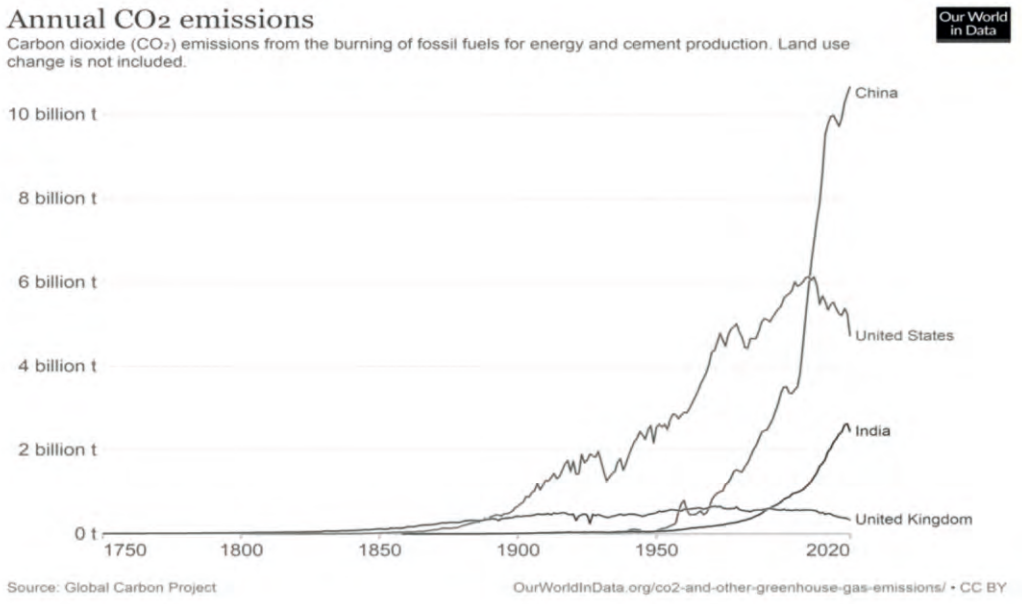
India's energy intensity has been low since 1965, increased for a brief period during the New Economic Reforms of 1991, and again, is on its way back toward the lowest position. Although all countries show a declining trend, China tops the energy intensity, which means that a greater negative impact on the environment is caused by its production activities.

Further, as shown in Figure 5, the highest contribution to the annual $CO_2$ emissions is from China, even though the industrialization process started later compared to other countries; whereas, India is the lowest contributor to the emissions. The United States and the United Kingdom are the early most countries to add emissions with the industrialization process. Hence, it becomes interesting to provide a comparative analysis of these four countries.

After discussing the historical trend, Table 3 provides a comparison of the share of global cumulative $CO_2$ emissions of India, China, the US, and the UK for 2020. It shows that India's share has been the lowest at 3.21%, whereas the United States ranks the highest with 24.56%.

After studying the fact-based analysis in this section and concluding that India's performance is better

**Figure 5.** ***Annual $CO_2$ Emissions of India, China, United States, and United Kingdom (1750 – 2020)***




Source : Our World in Data. (n.d.a). $CO_2$ emissions. https://ourworldindata.org/co2-emissions

**Table 3.** ***Share of Global Cumulative $CO_2$ Emissions, 2020***

| Country | Emission |
|---|---|
| United States | 24.56% |
| China | 13.89% |
| United Kingdom | 4.61% |
| India | 3.21% |

Source : Our World in Data. (n.d.a). $CO_2$ emissions.

compared to other nations and it pollutes the environment by a less amount compared to other countries, the next section discusses the empirical estimation of income (GDP) elasticity of $CO_2$ emissions.

## Comparative Empirical Analysis of India, China, the US, and the UK (1970 – 2019)

This section shows the empirical estimation of income elasticity (GDP) of $CO_2$ emissions of India, China, the United States, and the United Kingdom for 49 years (1970 – 2019), as the data before that is not available.

### *The Empirical Estimation of Income Elasticity (GDP) of $CO_2$ Emissions*

This analysis provided in five tables (Tables 3, 4, 5, 6, and 7) is associated with the empirical estimation of income elasticity (GDP) of $CO_2$ emissions in four countries, and Table 8 provides the comparison of the elasticities of all four countries.

