

**Czech University of Life Sciences Prague**

**Faculty of Economics and Management**

**Department of Economics**



**Bachelor Thesis**

**Impact of Environmental Problems on Food Security  
in India**

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# **BACHELOR THESIS ASSIGNMENT**

Aleksei Shilov

Business Administration

Thesis title

**Impact of environmental problems on food security in India**

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## **Objectives of thesis**

Analysis of the impact of global environmental problems on food security, the current and predicted situation, the causes of deterioration and possible solutions on the example of India.

The article analyzes the current situation with food security, the problems that have arisen and the decisions taken so far. The main goal is to prove the impact of global environmental problems on food security in India. For the implementation of which:

Study of the current and predicted level of food security and measures for improvement.

Identification of the main environmental problems that adversely affect food security.

Finding causes of deterioration and possible solutions to that based on a 10-year statistical data.

## **Methodology**

The theoretical part defines the concept of food security and global environmental, how they correlate, what topics is responsible and description of the current situation in India. The description will be based on books, since journals and articles.

As for the practical part , the paper will outline the problems and solutions based on key findings of recent research and statistical data since 2000 till 2020 year using FAO, UN SDGs, Indian statistical office. The data will be processed by methods of statistical analyses – regression, time series analyses.

## The proposed extent of the thesis

40 – 50 pages

## Keywords

food, security, global, environmental, India, region, situation, level, problems

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## Recommended information sources

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## **Declaration**

I declare that I have worked on my bachelor thesis titled "Impact of Environmental Problems on Food Security in India" by myself and I have used only the sources mentioned at the end of the thesis. As the author of the bachelor thesis, I declare that the thesis does not break any copyrights.

In Prague on 15.03.2023

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# **Impact of Environmental Problems on Food Security in India**

## **Abstract**

The bachelor thesis examines food security issues and choices. To demonstrate how global environmental issues affect Indian food security. Implementation: Food security assessment and improvement strategies are also delivered by the author, as well as identification food security-threatening environmental issues and identification of degradation causes, if there are any and remedies using 10-year statistical data.

The theoretical part defines the concept of food security and global environmental, how they correlate, what topics is responsible and description of the current situation in India. The description will be based on books, since journals and articles. As for the practical part, the paper will outline the problems and solutions based on key findings of recent research and statistical data since 2000 till 2020 year using FAO, UN SDGs, Indian statistical office. The data will be processed by methods of statistical analyses – regression and time series analyses.

In his conclusion, the author suggests that environmental issues are not directly related to the country's food security and the author concludes that those two phenomena are dependent on the country's economic and social transformations that are actively taking place in the first half of the 21<sup>st</sup> century.

**Keywords:** food, security, global, environmental, India, region, situation, level, problems

# Dopad environmentálních problémů na potravinovou bezpečnost v Indii

## Abstrakt

Bakalářská práce se zabývá problematikou a výběrem potravin. Ukázat, jak globální problémy životního prostředí ovlivňují indickou potravinovou bezpečnost. Implementace: autor také dodává strategie hodnocení a zlepšování bezpečnosti potravin, jakož i identifikaci otázek životního prostředí ohrožujících bezpečnost potravin a identifikaci příčin degradace, pokud existují, a nápravná opatření pomocí 10letých statistických údajů.

Teoretická část definuje koncept potravinové bezpečnosti a globálního životního prostředí, jak spolu souvisí, jaká témata jsou zodpovědná a popis současné situace v Indii. Popis bude založen na knihách, protože časopisy a články. Pokud jde o praktickou část, příspěvek nastíní problémy a řešení na základě klíčových zjištění nedávného výzkumu a statistických údajů od roku 2000 do roku 2020 s využitím FAO, SDGs OSN, Indického statistického úřadu. Data budou zpracována metodami statistických analýz - regresních a časových řadových analýz.

