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Research Paper

Examining the Relationship between Economic Growth and Environmental Degradation in Karnataka

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Abstract
The study aims to elucidate the intricate relationship between environmental degradation and economic growth within the context of Karnataka. This relationship is multifaceted, with each aspect capable of influencing the other in numerous ways. Economic growth often entails heightened resource extraction and industrial activities, which, unfortunately, can significantly contribute to environmental degradation. In this study, we rely entirely on secondary sources of data, meticulously sourced from various government bodies such as the Environment Statistics National Statistical Office, Ministry of Statistics and Programme Implementation, Government of India, and the Reserve Bank of India (RBI). Our analytical approach involves employing simple descriptive statistical tools like averages and percentages, supplemented by line and bar diagrams. Karnataka has undergone notable changes in economic growth, coinciding with shifts in its environmental landscape. The insightful data presented in the study unequivocally demonstrates that heightened economic growth corresponds with a decrease in air pollution levels. This empirical evidence underlines the environmentally conscious nature of the economic growth experienced in Karnataka. Nonetheless, achieving sustainable development mandates the imperative need to strike equilibrium between robust economic growth and vigilant environmental protection.

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I. Introduction:

The topic of environmental degradation and economic growth in Karnataka, a state in southern India, is of paramount importance due to its implications for sustainable development. Karnataka, known for its rich biodiversity, vibrant economy, and rapid urbanization, faces significant challenges in maintaining a balance between economic progress and environmental preservation. Environmental degradation refers to the deterioration of the natural environment, including the depletion of resources, pollution, deforestation, loss of biodiversity, and the degradation of ecosystems. On the other hand, economic growth pertains to the increase in a region's production, income, and consumption levels, often measured by indicators such as gross domestic product (GDP) and employment rates. Karnataka has witnessed substantial economic growth in recent decades, driven by sectors such as information technology, manufacturing, agriculture, and services. This growth has led to improvements in infrastructure, job creation, and living standards. However, it has also placed immense pressure on the environment, resulting in various forms of environmental degradation. The objective of understanding the relationship between environmental degradation and economic growth in Karnataka is to assess the trade-offs and synergies between these two factors.

Sustainable development is the key to ensure long-term prosperity while preserving the environment for future generations. By studying the patterns, drivers, and consequences of environmental degradation in the context of economic growth, it becomes possible to identify effective strategies and policies to achieve a sustainable and resilient future. This research endeavour will involve examining various environmental indicators such as air and deforestation rates and land degradation. It will also analyze economic growth indicators such as GSDP and per capita GSDP. By understanding the interplay between these factors, we can gain insights into the potential trade-offs associated with economic growth and environmental preservation.

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Ultimately, this research aims to propose recommendations and strategies that can help Karnataka strike a balance between economic progress and environmental sustainability.

The study aims to understand the relationship between environmental degradation and economic growth in Karnataka. Environmental degradation and economic growth are interconnected and can influence each other in several ways. Economic growth often entails increased resource extraction and industrial activities, which can contribute to environmental degradation. For example, mining activities can lead to habitat destruction and water pollution, while industrial processes can release pollutants into the air and water. Economic growth can lead to increased pollution levels, which can have adverse effects on human health and ecosystems. Environmental degradation can trigger the implementation of regulations and sustainability initiatives, which can impact economic growth. Stricter environmental regulations may increase costs for industries, while sustainability initiatives such as renewable energy investments can foster green growth and innovation. Environmental degradation can result in the loss of ecosystem services that are crucial for human well-being and economic activities. For example, the degradation of forests reduces their ability to provide clean water, regulate climate, and support biodiversity. Recognizing the economic value of ecosystem services can influence policy decisions and promote sustainable development practices. The United Nations' SDGs recognize the interlinkages between environmental protection and economic growth. Achieving sustainable development requires balancing economic growth with environmental sustainability, aiming for inclusive and environmentally sound economic progress.

The study is entirely dependent on secondary sources of data, which have been collected from various government sources such as the Environment Statistics National Statistical Office, Ministry of Statistics and Programme Implementation, Government of India, and the Reserve Bank of India (RBI). Simple descriptive statistical tools, such as averages and percentages, have been used, along with line and bar diagrams. The paper is organized as follows: Section II provides a review of the literature. Section III focuses on environmental degradation in Karnataka. Section IV examines economic growth in Karnataka. Finally, Section V presents the research findings and conclusions.