Income (GDP) elasticity of $CO_2$ emissions is 1 / 0.7179 = 1.3929. This indicates that a 1% increase in GDP leads to a 1.39% increase in the $CO_2$ emissions of India (Table 4).

Income (GDP) elasticity of $CO_2$ emissions is 1 / 0.4946 = 2.021. This indicates that a 1% increase in GDP leads to a 2.02% increase in $CO_2$ emissions of China (Table 5).

Income (GDP) elasticity of $CO_2$ emissions is 1 / 0.0803 = 2.021. This indicates that a 1% increase in GDP leads to a 12.45% increase in $CO_2$ emissions of the United States (Table 6).

Income (GDP) elasticity of $CO_2$ emissions is 1 / 0.11203 = 2.021. This indicates that a 1% increase in GDP leads to an 8.9% decrease in $CO_2$ emissions of the United Kingdom (Table 7).

**Table 4.** ***Empirical Estimation of Income Elasticity of $CO_2$ Emissions of India (1970 – 2019)***

| ***Regression Statistics*** | |
|---|---|
| Multiple *R* | 0.982079 |
| *R* Square | 0.964479 |
| Adjusted *R* Square | 0.963739 |
| Standard Error | 0.066451 |
| Observations | 50 |

| | ***Coefficients*** | ***Standard Error*** |
|---|---|---|
| Intercept | –2.47651 | 0.231339 |
| GDP | 0.717998 | 0.019888 |

Log $CO_2$ = $X$ + log *GDP*
Log $CO_2$ = –2.47 + 0.7179 *GDP*

**Table 5.** ***Empirical Estimation of Income Elasticity of $CO_2$ Emissions of China (1970 – 2019)***

| ***Regression Statistics*** | |
|---|---|
| Multiple *R* | 0.984686 |
| *R* Square | 0.969607 |
| Adjusted *R* Square | 0.968973 |
| Standard Error | 0.06169 |
| Observations | 50 |

| | ***Coefficients*** | ***Standard Error*** |
|---|---|---|
| Intercept | 0.572885 | 0.151783 |
| GDP | 0.496467 | 0.012687 |

Log $CO_2$ = $X$ + log *GDP*
Log $CO_2$ = 0.5728 + 0.4946 *GDP*

**Table 6.** ***Empirical Estimation of Income Elasticity of $CO_2$ Emissions of the United States (1970 – 2019)***

| ***Regression Statistics*** | |
|---|---|
| Multiple *R* | 0.788798 |
| *R* Square | 0.622202 |
| Adjusted *R* Square | 0.614331 |
| Standard Error | 0.024054 |
| Observations | 50 |

| | **Coefficients** | **Standard Error** |
|---|---|---|
| Intercept | 5.671463 | 0.11586 |
| GDP | 0.080384 | 0.009041 |

Log $CO_2$ = $X$ + log *GDP*
Log $CO_2$ = 5.671 + 0.0803 *GDP*

**Table 7.** ***Empirical Estimation of Income Elasticity of $CO_2$ Emissions of the United Kingdom (1970 – 2019)***

| ***Regression Statistics*** | |
|---|---|
| Multiple *R* | 0.791321 |
| *R* Square | 0.626189 |
| Adjusted *R* Square | 0.618401 |
| Standard Error | 0.036636 |
| Observations | 50 |

| | ***Coefficients*** | ***Standard Error*** |
|---|---|---|
| Intercept | 7.072915 | 0.150109 |
| GDP | –0.11203 | 0.012493 |

Log $CO_2$ = $X$ + log *GDP*
Log $CO_2$ = 7.072915 – 0.11203 *GDP*

**Table 8.** ***Comparison of Income (GDP) Elasticity of $CO_2$ Emissions of India, China, US, and UK (1970 – 2019)***

| Country | Income (GDP) Elasticity of $CO_2$ Emissions |
|---|---|
| India | 1.3929 |
| China | 2.021 |
| United States | 12.45 |
| United Kingdom | –8.9 |

Table 8 summarizes the results of the empirical estimation of the elasticities. As shown in Table 6, the United Kingdom is the only country with a negative relationship between GDP and $CO_2$ emissions. However, this relation became negative only recently. For the three countries, as shown in Table 4, Table 5, and Table 6, there is a positive relation between GDP and $CO_2$ emissions, with India's elasticity being the lowest and the United States's elasticity being the highest.

