Economic Growth and Sustainable Development

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DECLARATION BY STUDENT

I hereby declare that the data presented in this Dissertation report entitled, "Economic Growth and Sustainable Development", is based on the results of investigations carried out by me in the Economics disciplin at the Goa Business School, Goa University under the Supervision of Ms Heena Subrai Gaude and the same has not been submitted elsewhere for the award of a degree or diploma by me. Further, I understand that Goa University will not be responsible for the correctness of observations / experimental or other findings given the dissertation.

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COMPLETION CERTIFICATE

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ABSTRACT

This study explores the connections between Net Primary Product (NPP), a measure of ecosystem productivity, Gross Domestic Product (GDP), an indicator of economic activity, and population in India. Understanding these relationships is vital for sustainable development, as it helps assess the impact of economic growth on ecological health and human well-being. Employing a mixed-methods approach, the study utilizes geospatial analysis of NPP data and econometric modeling to investigate the relationships between NPP, GDP per capita , and Population using data from 2001 to 2018. The study concludes by emphasizing the need for sustainable development policies that promote economic growth alongside ecological protection. It highlights the need for further research to better understand the complex dynamics between NPP, GDP, and Population in India. This research contributes to ecological economics by offering insights into the relationships between economic activity, ecosystem productivity, and population in a developing nation like India. The findings can inform policymakers and stakeholders in developing strategies for sustainable development.

CHAPTER 1: INTRODUCTION

1.1 BACKGROUND

After LPG in the 1990s India has seen rapid economic growth, India is 5th largest economy and densely populated country. But as economic growth has increased in recent time India, a rapidly developing economy and the second-most populous country in the world, presents a fascinating case study for exploring the intricate relationships between Net Primary Production (NPP), Gross Domestic Product (GDP), and population. With a population projected to reach 1.7 billion by 2050, India faces significant challenges in balancing economic growth, environmental sustainability, and human well-being. As the world's third-largest emitter of greenhouse gases, India's economic development is closely tied to its natural resource base, particularly its forests, which cover around 21% of its land area. The country's Net Primary Production (NPP), a measure of the total amount of organic matter produced by plants, is a critical indicator of ecosystem health and productivity. Understanding the relationship between NPP, GDP, and population is crucial for informing policies that promote sustainable development and mitigate the impacts of climate change. India's economic growth, as measured by GDP, has been remarkable over the past few decades, with the country emerging as a global economic powerhouse. However, this growth has come at a cost, with increasing pressure on natural resources, environmental degradation, and rising inequality. The population factor further complicates this relationship, as India's growing population puts additional strain on resources, infrastructure, and ecosystems. Therefore this study aims to investigate the relationship between Net Primary Production (NPP), GDP, and population in India, exploring the complex interactions and trade-offs between economic development, environmental sustainability, and human

well-being. By examining these relationships, this research seeks to contribute to the development of sustainable development strategies that balance India's economic growth with environmental sustainability and social equity.

1.2 OBJECTIVES

The objective of this study is to analyze how variations in GDP and population affect the NPP across states in India.

1.3 Research Question

What is the relationship between Net Primary Product (NPP), GDP and Population and how do variations in GDP and Population impact Net Primary Product?

1.4 Scope

Understanding the relationship between NPP, GDP and Population is important and it provides valuable insight into the mechanism of economic growth and development thereby helping economist and policymakers in achieving a deeper understanding about the factors influencing our nation economic performance. Understanding the connection between NNP, GDP and Population can shed light on the sustainability of the economic activity on natural resources. Given the increasing concern about climate change, biodiversity loss and resource depletion this study can inform policy development regarding economic progress, environmental conservation and population management.

CHAPTER 2- LITERATURE REVIEW

Economic growth has long been considered a cornerstone of societal progress. Studies have shown a positive correlation between economic prosperity and social well-being, particularly in developing nations. Increased national wealth can translate into greater resource allocation for social programs, infrastructure development, and improved living standards (Lianos et al., 2022). However, the benefits of economic growth are not always equally distributed, necessitating careful policy design to ensure inclusive development and bridge potential inequalities.

A critical consideration alongside economic advancement is its environmental impact. Research suggests a clear link between economic activity and environmental pressure. Burman and Kumar (2020) point to a bidirectional relationship between GDP and carbon dioxide emissions, implying that economic growth often coincides with increased energy consumption and pollution.

This aligns with the concept of human appropriation of net primary production (HANPP) introduced by Peng et al. (2015). HANPP quantifies the impact of economic activities and population growth on the biosphere's capacity to regenerate resources, highlighting the potential for unsustainable practices.