Ve svém závěru autor naznačuje, že otázky životního prostředí přímo nesouvisí s potravinovou bezpečností země, a autor dochází k závěru, že tyto dva jevy jsou závislé na ekonomických a sociálních transformacích země, ke kterým aktivně dochází v první polovině 21. století

**Klíčová slova:** jídlo, bezpečnost, globální, životní prostředí, Indie, region, situace, úroveň, problémy

## Table of contents

<b>1</b>	<b>Introduction</b> .....	<b>11</b>
<b>2</b>	<b>Objectives and Methodology</b> .....	<b>12</b>
2.1	Objectives .....	12
2.2	Methodology .....	12
<b>3</b>	<b>Literature Review</b> .....	<b>15</b>
3.1	Food Security .....	15
3.1.1	Concept .....	15
3.2	Pillars .....	20
3.2.1	Current Situation in India .....	23
3.3	Environment Protection .....	27
3.3.1	Reasons .....	27
3.3.2	Action .....	30
3.3.3	Situation in India .....	30
3.3.4	Possible threats to Food Security .....	33
3.4	International Response .....	34
<b>4</b>	<b>Practical Part</b> .....	<b>35</b>
4.1	Time Series Analysis .....	35
4.1.1	Food Security .....	35
4.1.2	Environmental Issues .....	41
4.2	Linear Regression Analysis .....	45
<b>5</b>	<b>Results and Discussion</b> .....	<b>49</b>
5.1	Effect of Environmental Issues on Food Security .....	49
5.2	Future of Food Security .....	51
5.3	Recommendations .....	51
<b>6</b>	<b>Conclusion</b> .....	<b>53</b>
<b>7</b>	<b>References</b> .....	<b>54</b>
<b>8</b>	<b>Appendix</b> .....	<b>59</b>

## List of pictures

Figure 1, Global Overview of GFS Index with India as primary target .....	20
Figure 2, States of India .....	22
Figure 3, Desertification of India (2011-2013) .....	25



Figure 4, The usual train route in India.....	27
Figure 5, Nathu La in India .....	29
Figure 6, India's share of the world population.....	32
Figure 7, food security index chart .....	35
Figure 8, food production index chart.....	36
Figure 9, development of poverty rate over time.....	37
Figure 10, prevalence of undernourishment chart.....	38
Figure 11, exchange rate chart .....	39
Figure 12, GDP per capita chart.....	40
Figure 13, unemployment and inflation chart.....	41
Figure 14, carbon dioxide emissions per capita chart.....	42
Figure 15, crude oil imports chart .....	43
Figure 16, renewable share in total energy output .....	44
Figure 17, correlation matrix.....	45
Figure 18, parameters for the model .....	46
Figure 19, fitted versus observed .....	47
Figure 20, econometric verification of the model.....	48

## List of tables

Table 1, linear regression dataset.....	59
Table 2, time series analysis of Food Security.....	60
Table 3, time series analysis of availability .....	60
Table 4, time series analysis of access .....	61
Table 5, time series analysis of utilization .....	62
Table 6, dataset used for stability.....	62
Table 7, dataset used for environment .....	63

## List of abbreviations

UN ... United Nations

GSF ... Global Food Security

SDG ... Sustainable Development Goals

FAO ... Food and Agriculture Organization

# 1 Introduction

The author's main motivation behind choosing such a topic was the fact that people often treat India as a least developed countries suffering from pollution and countless problems with environment and poverty, as well as with food insecurity. In fact, the author has a genuine interest in identifying if the situation is really as bad as the general stereotype says. For this purpose, the author combines the two – food security and environmental issues and in his thesis, he will be answering the question of whether the two are related and what is even more important, whether environmental problems can have any impact on the food security of the country.

The author believes that this bachelor thesis has a high importance for the world in the beginning of the 21<sup>st</sup> century, where the sustainability movement is becoming more and more powerful. Yet, people seem to consider the aspect of sustainability the most in the Western hemisphere, so the author is really tempted by the question of in what direction one of the world's fastest economically and demographically growing country is currently moving in terms of sustainability.

The author's bachelor thesis answers all those questions through an academic lens based on empirical evidence obtained from the time series and linear regression analyses, which are both implemented to this bachelor thesis as the main tools for achieving given results related to the aforementioned domains.

## **2 Objectives and Methodology**

### **2.1 Objectives**

Analysis of the impact of global environmental problems on food security, the current and predicted situation, the causes of deterioration and possible solutions on the example of India. The article analyzes the current situation with food security, the problems that have arisen and the decisions taken so far. The main goal is to prove the impact of global environmental problems on food security in India. For the implementation of which: Study of the current and predicted level of food security and measures for improvement. Identification of the main environmental problems that adversely affect food security. Finding causes of deterioration and possible solutions to that based on a 10-year statistical data.