The next section will discuss some of the new technologies, programs, and policies adopted by India to further reduce the negative effect on the environment that is helping India keep its emissions low.

## Sustainable Practices of Ancient India

An in-depth analysis of the Indian literature associated with the ancient practices provides infinite references for the conservation and preservation of the climate and the environment. Indian literary texts guide us to understand the previous knowledge behind the vitality of preserving balance in forest ecology. Furthermore, the ancient scriptures (*Arthashastra, Brahamanas, Upanishads, Vedas, The Ramayana, The Mahabharat*) and Indian archeology also provide evidence of the existence of extremely developed and coordinated city planning, well-organized sewage system, and water treatment methods in the Harappan civilization.

India has adopted clean policies and practices that have had the least negative impact on the climate since ancient times. Research has shown that the region was subject to climate change during the period when the Indus Valley Civilization was at its height (2500–1900 BC) ("How Indus Valley Civilization," 2017). Coexisting with nature is an integral part of the Indian tradition and displays deep values for environment conservation where it considers the Earth as 'Mother' and rivers as 'Lokamata.' Indians encourage ecological balances between nature and humans through holy embodiments and rituals for the sustenance of life on the earth conducive to nature.

### *Sustainable Ancient Indian Architecture*

It is important to revisit our past as it seems that the lessons learned from ancient times are being ignored during the phase of modernization and industrialization. It is important to seek answers to the questions that require primordial knowledge as various religious philosophies impact our correlation with the environment, climate, and the natural world. Is there a positive or a negative relationship? Could they create an effect on our sensitivity, concentration, and behavior? Could these age-old practices be used to enhance climate mitigating actions in the world, especially in developing countries? (Goldemberg,1988).

Even though there was no dearth of natural resources in ancient times, our ancestors still followed sustainable practices to conserve them for future generations. The Ajanta caves from ancient India demonstrate how the vaulted ceilings have sun windows to naturally light up the prayer halls. Also, evidence of environmentally sustainable structure-like ice blocks placed in a circular pattern forming dome-shaped houses called igloos have been used by Eskimos for many centuries. These ice blocks are tightly packed and serve as insulation, thus

keeping the igloos warm. The low tunnel inside the igloo helps to trap the heat inside; in addition, a top vent is made to create a way for hot air, which is important to avert the melting of the ice blocks.

Additionally, Badgirs were enormously used in hot, dry areas such as Rajasthan and the Middle East. They refer to the age-old methods to make and keep the building cool. The structure was such that it had wind towers with openings just above the ground level, paving the cool air in and directing it to the basement chambers to maintain the cooling effect. In turn, the hot air was allowed to move outside the structure from the opening at the top, further enhancing the cooling effect.

As bamboo is a waterproof sustainable building material with great tensile strength, it has been used in India for many centuries, especially in the construction of bridges and houses. Baolis are an additional model of environment-friendly architecture that refer to the human-created step-wells that played an eminent role in the preservation of water and acted as great underwater sources. They, especially in the villages, came to the rescue during the water shortages in hot seasons by providing water for washing, drinking, and irrigation ("World Environment Day: A look at the history, 2021").

### *Importance of Environment Conservation in Ancient Indian Scriptures*

Vedas, the most ancient texts in the world, are a great source of enormous scientific knowledge. We can learn from Vedas and adopt ancient practices and perceptions to avoid negative externalities to the environment and resources (Renugadevi, 2012). There exists a great correlation between the selected ancient texts and their impact, which may encourage the endorsement of a balanced life with the contemporary scientific understanding of the enormous negative impact on human life itself due to the destruction of the environment caused by human activities (Coulson-Thomas, 2017).