The relationship between economic growth and the environment is, however, more nuanced than a simple cause-and-effect dynamic. While economic activity can undeniably pose environmental challenges, it also holds the potential to unlock positive change. When coupled with a shift towards environmentally conscious practices and policies, economic growth can lead to increased investment in environmental protection and resource sustainability. Studies by Busari et al. (2022) and Ho et al. (2019) delve into the intricate relationship between population growth, economic development, and energy consumption, underscoring the importance of embracing

sustainable development strategies that integrate environmental concerns into economic planning.

Understanding the health of ecosystems and their ability to absorb greenhouse gases is crucial for mitigating climate change. Net Primary Productivity (NPP) serves as a valuable tool in this regard. Beardall et al. (2009) highlight the significant contribution of NPP, particularly in oceanic ecosystems, to overall global primary productivity. Studying the factors influencing NPP, such as photosynthesis and respiration, is essential for accurate carbon budget calculations and assessing the long-term impacts of climate change (Ryan-Keogh et al., 2023).

In conclusion, the pursuit of economic growth requires a delicate balancing act. While it offers a path to societal well-being, its environmental consequences must be carefully considered. By fostering environmentally conscious practices and prioritizing sustainable development strategies, we can unlock the positive potential of economic growth while safeguarding the natural world for future generations.

CHAPTER 3 –METHODOLOGY

3.1 Study Area

Figure 3.1

The study area, India, is a vast and diverse country located in South Asia, covering an area of approximately 3.28 million square kilometers. With a population of over 1.4 billion people, India is the most populous country in the world, accounting for about 18% of the global population. The country's geography is characterized by a range of ecosystems, including forests, grasslands, deserts, and mountains, which support a rich biodiversity. India's economy has experienced rapid

growth in recent decades, driven primarily by the service sector, with the country emerging as a global economic powerhouse. However, this growth has also led to significant environmental challenges, including deforestation, pollution, and climate change, which have important implications for sustainable development and human well-being.

3.2 Data Sources

3.2.1 Bhuvan

Bhuvan is a geo-platform developed by the Indian Space Research Organisation (ISRO) and helps in geospatial analysis. It offers various Earth observation datasets to study, including biomass and vegetation index. It will give us access to data on Net Primary Product (NPP).NPP represents the amount of organic matter produced by plants in a particular area over a period of time. It's a crucial indicator of ecosystem productivity. Bhuvan likely provides NPP data in raster or grid format, where each grid cell holds the NPP value for that specific location.

3.2.2 EPWRF

Secondary data based on GDP and Population (in Thousands) over a period of 2001 to 2018 from EPWRF for conducting the analysis.

3.3 Data

3.3.1 Net Primary Product

Net Primary Product (NPP) is a measure of the amount of organic matter that accumulates in an ecosystem after accounting for the energy used by plants themselves. NPP represents the new

organic material produced by plants within an ecosystem over a specific period, forming the base of the food chain that supports herbivores, carnivores, and omnivores. NPP = GPP – R (NPP is typically expressed in units of grams of carbon per square meter per year ($gC/m^2/yr$). NPP is a crucial indicator of ecosystem health and productivity, the Higher NPP implies a more productive ecosystem, capable of supporting a larger herbivore Population and ultimately, a richer food chain and NPP is also essential for understanding the global carbon cycle. Plants play a vital role in separating carbon from the atmosphere through photosynthesis. NPP reflects the rate at which carbon is being stored in organic matter within an ecosystem. By analyzing NPP data from 2001 to 2018 of India which is released by Bhuvan, we can study various ecological processes in India like the Impacts of climate change and environmental disturbances on ecosystem productivity, the effect of land-use changes and their effects on food security and biodiversity and the potential for carbon sequestration by different ecosystems.

3.3.2 **GDP Constant 2011 Back Series**

The GDP per capita constant 2011 back series estimates India's GDP using a base year of 2011-12, extended backwards for a certain period. GDP is calculated using a base year and is known as real GDP. Using a constant base year allows for an accurate comparison of economic growth over time, as it eliminates the impact of inflation and studies real output. The base year for calculating GDP is revised to reflect changes in the economy's structure, and a back series is created to extend the newly calculated GDP estimates backward in time. The research is conducted using 18 year GDP Per Capita Data of 2011 Back series from 2001 to 2018 to study state wise per Capita GDP.