II. Review of Literature:

Numerous studies have explored the relationship between environmental degradation and economic growth, providing valuable insights into the specific context. This review of literature highlights key findings and perspectives from previous research in this field. The Environmental Kuznets Curve (EKC) hypothesis suggests an inverted U-shaped relationship between environmental degradation and economic growth. Initial stages of economic development may result in increased environmental degradation, but as income levels rise, societies become more aware of environmental issues and implement measures to address them.

The article by Ecological Economics Unit (1999) provides a comprehensive view of the current state of Karnataka's natural resources and environment, encompassing forest cover, land use, soil erosion, watershed development, livestock and fisheries, mineral ore reserves, industrial pollution, and urban environment. Neglect from the government in addressing these environmental issues has spurred public movements focused on people's access to natural resources and health-related concerns. However, there is a pressing need for a systematic and organized approach to tackle these problems at an institutional level. The assertion is made that evaluating environmental degradation or pollution levels should not be limited to measuring the actual emissions of specific hazardous substances alone (Kathuria, 2002, 2004 vai Mukherjee and Chakraborty, 2007). It's crucial to also take into account other factors that influence the dispersion and intensity of pollution. Mukherjee and Chakraborty, (2007) argued that empirical studies demonstrate that certain local pollutants such as Sulphur dioxide (SO2), Suspended Particulate Matter (SPM), Carbon monoxide (CO), etc., align with the Environmental Kuznets Curve (EKC) hypothesis. Mukherjee and Kathuria (2006) conducted a study examining the Environmental Kuznets Curve (EKC) relationship across 14 major Indian States during the period 1990-2001. They analyzed 63 environmental variables categorized into eight environmental groups. The findings suggest an S-shaped relationship between Environmental Quality (EQ) and Per Capita Net State Domestic Product (PCNSDP), signifying that economic growth in these Indian States has primarily come at the expense of environmental quality.

Overall, the literature highlights the complex relationship between environmental degradation and economic growth. It underscores the importance of balancing economic development with environmental preservation through effective policies, regulations, and sustainable practices. However, further research is needed to gain a comprehensive understanding of the specific drivers, impacts, and potential solutions in the context of Karnataka's unique environmental and economic landscape.

III. Environmental Degradation in Karnataka:

Environmental degradation refers to the deterioration of the natural environment, including ecosystems, habitats, and natural resources, due to human activities. In the context of Karnataka, environmental degradation holds significant importance due to several reasons. Forests play a crucial role in climate regulation by absorbing carbon dioxide, a greenhouse gas, from the atmosphere. Karnataka's forests contribute to carbon sequestration and help mitigate the impacts of climate change. Environmental degradation, such as deforestation and forest degradation can reduce the forest cover and its carbon storage capacity, exacerbating climate change effects and leading to increased vulnerability to natural disasters like floods and droughts.

Table 1: Annual average value of Air Pollutants in Karnataka

Years	Numbers of City	Numbers of Location	Sulphur Dioxide (SO_2)	Nitrogen Dioxide (NO_2)	Particulate Matter$_{10}$ (PM_{10})	Particulate Matter$_{2.5}$ ($PM_{2.5}$)
			MpMC	MpMC	MpMC	MpMC
2010	09	19	12.0	26.0	92.0	NA
2012	17	29	9.0	20.1	82.6	NA
2014	16	26	8.0	18.5	90.8	NA
2016	15	25	3.5	20.7	80.0	43.2
2017	18	30	3.0	21.0	79.0	37.0
2018	19	22	3.5	15.1	64.7	29.3
2019	19	20	4.7	14.1	60.6	23.7
2020	19	22	3.6	13.6	57.5	22.4

Note: *MpMC - Micrograms per Meter Cube*
Source: *Environment Statistics - Vol. I, NSO, GoI*