In addition, the author also creates five research questions:

- 1) How was the situation with food security evolving in India?
- 2) How was the situation with environment issues evolving in India?
- 3) Is there any relationship between environment issues and food security in India?
- 4)

### **2.2 Methodology**

The theoretical part defines the concept of food security and global environmental, how they correlate, what topics is responsible and description of the current situation in India. The description will be based on books, since journals and articles. As for the practical part, the paper will outline the problems and solutions based on key findings of recent research and statistical data since 2000 till 2020 year using FAO, UN SDGs, Indian statistical office. The data will be processed by methods of statistical analyses – regression and time series analyses. The author selects 4 variables each representing one pillar of food security, where: food production index represents availability, poverty rate represents access, prevalence of undernourishment represents utilization and exchange rate represents success.

The practical part of the thesis consists of two primary components – the first one involves a time series analysis that will shed brighter light on the development of indicators simultaneously related to food security and environmental issues, such as pollution. Time series analysis is an important component that will help to better understand if there was a significant progress in selected indicators. For this analysis, the author uses time series analysis represented by a trend analysis, which involves a creation of a linear trend, based on the following formula:

$$y = a + bx \quad (1)$$

Then, the author proceeds to the computation of base indices and chain indices for some cases. Base index is based on the following formula according to Dixon (1951):

$$\text{Base Index (in \%)} = \left( \frac{\text{Value from a given year}}{\text{Base year}} - 1 \right) * 100 \quad (2)$$

Chain index is based on the following formula:

$$\text{Chain Index (in \%)} = \left( \frac{\text{Value from a given year}}{\text{Value from the previous year}} - 1 \right) * 100 \quad (3)$$

Finally, after analysing the development of those indicators, the author proceeds to the main component of the analysis, where he ultimately identifies if environmental factors and issues have any statistical effect on the development of food – this is verified according to t-tests. The linear regression model (based on the annual time series from 2012 to 2022), which will be created by the author has the following components:

$$yt = \beta_0 + \beta_1 X_{1t} + \beta_2 X_{2t} + \beta_3 X_{3t} + \varepsilon_i$$

- Y stands for the variable of food security index measured in points.
- X<sub>1</sub> stands for CO<sub>2</sub> emissions per capita in India.
- X<sub>2</sub> stands for the share of renewable sources of energy in India in percentages.
- X<sub>3</sub> stands for crude oil imports annually in barrel/day.

The assumption is that the sign of the first variable and the third one will be negative, while the sign of the second one will be positive. Afterwards, the author tests statistical significance of the model using F test, t-tests for three variables, White's test for heteroscedasticity, test for autocorrelation and test for normality (parts of the econometric verification). Before proceeding to the model estimation using the OLS, the author first checks if there is a presence of multicollinearity in the dataset. The dataset used for the estimation is presented in Table 1 available in the appendix of this bachelor thesis.

## 3 Literature Review

### 3.1 Food Security

#### 3.1.1 Concept

When contrasted with the concept of "danger," the noun "safety" is thought of in a more favorable light since it denotes the absence of risk. However, understanding the degree to which "danger" or "security" exists is always a matter of subjectivity. This means that it is regarded and analyzed independently by a particular person or group in regard to themselves, other subjects, and phenomena within a certain time frame and set of conditions. Therefore, when author will talk about security and referring to a situation in which the person in question is enjoying his or her best possible circumstances and is shielded from the influence of destructive forces on him, his surroundings, and the resources that are being utilized. However, the word "security" can also be used in an ambiguous sense (for example, both abstractly and concretely). When considering the term "food security," it is necessary to clarify the structure of the category known as "food," which includes the following:

- collected natural plant products (for instance, seaweed, mushrooms, berries, hazelnuts, etc.);
- extracted natural products of animal origin (fish and animal seafood, wild animals, eggs of wild animals, etc.);
- grown plant products (both at home and at work);
- grown products of animal origin (in domestic and industrial conditions); artificially produced food products (a combination of the above components in the finished food product) (Vdovenko, 2021).

As a consequence of this, it is vital to identify the elements that impact food security because there is such a vast variety of food goods.