3.3.3 Population (in 000s)

The EPWRF India Time Series database offers state-wise Population data, although it may not be as extensive as dedicated Population databases from government agencies. Specific Population data available on EPWRF depends on the module you access, which may include total Population figures, Population projections, age breakdowns, and urban and rural Population distribution. The Population data likely originates from official sources like the Indian Census. EPWRF presents the data in a specific format or alongside other economic indicators. The research is being conducted with State wise Population data from 2001 to 2018 and it is represented by in 1000 (Thousands).

3.4 Multiple Regression Model

The analysis employs a multiple regression model with the following formula:

$$\mathbf{NPP = \beta_0 + \beta_1 GDP\ per\ Capita + \beta_2 Population + \varepsilon}$$

Where:

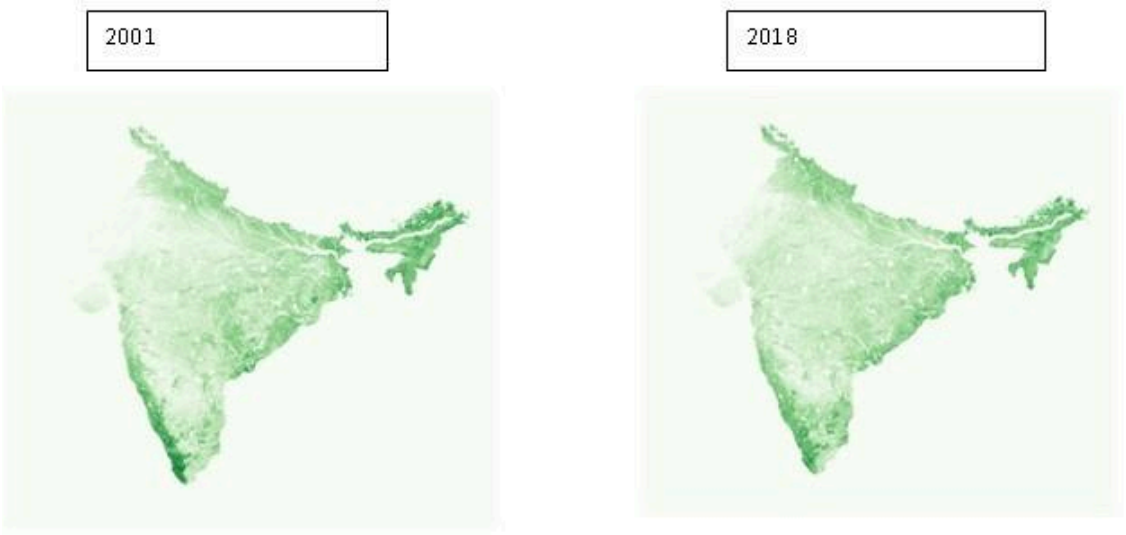
- β_0 is the intercept representing the average value of NPP when all other variables are zero (if applicable).
- β_1 and β_2 are the regression coefficients for GDP per Capita and Population, respectively. These coefficients indicate the change in NPP associated with a one-unit change in the corresponding variable, holding all other variables constant.
- ε represents the error term, capturing the unexplained variation in NPP.

CHAPTER 4 – ANALYSIS

4.1 Model Specification

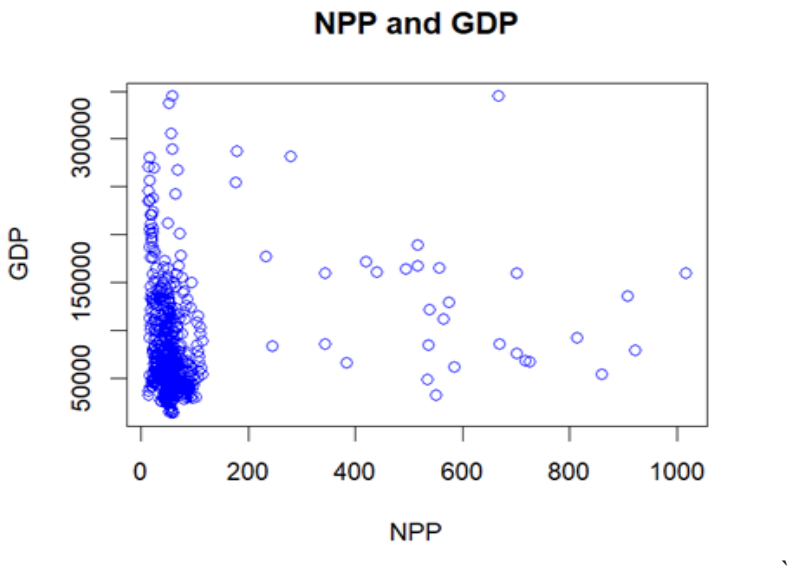
We described the data utilized, including Net Primary Productivity (NPP) zonal statistics, state-wise constant Gross Domestic Product (GDP), and Population data. We also presented the chosen linear regression model to investigate the relationship between NPP and these socio-economic factors. This chapter delves into the analysis itself. We will present the results obtained from the linear regression model, including the estimated coefficients, their significance levels, and any relevant diagnostic tests performed to assess the model's fit. We will interpret these findings to understand how constant GDP and Population influence NPP (NPP) across the analyzed regions.