In addition to the various mentions of weather cycle, rainfall trends, environmental conservation, and ecological balance, the adverse effects of climate change are discussed in the hymns and verses of the four Vedas: *Ṛigvēda* (RV), *Yajurvēda* (YV), *Sāmavēda* (SV), and *Atharvavēda* (AV), signifying a high level of awareness in the seers of that time ("World Environment Day: A look at the history, 2021"). Thus, *Sanatan Dharma* displays guidance for environmental protection and conservation in which the exploitation of nature is considered unjust and disrespects God as Sanatan Dharma regards nature as 'the body of God' and correlates various birds and animals with Gods and Goddesses. Thus, revisiting the past makes us realize that we can learn from our ancestors and that India can lead other countries to adopt a sustainable culture (Singh, n.d.).

## Sustainable Practices in Modern India

India's sustainability and low level of emissions are due to a comprehensive and holistic approach involving everyday lifestyle practices, the role of the government, and encouragement of sustainable entrepreneurship and business models in the private sector, along with social awareness and promoting a circular economy. This section discusses these aspects in detail.

### *Sustainable Lifestyle Practices*

According to Consumer Greendex (Ministry of Environment, Forest, and Climate Change, 2017), India is a top-scoring environmentally sustainable country in consumption. Table 9 discusses the lifestyle practices in India that can be adopted by other countries to reduce emissions, especially the US and China, as their consumption emissions are high (Figure 2).

**Table 9.** ***Sustainable Lifestyle Practices in India***

| Practices | World | India |
|---|---|---|
| 1. Transport | 23% $CO_2$ emissions in total emissions (Sims et al., 2014). | Non-motorized transport is 40% – 50% in mega cities (Tiwari & Jain, 2013). |
| 2. Food wastage | The carbon footprint is 3.3Gt$CO_2$, where upstream (production) share is 54% and downstream (consumption) share is 46% (FAO, 2013). | Natural preservation techniques: Salt application in pickles, sun drying, and using natural disinfectants like neem (Ministry of Environment, Forest, and Climate Change, 2017). |
| 3. Per capita food waste by consumers | 95 – 115kg/year in Europe and North America (Ministry of Environment, Forest, and Climate Change, 2017). | 6 – 11kg/year in South/Southeast Asia and Sub-saharan Africa (Ministry of Environment, Forest, and Climate Change, 2017). |
| 4. Energy conservation | 11% $CO_2$ emissions from electricity and heat generation from residential use in total $CO_2$ emissions (2012) (International Energy Agency, 2014). | • Indian users switch off unwanted fans<br>• Use fans and desert coolers in summers<br>• Use earthen pots for cooling water<br>• Sun drying clothes<br>• Hand washing clothes and dishes saves 200 – 300k Wh/year in one round of dishes (Bijli Bachao, 2022). |
| 5. Waste management | Global municipal solid waste from urban settlements is 46% of the total waste generated. Developed countries focus on recycling, but reuse is limited (Edenhofer, 2014). | • India has a thriving informal-recycling industry where the door-to-door collection of waste is done and supplied to the recycling industry in forward linkages.<br>• India has a flourished second-hand market of luxurious products like cars that encourages reuse.<br>• There is a culture of clothes, books, and toys to be used by younger siblings or to be donated. |

### *Role of the Government : Indian Climate Change and Environmental Management Policies*

India is adopting a comprehensive approach of increasing the GDP along with implementing the best policy practices with practical guidance from our ancestors to achieve the environmental policy targets to have a sustainable future. The Government in India is adopting a proactive role, has enacted stringent environmental legislation, and has created institutions to monitor environmental challenges.

- The National Environment Policy (NEP) will act as a regulatory kit to harness market forces and incentives.
- To promote environmental litigation, India has become one of the first three countries that have a National Green Tribunal (NGT).
- GOI has established National Environment Assessment and Monitoring Authority (NEAMA) to conduct environment appraisals.
- To promote sustainable and climate-resilient infrastructure with the growing needs of urbanization, the Indian flagship program: Housing for All, is launched in which 16 environmentally friendly technologies are identified to be adopted in building and construction processes.
- Under the Smart City Mission, Climate Smart Cities Assessment Framework is launched for the public to provide an assessment on climate-associated arenas.