The table 1 provides the annual average values of air pollutants in Karnataka for the years 2010 to 2020. The pollutants measured include Sulphur Dioxide (SO2), Nitrogen Dioxide (NO2), Particulate Matter 10 (PM10), and Particulate Matter 2.5 (PM2.5). The data is collected from multiple cities and locations within the state. The average levels of Sulphur Dioxide (SO2) have generally decreased over the years. In 2010, the average SO2 level was 12.0 MpMC (micrograms per cubic meter), which decreased to 3.6 MpMC in 2020. This decline indicates a reduction in the emission of sulphur dioxide, likely due to stricter regulations and improved industrial practices. The average levels of Nitrogen Dioxide (NO2) show relatively stable values with slight fluctuations. In 2010, the average NO2 level was 26.0 MpMC, which decreased to 13.6 MpMC in 2020. This decline suggests a decrease in nitrogen dioxide emissions, potentially due to emission control measures and cleaner fuel usage. The average levels of Particulate Matter 10 (PM10) exhibit a decreasing trend. In 2010, the average PM10 level was 92.0 MpMC, which decreased to 57.5 MpMC in 2020. This reduction indicates an improvement in air quality concerning larger particulate matter, which could be attributed to measures addressing industrial emissions, dust control, and vehicular pollution.

The data for Particulate Matter 2.5 (PM2.5) is available from 2016 onwards. The average levels of PM2.5 show a decreasing trend over the available years. In 2016, the average PM2.5 level was 43.2 MpMC, which decreased to 22.4 MpMC in 2020. This decline suggests efforts to reduce fine particulate matter, which can have adverse health effects, possibly through stricter regulations and improved pollution control measures. Overall, the data indicates a positive trend of decreasing air pollution levels in Karnataka over the years. It suggests that the state has made progress in reducing emissions of sulphur dioxide, nitrogen dioxide, and particulate matter. These improvements can be attributed to various factors such as stricter regulations, better industrial practices, and emission control measures. However, it's important to continue monitoring and implementing pollution control strategies to maintain and further improve the air quality in the state.

Table 2: Category-Wise Distribution of Land Degradation in Karnataka (area in hector)

Category	2005-06	Percent*	2015-16	Percent*
Water Erosion	48,77,327	25.4	48,76,020	25.4
Water Logging	2,004	0.0	2,004	0.0
Salinisation/ Alkalisation	1,16,516	0.6	1,16,510	0.6
Acidification	33,797	0.2	33,797	0.2

Anthropogenic	60,136	0.3	62,217	0.3
Others	1,80,544	0.9	1,79,657	0.9
Total	**52,70,324**	**27.5**	**52,70,205**	**27.5**

Note: * *As Percentage to Total Geographical Area of the State*
Source: *Environment Statistics - Vol. I, NSO, GoI*

Table 2 provides the category-wise distribution of land degradation in Karnataka, measured in hectares, for the years 2005-06 and 2015-16. The table includes various categories of land degradation and their corresponding areas. In 2005-06, the area affected by water erosion was 48,77,327 hectares, which accounted for 25.4% of the total. In 2015-16, the area affected by water erosion remained relatively stable at 48,76,020 hectares, accounting for 25.4% of the total. Water erosion refers to the wearing a way of land surfaces by water, leading to soil loss and reduced land productivity. The area affected by water logging was 2,004 hectares, which accounted for 0.0% of the total in both 2005-06 and 2015-16. Water logging occurs when the water table is high, leading to water accumulation in the soil, which can negatively impact agricultural productivity. In 2005-06, the area affected by salinisation/alkalisation was 1,16,516 hectares, accounting for 0.6% of the total. In 2015-16, the area affected by salinisation/alkalisation remained relatively stable at 1,16,510 hectares, accounting for 0.6% of the total. Salinisation/alkalisation refers to the accumulation of salts or alkaline substances in the soil, rendering it unsuitable for agriculture.

The area affected by acidification was 33,797 hectares, accounting for 0.2% of the total in both 2005-06 and 2015-16. Acidification occurs when the soil becomes acidic due to factors such as pollution or improper land management practices, negatively impacting plant growth. In 2005-06, the area affected by anthropogenic (human-induced) land degradation was 60,136 hectares, accounting for 0.3% of the total. In 2015-16, the area affected by anthropogenic land degradation increased slightly to 62,217 hectares, accounting for 0.3% of the total. Anthropogenic land degradation refers to degradation caused by human activities such as deforestation, overgrazing, and unsustainable land use practices.