4.2 Map



Due to India's diverse geography and climate, the NPP is expected to vary significantly across states. States with dense forests, particularly in the Western Ghats, Eastern Ghats, and North-Eastern regions, indicate higher NPP. These areas experience ample rainfall and have a longer growing season, leading to increased plant growth and biomass production. Conversely, states with arid or semi-arid climates, like Rajasthan or parts of Gujarat, might have lower NPP. These regions receive less rainfall and have limited vegetation cover, resulting in less organic matter production.The graph might also reveal trends based on agricultural practices. States with intensive agriculture, characterized by high-yielding crop varieties and irrigation, could show elevated NPP compared to those relying on traditional, rain-fed agriculture.4.3 Scatter Plot

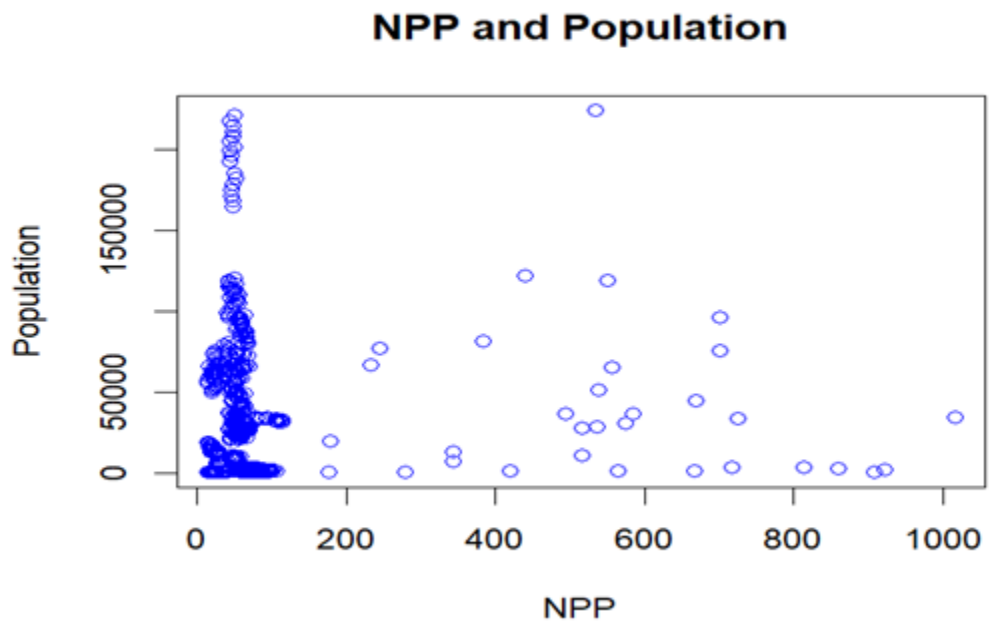
4.3.1 NPP and GDP



A scatter plot is a visual tool used to explore the relationship between two numeric variables, we're looking at the potential connection between NPP, a measure of plant growth in an

ecosystem, and GDP per capita, a representation of a country's per capita income. The X-axis, ranging from 200 to 1000, represents the NPP values. The Y-axis, ranging from Rs 50,000 to Rs 300,000, represents the GDP per capita. By analyzing where the dots fall on the graph, we can identify patterns. The random scattering of dots would suggest no clear relationship between NPP and GDP in this data set. It's important to note that correlation doesn't necessarily imply causation. Just because NPP and GDP appear linked doesn't necessarily mean one directly causes the other.