The author suggests focusing on two distinct categories of internationally influential factors: those that are systemic and those that are structural. The following are examples of systemic factors: natural (such as land, water, or oxygen supplies, temperature, weather, natural events, etc.); human-made (such as laws and regulations);

- the biological (the state of ontogeny subjects: bacteria, animals, plants, and people);
- the technical (the level of development of scientific and technical progress, available knowledge, databases, measurement procedures, man-made territories, structures, buildings, roads, technologies, equipment, and so on);
- the economic (the sphere of social relations in terms of rational production, exchange, distribution, and consumption of the results of human activity);
- the social (the sphere of social relationships) (forms of management, legislation, standards, programs, institutions, institutions, management decisions of subjects within the scope of the possibilities for the exercise of power, military conflicts) (Ponomarova, 2019).

The following are examples of structural factors: threats (hazardous processes, events, or circumstances that produce harm or may create harm and require eradication), dangers (perceived conditions that, if they exist, might cause harm), and structural dependencies.

- issues, which can be questions, phenomena, or items that are hard to understand, intriguing, or cause difficulties, and which also need to be studied and solved;
- difficulties (strategic directions, indications, and demands for action);
- inclinations (developmental directions of topics, forces, and variables);
- subjects (the main driving forces and participants in the events) (Timmer, 2017).

After considering the two groups of factors mentioned above, one can make the argument that each of them has the potential to cause either security or danger in the areas of food production, exchange, distribution, and consumption on both the global and regional levels. This assertion can be made after considering the two groups of factors mentioned above. That is to say, the risk becomes present whenever there is a departure from the conditions that are ideal for satisfying the dietary requirements of an individual, a group of individuals, a region, or the planet as a whole. When subjects begin to deviate from the standard, traditional, formalized, and legal actions of the majority, the deviation that is indicated may be due to the influence of natural forces that are beyond the control of humans as well as anthropogenic human actions (Albuquerque, 2018). This occurs when subjects begin to deviate from the actions of the majority (that is, act more actively or more passively).



Therefore, a quantitative shortage of food (for instance, as a result of crop failure, natural disasters, the high cost of food or military conflicts) causes a feeling of hunger, which, as a consequence, leads to subsequent exhaustion, reduced efficiency, developmental delay, social conflicts, and other forms of destruction (Wynn, 1993). A surplus of food also generates the conditions for its excessive consumption, which is harmful to human health, as well as the conditions for the underutilization and rotting of food items, which leads to an excessive spending of the resources that are needed for the production of food. The consumption of low-quality food products can result in food poisoning in the short term, and in the medium and long terms, it can lead to a deterioration in health and, as a result, a decrease in working capacity, limitation of the functionality of social and professional self-realization, morbidity, and premature death. This is why the quality of food should also be taken into consideration (Hastorf, 2017). However, due to the fact that people have different physiological make-ups, it is essential to take into account the various responses of subjects in the areas to the quantity and quality of food that is readily accessible. It is rather difficult to ignore the sanitary conditions that prevail in India. India does not have favorable conditions for epidemiology and sanitation, so hygiene rules are mandatory. Raw water here is completely unsuitable even for brushing your teeth, and even more so for drinking. Ice that is made from this water can be sold on the street, so do not buy it on the street. The only water that can be consumed is plastic-packed water (Jha, 2010).

Fruits and vegetables that were bought on the street should not be washed with tap water, preferably even poured over with boiling water. Before each meal, be sure to wash your hands with soap and water. The epidemiological conditions are so bad that even the knife used by the seller to cut the fruit for testing can provoke a complex indigestion (Kumar, 2011).

India includes a fairly wide range of possible viruses and diseases that can be caused or originated in the food environment (Bisht, 2021).

As a result, the problem of ensuring food security is being focused on, and in each particular instance, it is necessary to take into account a number of aspects related to the subject that is being studied on microlevel, macrolevel, and global level:

- the region of location (a local locality, settlement, district, state, mainland, or the surface of the Earth);
- the field of activity (belonging to a particular sector of the economy, kind of economic activity, industry, market, etc.);
- the time period (operational, short-term, medium-term, long-term, strategic) (Pawlak, 2020).