↳ Corporate social responsibility (CSR) has a high correlation with sustainability (Batham, 2013). India became the first country to legalize CSR in 2014, and as a result, CSR spending in 2018 was USD 1 billion, that is, 47% higher than in 2014. Of this, 12% was for environmental sustainability.

↳ Although global forest cover reduced to 24.4% of the total land area, but with active and efficient forest conservation policies and practices, India recorded an increase of 2,261 sq km of forest and tree cover in 2019.

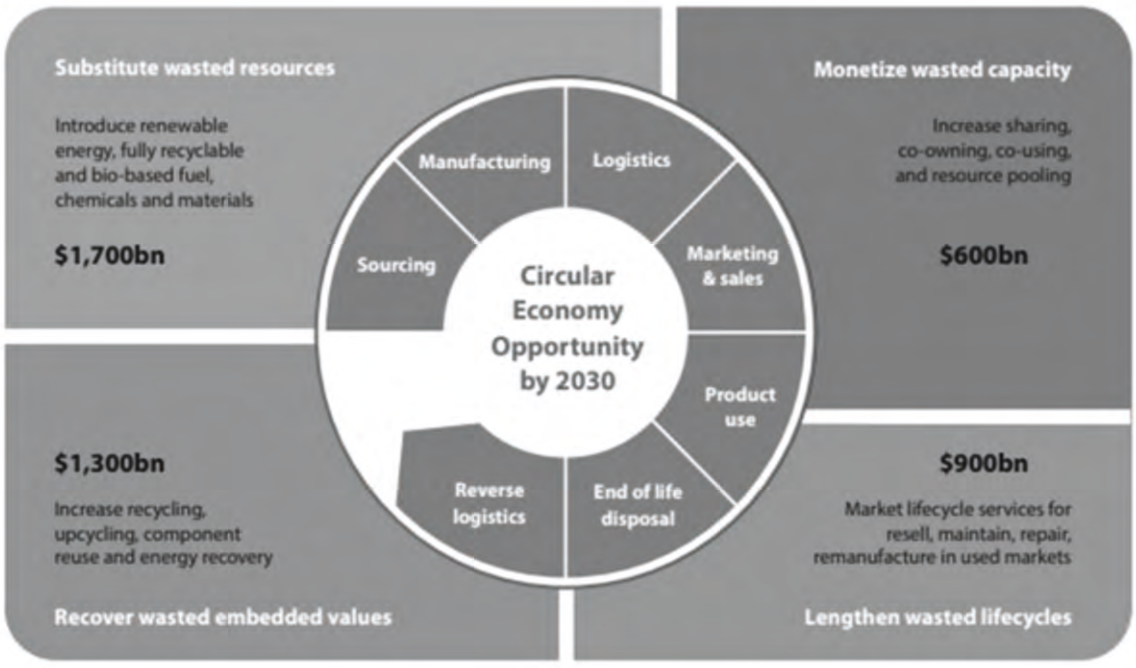
### *Role of the Private Sector and Transition of India from a Linear to a Circular Economy : India's Model of Corporate Sustainability for the World*

Sustainable entrepreneurship programs and business models have led to green economic growth in India. Over the years, government schemes like Zero Defect, Zero Effect (ZED) have helped Indian businesses and entrepreneurs to adopt energy optimization, waste management, and green buildings. Imperfections in the market and individual and collective economic activities provide a way for sustainable entrepreneurship programs and business models leading to green economic growth (Cohen & Winn, 2007). Young entrepreneurs have provided environmentally conscious products and services, thereby creating a dynamic eco-friendly infrastructure of sustainable ecosystems in India (Prasadh & Suresh, 2016).

For instance, the Everloop team has made the waste value chain accessible to electronic waste recyclers by digitalizing it and helping businesses achieve zero waste targets. Apart from the large companies and conglomerates, eight clean-tech startups ranging from biofuels to energy efficiency have received funding of $1 million (Gangadharan, 2021). Rising fuel prices have accelerated the expansion of the solar industries in India, especially in small and medium-sized enterprises (SMEs).

The transition of India from a linear to a circular economy can help it protect half a trillion dollars that are

**Figure 6.** ***Value Realization Potential from Circular Business Models by 2030 in India***




Source : FICCI. (2018).