4.3.2 NPP and Population

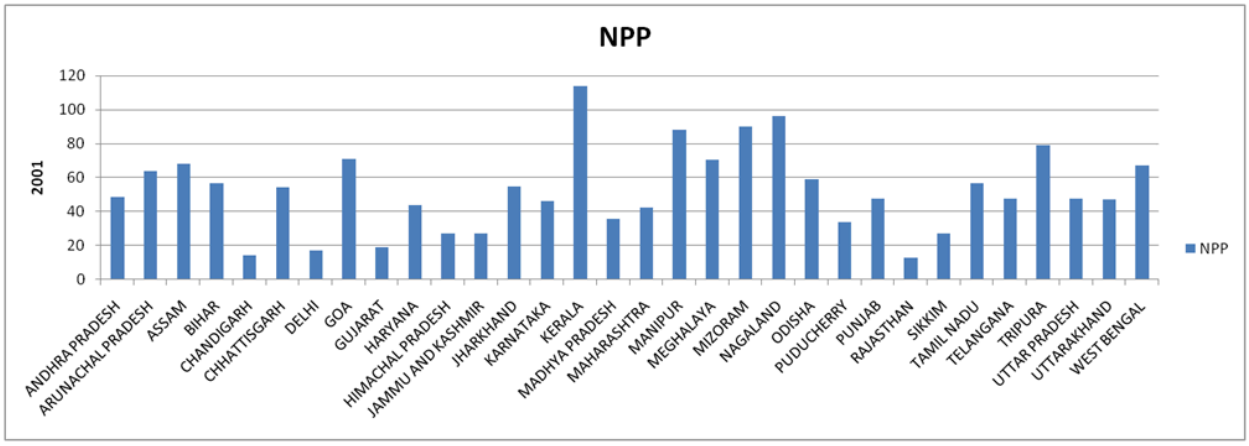


A scatter plot is a visual tool used to explore the relationship between two numeric variables. We're looking at the potential connection between NPP, a measure of plant growth in an

ecosystem, and Population in Thousands, a representation of a country's population. The X-axis, ranging from 200 to 1000, represents the NPP values. The Y-axis, ranging from 20000 to 280000 represents the Population in Thousands. By analyzing where the dots fall on the graph, we can identify patterns. The random scattering of dots would suggest no clear relationship between NPP and Population in this data set. It's important to note that correlation doesn't necessarily imply causation. Just because NPP and Population appear linked doesn't necessarily mean one directly causes the other.

4.4 Graph

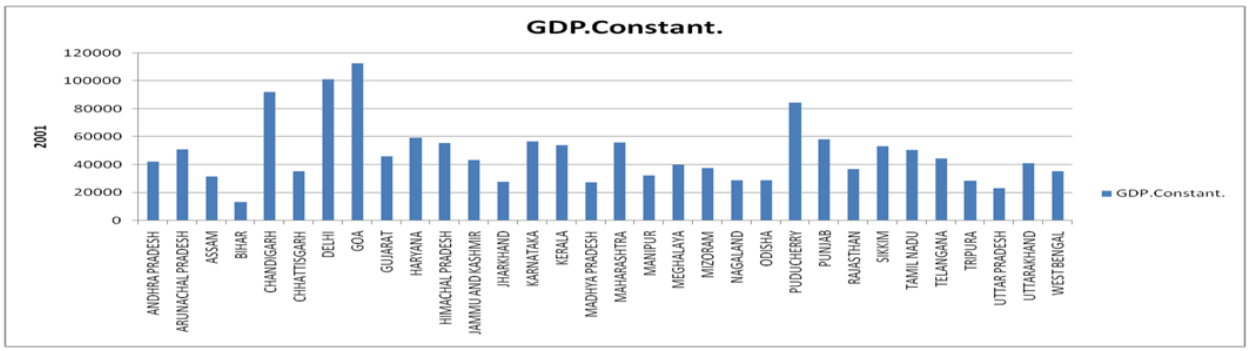
4.4.1 2001 NPP



States with dense forests, particularly in the Western Ghats, Eastern Ghats, and North-Eastern regions, might have taller bars indicating higher NPP. These areas experience ample rainfall and have a longer growing season, leading to increased plant growth and biomass production. Conversely, states with arid or semi-arid climates, like Rajasthan or parts of Gujarat, might have shorter bars reflecting lower NPP. These regions receive less rainfall and have limited vegetation