Therefore, author assert that the establishment of global food security ought to be predicated on a methodical strategy that takes into consideration the condition of the living environment (the natural and biological potential of the region), the interests of subjects (formed by worldview, knowledge, and tasks), the actions subjects (based on skills and efforts expended), and the resource capabilities of the area (primarily technical, economic, managerial) (Brussaard, 2010).

In summing up the beneficial experiences of countries and their territorial units (district, region, state, land, province, district, region, city, district, etc.), it is possible to note that ensuring regional food security provides for such conditions as:

- sufficient quantities of high-quality food;
- resource provision of the population with the possibility of acquiring, transporting, storing, and consuming high-quality food;
- implementation of international quality standards in national legislation (Irtysheva, 2019).

Because India is one of the leading countries in terms of population, which at the present is 1.4 billion people which is an astounding figure, it is reasonable to believe that the process of obtaining food and consuming it is a quite sophisticated one (Worldometer, 2022). Food is without a doubt at the top of the list when it comes to the requirements that humans have, and the very fact that this is the case is the reason why there is such a thing as food security (Imathiu, 2020). It is a given that the ultimate objective is for all people, at all times, to have access - physically, socially, and economically - to sufficient amounts of food that is both safe and nutritious, so that they can satisfy both their dietary requirements and their food preferences in order to lead a healthy and active lives. However, it is essential to keep in

mind that not everything can be reduced to such a straightforward explanation. One of the difficulties involves getting food to everyone who needs it, not just in India but also elsewhere in the world. Food production is determined by a number of factors, some of which are highly significant (Milesi, 2010). For instance, climate change is among the most evident elements that plays a big role, and it is one that, year after year, makes the issue of food insecurity in a nation as huge as India even more difficult to manage. Although it is challenging to provide a succinct explanation of the connection among agriculture and food security, the majority of research has concentrated on one facet of food security, specifically the availability of food (Elijah, 2018).

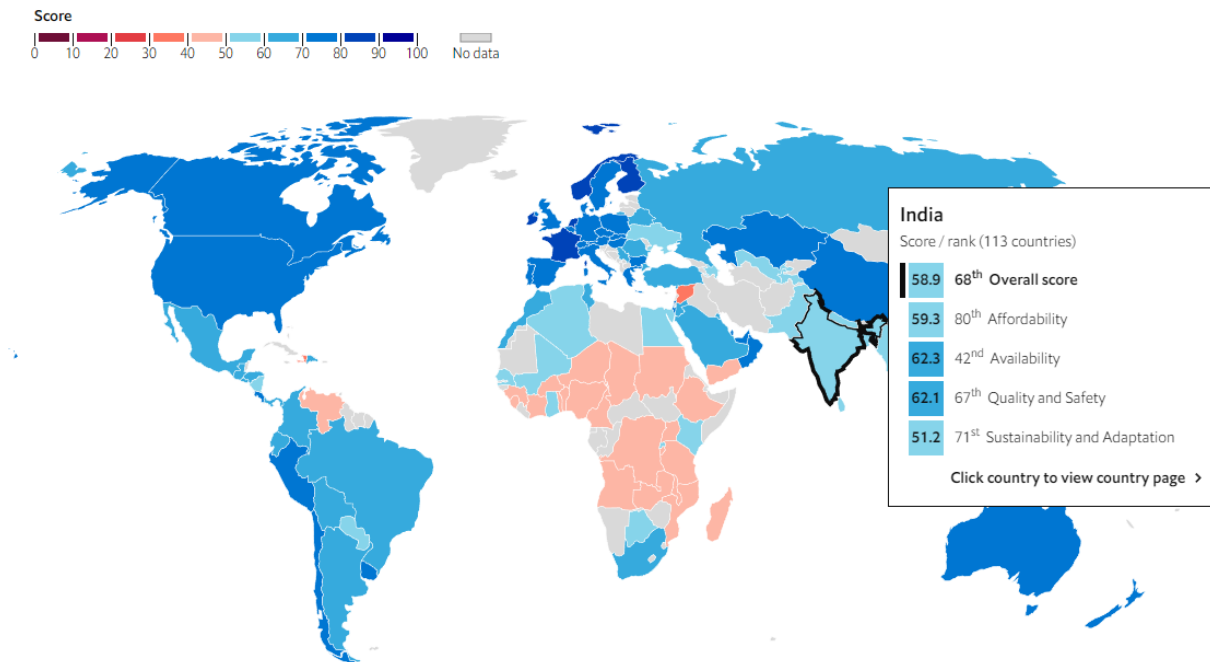
Of course, it is also important to note that there is a Global Food Security, and it was designed and built by the London-based Economist Impact and sponsored by Corteva Agriscience (Smyth, 2019). The GFS index measures the main factors of food security in 113 countries based on factors:

- Affordability
- Availability
- Quality and safety
- natural resources and resilience.