The "Others" category includes land degradation types mentioned in the table. In 2005-06, the area under the "Others" category was 1,80,544 hectares, accounting for 0.9% of the total. In 2015-16, the area under the "Others" category slightly decreased to 1,79,657 hectares, accounting for 0.9% of the total. In 2015-16, the total land area affected by land degradation remained almost the same at 52,70,205 hectares, accounting for 27.5% of the total land. Water erosion is the most significant category of land degradation in Karnataka, with a substantial area affected in both 2005-06 and 2015-16.

IV. Economic Growth in Karnataka:

The economic growth of a state is measured by indicators such as the Gross State Domestic Product (GSDP) and per capita GSDP, which provide insights into the overall economic performance and the standard of living of its residents. In the case of Karnataka, located in southern India, the state has witnessed significant progress in terms of economic growth, reflected in its GSDP and per capita GSDP. The GSDP represents the total value of all goods and services produced within the state's geographical boundaries in a specific period. It serves as a key indicator of economic activity and productivity. Karnataka has emerged as one of the leading states in India, both in terms of GSDP and overall economic development.

Table 3 provides data on the Gross State Domestic Product (GSDP) and Per Capita GSDP of Karnataka over a series of years. The table includes the constant values of GSDP, growth rates of GSDP, Per Capita GSDP, and their respective growth rates.

Table 3: Gross State Domestic Product and Per Capita GSDP of Karnataka (constant)

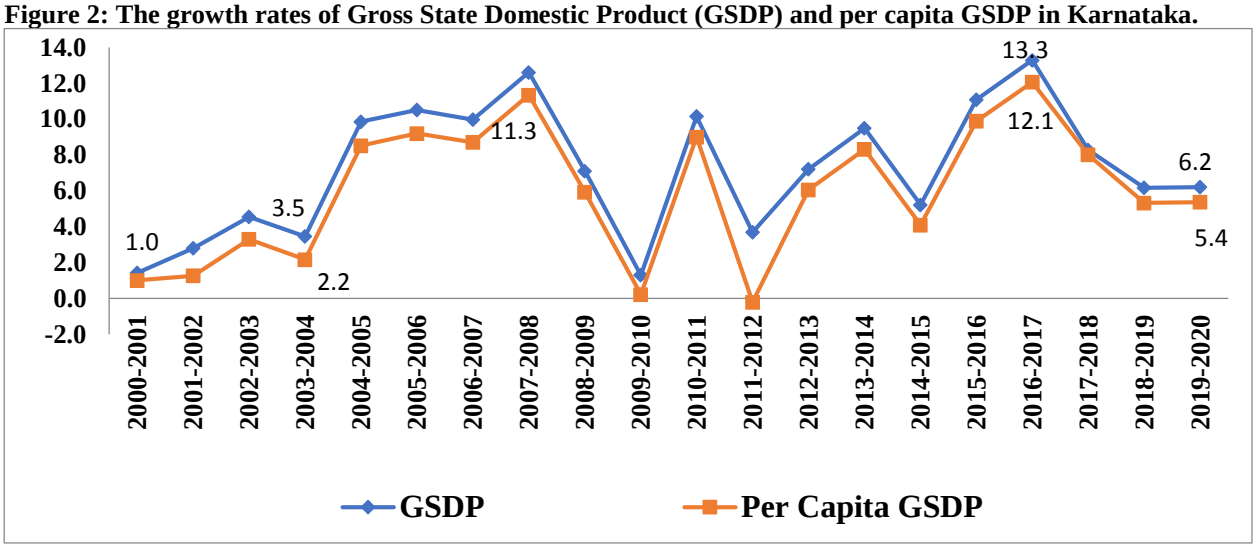
Year	GSDP (Crore)	Growth Rate (Percentage)	Per Capita GSDP (Rupees)	Growth Rate (Percentage)
2000-2001	292555	1.4	55701	1.0
2001-2002	300741	2.8	56402	1.3
2002-2003	314417	4.5	58259	3.3
2003-2004	325282	3.5	59517	2.2
2004-2005	357341	9.9	64587	8.5
2005-2006	394908	10.5	70529	9.2
2006-2007	434303	10.0	76668	8.7
2007-2008	489040	12.6	85359	11.3