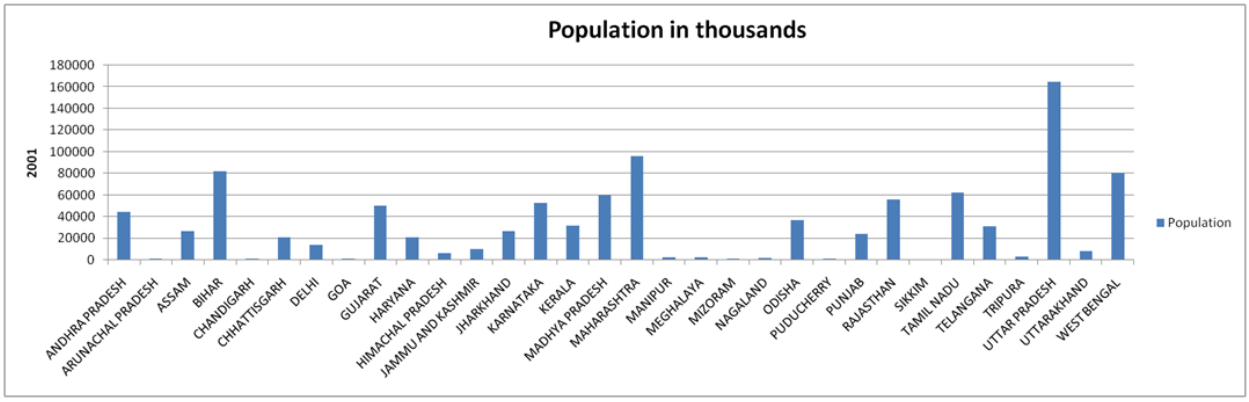
cover, resulting in less organic matter production. States with intensive agriculture, characterized by high-yielding crop varieties and irrigation, could show elevated NPP compared to those relying on traditional, rain-fed agriculture.

4.4.2 GDP per capita 2001



The bar graph depicting state-wise GDP per capita in 2001 would likely reveal significant disparities across India. Developed states with strong industrial bases and commercial activity, possibly concentrated in the west and south, could be expected to have higher bars on the graph compared to states reliant on agriculture or facing infrastructural limitations. States with high GDP per capita might indicate areas with a more developed job market, higher living standards, and potentially greater investment in education and healthcare.States with lower bars could highlight regions needing targeted economic development initiatives to improve living standards and create a more geographically balanced economy.

4.4.3 2001 Population



The bar graph would provide a quick visual grasp of India's vast and uneven population distribution in 2001. Uttar Pradesh, with its massive population, would likely stand out with the tallest bar, followed by other populous states like Maharashtra, Bihar, and West Bengal. South Indian states like Andhra Pradesh, Tamil Nadu, and Karnataka would also likely have prominent bars. In contrast, smaller states in the Northeast (e.g., Sikkim, Mizoram) and the union territories (e.g., Daman & Diu, Lakshadweep) might be represented by shorter bars.

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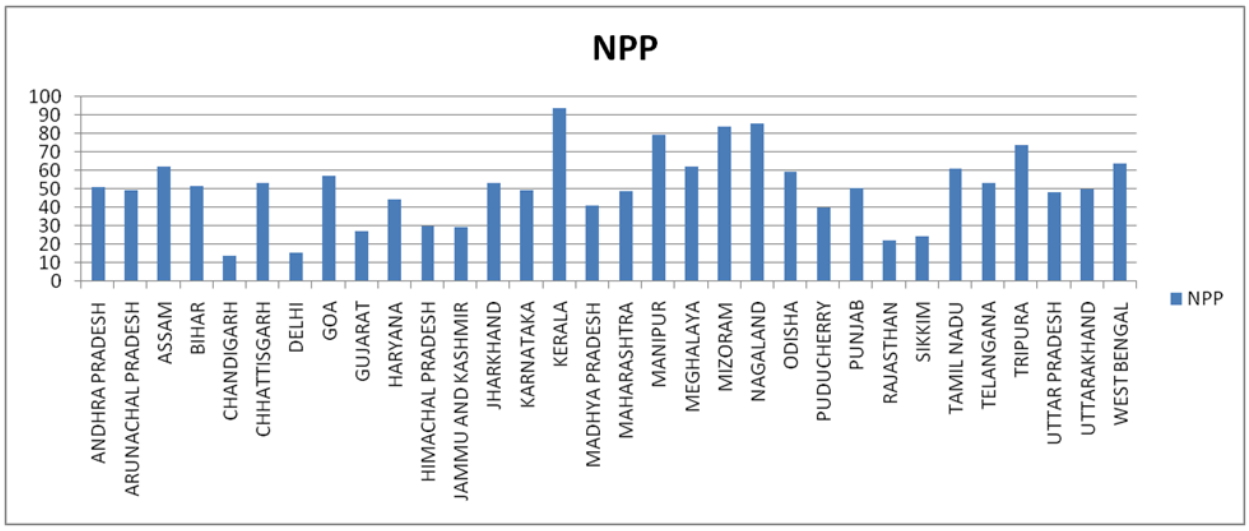
4.4.4 2018 NPP