**Table 10.** ***Circular Economy Initiatives in India***

| | |
|---|---|
| 1. Ambuja Cement | Provides sustainable waste management services to other industries using municipal, agricultural, and mixed industrial waste as an alternative fuel. |
| 2. Mahindra Sanyo | Recovers and reuses metal waste, transferring by-products to other industries like slag, which can be used in construction. |
| 3. SABIC | Utilizes $CO_2$ waste from plants in other to produce urea and methanol. |
| 4. JSW | Iron is recovered and recycled from sludge processing. |
| 5. Mahindra Group | Bio- CNG plant uses kitchen waste to generate fertilizers, CNG, and biogas. |
| 6. Saahas Zero Waste | Utilizes both dry and wet waste to generate biogas and composting. |
| 7. Safe Water Network | Recycling of water and reusing wastewater in toilets and farms. |
| 8. Tata Steel | Converts waste into fertilizers and improves yields per acre by 15% – 20%. |
| 9. IFFCO | Recovering $CO_2$ from ammonia production and reuse for urea production. |

currently at risk (FICCI, 2018), also paving the way for a new business model opportunity of about $4.5tn of GDP globally by 2030 (Accenture Strategy, 2015) as shown in Figure 6. Table 10 lists various circular economy initiatives in India.

## Conclusion and Theoretical and Managerial Implications : India's Pioneering Principles Leading the World

Only the collective action taken worldwide will help have more climate-friendly economic growth and development. This will be beneficial to the entire humankind and the environment as well. In addition to sustainable enterprises, research institutions, social scientists, environment scholars, and analysts, innovation and incubation centers can play a significant role in world sustainability.

After conducting an in-depth analysis, it may be concluded that India can strongly lead the way for other countries with its core belief that man depends on the planet and, thus, is an extension of it. India has undertaken various policies and programs associated with reducing the carbon footprint, adopting green GDP, technologies to improve the energy intensity, and vowing to net zero emissions by 2060, among many others. Also, India is practically guiding the way in the world by disrupting the linear 'take-make-waste' model and transforming itself into a circular economy. India has been following sustainable production and consumption practices since ancient times. But the modern world started giving importance to sustainable development only after the realization that the non-renewable resources are rival in nature, that is, their consumption by one generation reduces the resource endowment for the next generation. After that, many climate-associated international agreements have been formed, and they notify in the direction that it is the collective responsibility of the world to perform, produce, and consume in a manner that least affects the environment and climate.

The Indian ideology of life is personified in the coexisting world view of inter-related harmony in all aspects of life and nature, and its low carbon footprint since ancient times is due to its sustainable and environment-friendly traditional lifestyle practices followed rather than being substituted by unsustainable new age practices and technologies. A similar trend is now being observed in other countries on reviving green consciousness from traditional cultures by developing green development models.

India is leading the way to achieving a balance between growth and development by simultaneously addressing progress and environmental conservation, by facilitating communications with key stakeholders, and thus maximizing the return on environmental investments for ecosystem vitality. The Sustainable Goals were

accepted by the General Assembly of the United Nations (2015). The Paris Agreement on Climate Change (2015) is another historic step in climate action signed by 197 countries. In both these summits, the pro-active performance of India proved that India is once again on the way to becoming a global leader in environmental protection, sustainable development, and a green economy. The notable point is that India's leadership globally on climate action is before the agreement of the 2030 development agenda (Puri, 2019). At the previous G20 Summit, India stated that one of the major challenges is to have inclusive and sustainable development. India also invited other BRICS leaders to join India's initiative to develop a disaster-resilient infrastructure.

India's geographical position is such that it is prone to floods and heat waves. Given these adverse conditions, if India, being a developing country, can commit to becoming net zero emissions by 2060, then surely other countries can follow the same. Such strong targets show a way forward to other countries for a better planet for future generations. To achieve these targets, India is adopting transformative changes such as green infrastructure investment and climate change mitigation measures (McCarthy, 2021).