2008-2009	523798	7.1	90424	5.9
2009-2010	530589	1.3	90618	0.2
2010-2011	584445	10.2	98774	9.0
2011-2012	606010	3.7	98567	-0.2
2012-2013	649673	7.2	104531	6.1
2013-2014	711313	9.5	113218	8.3
2014-2015	748429	5.2	117844	4.1
2015-2016	831330	11.1	129489	9.9
2016-2017	941774	13.3	145112	12.1
2017-2018	1019708	8.3	156741	8.0
2018-2019	1082614	6.2	165083	5.3
2019-2020	1149829	6.2	173942	5.4

Source: *RBI, State Finances: A Study of Budgets*

Karnataka has experienced consistent economic growth over the years, with varying growth rates. The growth rates range from as low as 1.3% in 2009-2010 to as high as 13.3% in 2016-2017. The highest growth rates are observed during the years 2016-2017, 2017-2018, and 2018-2019, indicating a period of significant economic expansion. Per Capita GSDP growth rates follow a similar trend to the overall GSDP growth rates. The highest growth rates are observed in the years 2016-2017, 2017-2018, and 2018-2019, indicating an improvement in the average income per person. The years 2008-2009 and 2009-2010 experienced relatively lower GSDP growth rates of 7.1% and 1.3%, respectively. This period corresponds to the global financial crisis, which had an impact on Karnataka's economy, resulting in a slowdown. However, the subsequent years, starting from 2010-2011, witnessed a recovery, with higher growth rates observed in GSDP and Per Capita GSDP. The years 2004-2005, 2005-2006, and 2006-2007 recorded high GSDP growth rates of 9.9%, 10.5%, and 10.0%, respectively. These periods reflect robust economic expansion, indicating a favourable business environment and increased productivity. Per Capita GSDP shows a consistent increase throughout the years, indicating improving living standards and average incomes in Karnataka. The growth rates of Per Capita GSDP range from 0.2% to 12.1%, highlighting the positive trajectory of individual prosperity. The years 2015-2016, 2016-2017, and 2017-2018 witnessed higher GSDP growth rates, indicating a period of accelerated economic growth.

Figure 2: The growth rates of Gross State Domestic Product (GSDP) and per capita GSDP in Karnataka.



Source: *RBI, State Finances: A Study of Budgets*

The Gross State Domestic Product (GSDP) of Karnataka has generally shown a positive growth rate over the years, indicating overall economic expansion. The growth rates range from as low as 1.3% in 2009-2010 to as high as 13.3% in 2016-2017. The growth rates exhibit fluctuations, with some years experiencing higher growth compared to others. The Per Capita GSDP represents the average income per person in Karnataka. The growth rates of Per Capita GSDP show a similar pattern to the GSDP growth rates but with some variations. The growth rates range from as low as -0.2% in 2011-2012 to as high as 12.1% in 2016-2017.

The years 2005-2006, 2006-2007, and 2007-2008 witnessed consistently high growth rates in both GSDP and Per Capita GSDP. This indicates a period of robust economic growth and increasing average income levels in Karnataka. The years 2008-2009 and 2009-2010 experienced lower growth rates compared to the previous years. This period corresponds to the global financial crisis, which had an impact on Karnataka's economy, leading to a slowdown. However, the subsequent years show a recovery with higher growth rates in GSDP and Per Capita GSDP.

The years 2015-2016, 2016-2017, and 2017-2018 witnessed higher growth rates, indicating a period of accelerated economic growth. This suggests sustained development and positive momentum in Karnataka's economy. While the overall trend of Per Capita GSDP growth is positive, there are years where the growth rates are lower or negative. For instance, in 2011-2012, there was a slight decline (-0.2%) in Per Capita GSDP compared to the previous year. The long-term trend in both GSDP and Per Capita GSDP indicates positive growth, reflecting the state's efforts in fostering economic development and improving living standards. Overall, the table demonstrates the economic growth of Karnataka over a series of years. The state has experienced periods of high growth, economic slowdown, and subsequent recovery. The positive growth rates in GSDP and Per Capita GSDP highlight the state's progress in terms of economic development and improving the average income levels of its residents.