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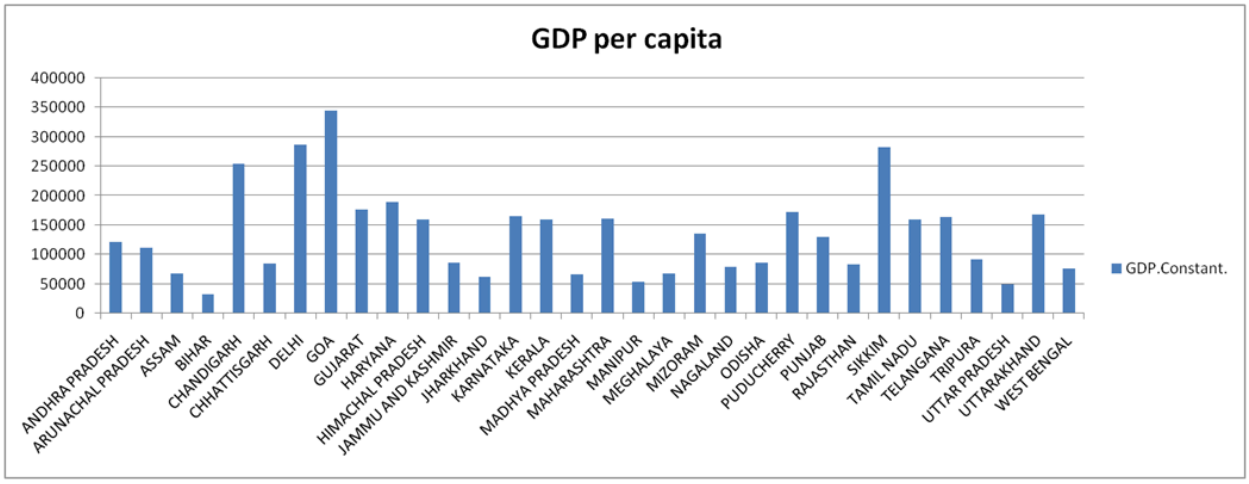
4.4.5 GDP per capita 2018



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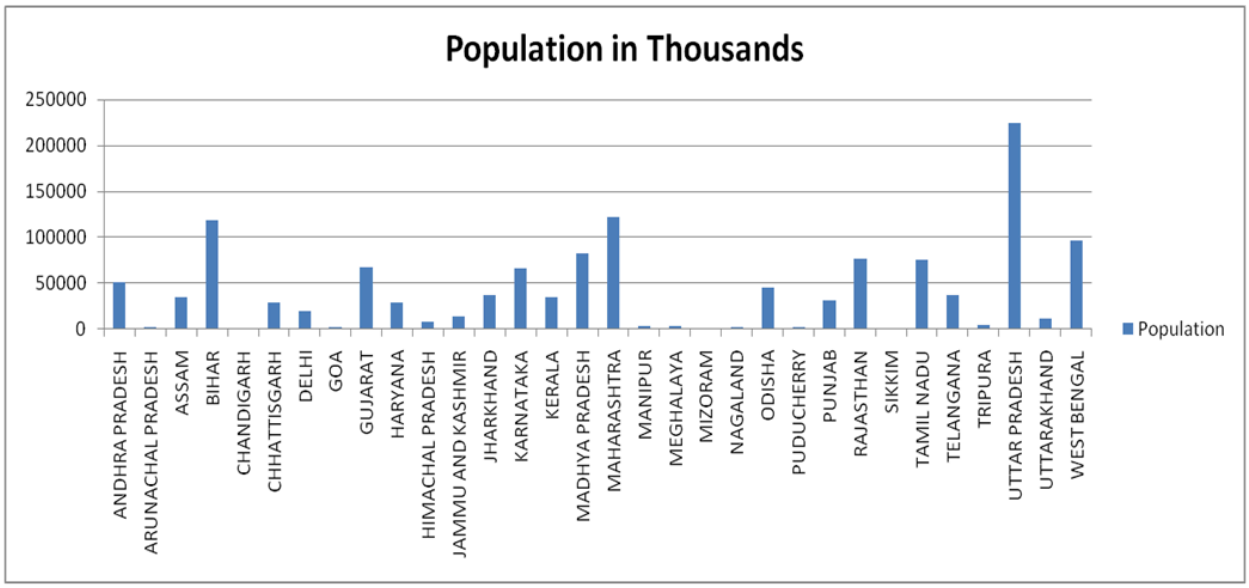
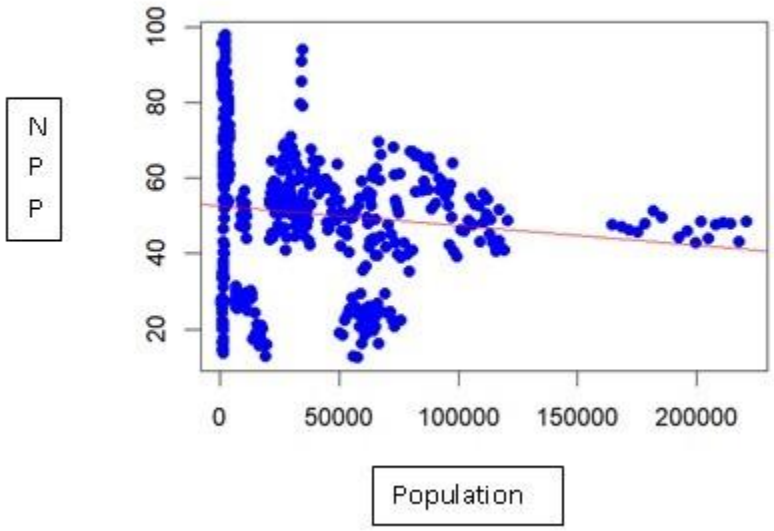
4.4.6 Population 2018