In its de-carbonization journey, apart from being a net zero emission country, India also plans to generate 90% of its energy from renewable sources, which currently stands at 23% (National Resources Defence Council). The dirtiest fossil fuel, which leads to maximum air pollution, is coal, so transforming itself from generating electricity from coal to renewable sources will accelerate the process of achieving its environmental targets (Dutta, 2015). India is leading the way for the world to create a conducive atmosphere for sustainable development, and a multi-level and multi-phased approach is required, as discussed in the previous section and generalized below:

- Firstly, large-scale investments into sustainable infrastructure and renewable sources of energy will be highly beneficial to achieve the targets of reduced air pollution as well as investment in new projects will also help eradicate poverty by creating more jobs and removing the problem of unemployment. This investment will be successful only if it is conducted comprehensively, that is, at the national, state, and regional levels.

- Secondly, achieving such high targets in a time-bound manner requires equal participation of all parties, including the private sector.

- Thirdly, investment in forest protection and conservation plays an obvious role as forests are two-way highways that release oxygen and act as carbon sinks and natural reservoirs, thus stabilizing the climate. This will encourage the forest product industries and thus increase national income by generating employment. India also targets to drag out three billion carbon dioxide from the environment with the help of forests that act as natural carbon sinks and climate-friendly technological interventions (McCarthy, 2021).

- Fourthly, India has an inherent advantage of the paradigm shift from a linear economy to a circular economy due to its thriving waste economy and informal sector, contributing 20% to GDP. Multi-stakeholder alliances are significant in facilitating such circular business models. According to the Ellen MacArthur Foundation analysis, India's transformation to a circular economy is expected to decrease GHG emissions by 44%, leading to ₹ a 40 lakh crore benefit annually by 2050 (Chauhan et al., 2022). In addition, greenhouse gases are estimated to be reduced by 44%. Many policies have been adopted for this significant shift, including construction and waste management rules, natural resource efficiency policy, metals recycling policy, and plastic waste management rules. Similar transformations for other countries will be highly beneficial.

It is recommended to set up a high-level committee of economists, urban planners, and institutions to suggest policies for green urban planning; procedures to issue green bonds and thus treating climate mitigation as a 'sunrise sector.' The government's sincerity plays a significant role in achieving sustainable goals and attracting investors to fund environment friendly projects to decrease carbon intensity. These moves will provide a boost to India's commitment at COP26 of achieving Net Zero by 2070, in addition to meeting its ambitious target of 175 gigawatts of renewable energy capacity by this year.

The achievements in the urban space so far since ancient times not only reaffirm India's stature as a global leader around the normative frameworks on sustainability, but also indicate that India is achieving environment sustainable targets of climate action and thus setting benchmarks globally vis-à-vis climate resilience and green growth.

## Limitations of the Study and Scope for Further Research

- The analysis period is from 1750 – 2020, but for a few objectives, the data of such old years were not available :
- The data for production and consumption of $CO_2$ emissions have been available since 1990.
- The data for energy intensity are available from 1965 onwards.
- The data for empirically estimating the income (GDP) elasticity of $CO_2$ emissions has been available since 1970.

India's comparison with other countries can highlight other key factors that different countries can adopt to mitigate the negative impact on the environment. Future studies can also examine the impact of climate change on human capital.

## Authors' Contribution

Dr. Manoj Sinha conceived the idea and developed the qualitative and quantitative design to undertake the empirical study. Dr. Tripti Sangwan extracted research papers with high repute, filtered these based on keywords, and generated concepts and codes relevant to the study design. Dr. Manoj Sinha verified the analytical methods and supervised the study. The numerical computations were done by Dr. Manoj Sinha using Advanced Statistical Analysis Software. Dr. Tripti Sangwan wrote the manuscript in consultation with Dr. Manoj Sinha.

## Conflict of Interest

The authors certify that they have no affiliations with or involvement in any organization or entity with any financial interest or non-financial interest in the subject matter or materials discussed in this manuscript.

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## About the Authors

**Prof. (Dr.) Manoj Sinha has 32 years of work experience. He has authored many books and has numerous research paper publications in national and international journals. His research interests are Gandhian studies and leadership, among others.**

**Dr. Tripti Sangwan holds 7 years of experience in teaching at various universities of India and holds a PhD in international economics. She has numerous paper publications in national and international journals. Her keen interest lies in the research of international issues, including environmental and climate changes.**