India ranked 71st in the 2021 Global Food Security Index out of 113 countries. Pakistan (52.6 points) performed better than India (50.2 points) in the food affordability category. Sri Lanka was even better with a score of 62.9 in this category on the GFS 2021 index. The government has come up with several schemes and initiatives as actions such as:

1. Eat Right India Movement
2. POSHAN Abhiyan
3. Food fortification
4. National Food Security Act
5. Integrated Child Development Services (ICDS) Scheme.
6. National Innovations Climate Resilient Agriculture (NICRA) (Yadav, 2022).

**Figure 1, Global Overview of GFS Index with India as primary target**



Source : The Economist, 2022

### 3.2 Pillars

Indian agricultural production focusing on four primary components that are essential to comprehending this subject. They include the accessibility of products to every individual on the earth as well as their consumption, the availability of items and their creation, and the availability of products. It is without a doubt that making sure food production inside the climate change environment will become a significant challenge (Chavas, 2008). In order to meet this challenge, it is recommended that sustainable agricultural practices be implemented, greater attention be paid to the food security and public health of urban areas, livelihood security be ensured, and long-term disaster relief be provided. Indian food system is one of the areas that will be most significantly impacted by climate change. It has an impact on the manner in which people create as well as consume food. The impact is considerably more significant on an economy that is predominately based on agriculture,

such as India, and it causes a ripple effect all the way through the chain of food production. The continuous heatwave has caused a variety of problems for agricultural production and the safety of food supplies (Dubey, 2021). Because of this, the wheat crop was harmed, which had a negative impact on the food supply. As a result, the price of wheat-based items skyrocketed. Wheat suffers losses on both a qualitative and quantitative scale due to the low yields as well as the poor quality of the grain that is produced. This is something that needs to be taken into consideration since the quantity of food as well as the nutritional value of the food affects how secure our food supply is (Kumar, 2021).

In reality of course, India is indeed a microcosm of an environmental instability that pervades the area. Recent research conducted by the Center for Global Development revealed that by the year 2050, almost 40 million people in India, more than in any other country, are at danger of passing away as a direct result of increasing sea levels. It is also estimated that rising temperatures might result in a reduction of agricultural production in India of between 35 and 40 percent by the year 2080 (Bhattarai, 2021).

In spite of the fact that India was home to even more than twenty percent of a planet's population, the country has just 4 percent of a world's fresh water (Welling, 2020). There are around 250 million people, or approximately 25 percent of India's total population, who do not have clean water access. The volume of water usage in India is just so high that the country's groundwater reserves are in danger of being depleted. According to the World Bank, India is indeed the nation that consumes the greatest amount of groundwater worldwide. The water tables in the three northwestern states of India, especially Punjab, the country's primary breadbasket, fell by four millimeters per year between 2002 and 2008, according to research that was conducted in the India in 2009 (Pahuja, 2020).

The situation with the available energy resources is very similar. As a result of the rapid expansion of India's economy, demand has skyrocketed, and it is anticipated that India will be the world's third largest user of energy by the year 2030. On the other hand, the devastating blackout that occurred inside the summer of 2012 illuminated the fact that the nation is unable to keep up without demand (Rawat, 2019).

When seen in the perspective of the long-term implications of climate change, the connection between resources and stability, and also what this implies for India's national security, is even more problematic. It is risky to assume that a causal link exists between the effects of climate change and rising levels of insecurity, although one might speculate about a number of possible outcomes. The first risk is that pre-existing tensions within a country may become much more acute as a direct result of climate change for a map of Indian states (Fig.1). The effects of climate change might make a lot of issues much worse, including the mass migration of people, the loss of food and water supplies, and the worsening of economic conditions.