The bar graph would provide a quick visual grasp of India's vast and uneven population distribution in 2001. Uttar Pradesh, with its massive population, would likely stand out with the tallest bar, followed by other populous states like Maharashtra, Bihar, and West Bengal. South Indian states like Andhra Pradesh, Tamil Nadu, and Karnataka would also likely have prominent bars. In contrast, smaller states in the Northeast (e.g., Sikkim, Mizoram) and the union territories (e.g., Daman & Diu, Lakshadweep) might be represented by shorter bars.

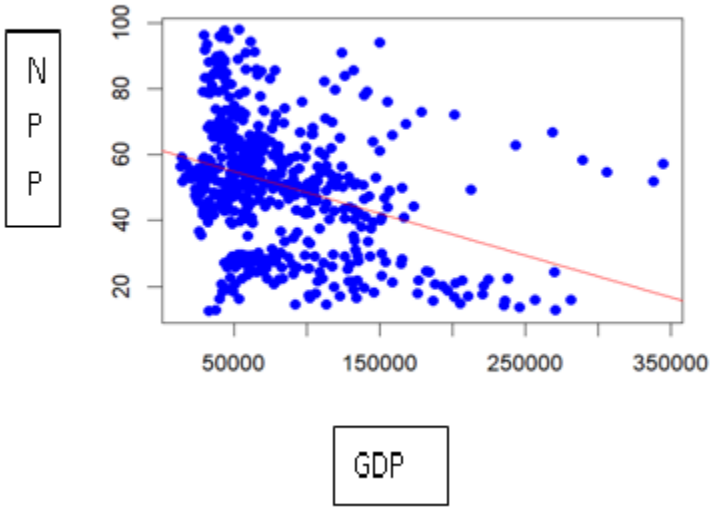
4.5 Regression Analysis

4.5.1 NPP and Population



The Y-axis represents the NPP (Net Primary Productivity), ranging from a minimum of 0 to a maximum of 100. NPP is a measure of the rate at which an ecosystem produces organic matter through photosynthesis. Higher NPP values indicate greater plant growth and organic matter production and X-axis represents the population size, ranging from a minimum of 50,000 to a maximum of 280,000.The data points on this graph would likely form a downward sloping line, indicating a negative correlation between NPP and population. The downward slope signifies that as the NPP (Y-axis) increases (moves to the right), the population size (X-axis) decreases (moves down). This implies that areas with higher NPP tend to have lower populations, and conversely, areas with lower NPP tend to support larger populations.

4.5.2 NPP and GDP



The Y axis represents the NPP (Net Primary Productivity), ranging from a minimum of 0 to a maximum of 100. NPP is a measure of the rate at which an ecosystem produces organic matter through photosynthesis. Higher NPP values indicate greater plant growth and organic matter production and X-axis represents the GDP per capita size, ranging from a minimum of 50,000 to a maximum of 3,50,000.The data points on this graph would likely form a downward sloping line, indicating a negative correlation between NPP and GDP. The downward slope signifies that as the NPP (Y-axis) increases (moves to the right), the size (X-axis) decreases (moves down).

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