Table 4: Annual Growth Rate of GSDP and Air Pollution in Karnataka (percentage)

Year	GSDP Growth	Sulphur Dioxide (SO2) Growth Rate	Nitrogen Dioxide (NO2) Growth Rate	Particulate Matter10 (PM10) Growth Rate	Particulate Matter2.5 (PM2.5) Growth Rate
2009-10	1.30	NA	NA	NA	NA
2011-12	10.15	-0.25	-0.23	-0.10	NA
2013-14	7.20	-0.11	-0.08	0.10	NA
2015-16	5.22	-0.56	0.12	-0.12	NA
2016-17	13.29	-0.14	0.01	-0.01	-0.14
2017-18	8.28	0.17	-0.28	-0.18	-0.21
2018-19	6.17	0.34	-0.07	-0.06	-0.19
2019-20	6.21	-0.23	-0.04	-0.05	-0.05

Note: *Negative growth rate in air pollution parameters indicates improvement in air quality*
Source: *Table 1 and 3*

The GSDP growth rate varies from year to year, ranging from 1.30% (2009-2010) to 13.29% (2016-2017). Sulphur Dioxide (SO2) growth rate shows fluctuations, with a significant decrease in 2015-2016 and a subsequent increase in 2017-2018. Nitrogen Dioxide (NO2) growth rate displays fluctuations, with a notable decrease in 2017-2018. Particulate Matter10 (PM10) and Particulate Matter2.5 (PM2.5) growth rates show fluctuations with a declining trend in general. There seems to be an inverse correlation between economic growth (GSDP growth) and Sulphur Dioxide (SO2) growth rate, particularly noticeable in 2015-2016 and 2016-2017. Nitrogen Dioxide (NO2) growth rate also shows a negative correlation with economic growth, especially in 2017-2018. Particulate Matter10 (PM10) and Particulate Matter2.5 (PM2.5) growth rates have fluctuations, but a clear correlation with economic growth is not evident from this data. Higher economic growth in 2016-2017 did not result in a significant increase in air pollutant growth rates, which suggests some degree of decoupling between economic growth and air pollution during that period. Overall the table 4 reveals that as economic growth increases environmental degradations comes down.

V. Findings and Conclusion:

The analysis of economic growth and environmental degradation in Karnataka reveals several key findings and a complex relationship between these two factors. Karnataka has experienced consistent economic growth over the years, as evidenced by the positive growth rates in the Gross State Domestic Product (GSDP) and Per Capita GSDP. The state has witnessed periods of high growth, indicating a favourable business environment, increased productivity, and improved living standards. Karnataka faces environmental challenges, as seen in the forest area decline, air pollution levels, and land degradation. The decline in forest area may have adverse impacts on biodiversity, ecosystem services, and carbon sequestration. The levels of air pollutants, such as Sulphur Dioxide (SO2), Nitrogen Dioxide (NO2), and Particulate Matter (PM10 and PM2.5), are of concern and require attention for public health and environmental quality. Land degradation, including water erosion, salinization/alkalization, and anthropogenic factors, highlights the need for sustainable land management

practices. During the period of 2016-2017, even with a notable surge in economic growth, there wasn't a significant rise in the growth rates of air pollutants. This implies a certain level of disconnection or decoupling between economic expansion and the increase of air pollution during that specific time frame.

In conclusion, while Karnataka has experienced significant change in economic growth, it also faces environmental changes. Table 3 clearly indicates that as economic growth increases, air pollution levels have decreased. This observation highlights that the economic growth experienced in Karnataka has been environmentally friendly. However, to achieve sustainable development, it is crucial to strike a balance between economic growth and environmental protection. The enhancement and rigorous enforcement of environmental laws are imperative. This should be coupled with economic measures such as disincentives and incentives to encourage automatic compliance (Ecological Economics Unit 1999). By adopting sustainable practices, implementing effective policies, and fostering collaboration, Karnataka can promote inclusive and environmentally conscious growth for the benefit of its people and the preservation of its natural resources.

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