**Figure 2, States of India**



Source: Mapsofindia, 2022

The undeveloped and poorest parts of India, which are also where the majority of India's internal disputes are situated, would be the most severely affected by these issues. This includes the central and eastern parts of the nation, where the Maoists have a large presence, as well as the northeastern area of India, which has separatist insurgent activities that are "festering." Conflicts that already exist over resources, such as disagreements between governments over the distribution of water, will also intensify (Prasad, 2012).

The effects of climate change might also make India's worries about the "external" security of the country even more severe. Tensions that already exist with Pakistan and China over water are expected to become even more tense. However, Bangladesh, a country with which India has been at odds for years over disagreements on the distribution of water along their shared border, may prove to be the greatest threat. Given how susceptible Bangladesh is to the effects of climate change, this will very certainly, over the next several decades, result in significant amounts of floods and losses of agricultural land. It is possible that millions of environment refugees would cross the border into the northeastern part of India. This is an unstable region that has separatist aspirations in addition to violence. In point of fact, it is arguable that a portion of a conflict in the region – as well as in Assam, which has seen a clean eruption of facing this season – stems from local resentment toward Bangladeshis who have immigrated there and in recent years (Narnaware, 2022). This is because Assam has seen a clean outbreak of attempting to fight this summer.

### **3.2.1 Current Situation in India**

The food processing industry in India is an important link in the chain that connects Indian farmers with customers in both India's home market and in overseas markets. Along the entirety of the value chain, the Ministry of Food Industry is exerting all possible effort to stimulate investment. According to the 3-digit categorization used by the NIC, the food industry accounts for 12.38% of all job opportunities produced across all sectors of registered firms, which together employ over 1.93 million individuals (NIC, 2022). According to the findings of NSSO Round 73, the unregistered food processing sector is responsible for the employment of 5.1 million people. Cereals, sugar, edible oils, drinks, and dairy products make up most India's primary food processing industries (Mukherjee, 2022).

The PMKSY (Pradhan Mantri Krishi Sinchayee Yojana) program has resulted in the approval of 61 feed-forward and feedback projects, 356 cold chain projects, 68 agro-processing clusters, 320 food processing and storage capacity development/expansion plans, 41 mega-food parks, and 68 agro-processing clusters (MofPi, 2022). Fruits and vegetables, poultry and meat processing, fisheries, food retail, dairy products, and other related industries are among the most important sub-segments of the food sector in India. A more

cautious approach to managing domestic grain markets, in which exports are authorized on a gradual basis, is the most likely course of action in the coming months. Before the restriction in May, India had shipped out 1.5 million tons of wheat, and it planned to ship another 1.8 million tons over the next six weeks (Jong-Jin, 2022). Of course, author of this work can't not to mention how situation in Ukraine right now affected the food production and import/export relationships in the world (de Gourcuff, 2023). But if the forthcoming harvest is in line with projections for agricultural output, New Delhi may be willing to release a few million extra tons. That's a good sign since it means India's exports will get closer to where they were this time last year. Because of its possible impact on global food prices, restrictions on rice exports are quite improbable. Existing inventories are high, and the rainy season has already hit the majority of rice-growing regions in the East and South (Dar, 2020). So long as headline inflation doesn't rise, most export restrictions will be eased in September or October of this year.

If the rainy season fails to arrive, economic development will stagnate, and the worst-case scenario would be realized. At this point, it's likely that commercial rice exports will be banned, and wheat limitations will be tightened much further (Kadaverugu, 2022). In order to keep prices down and fund food aid programs that may be extended until the end of the year, the government will have to cut its current inventories. While India is not a large wheat exporter, it plays a crucial role in the global rice market, so a restriction on exports would cause prices everywhere to skyrocket (Bairagi, 2022). All of this, presumably, would add fuel to the fire of agricultural protectionism across the world, with all of the associated difficulties. If this incident prompts a lasting political response, then it will have served its purpose. In other words, push the Narendra Modi government to try again to let market forces shape India's agriculture sector. Massive protests from farmers who benefited from the current subsidy scheme forced the cancellation of an earlier effort at change. The cyclical nature of India's erratic reaction to agricultural exports is problematic (Palande, 2021).

India's agricultural sector meets domestic demand solely because farmers lack the means to invest in production. Farmers in India might do better if they exported more of their products and used the money they made to invest in agricultural technologies and

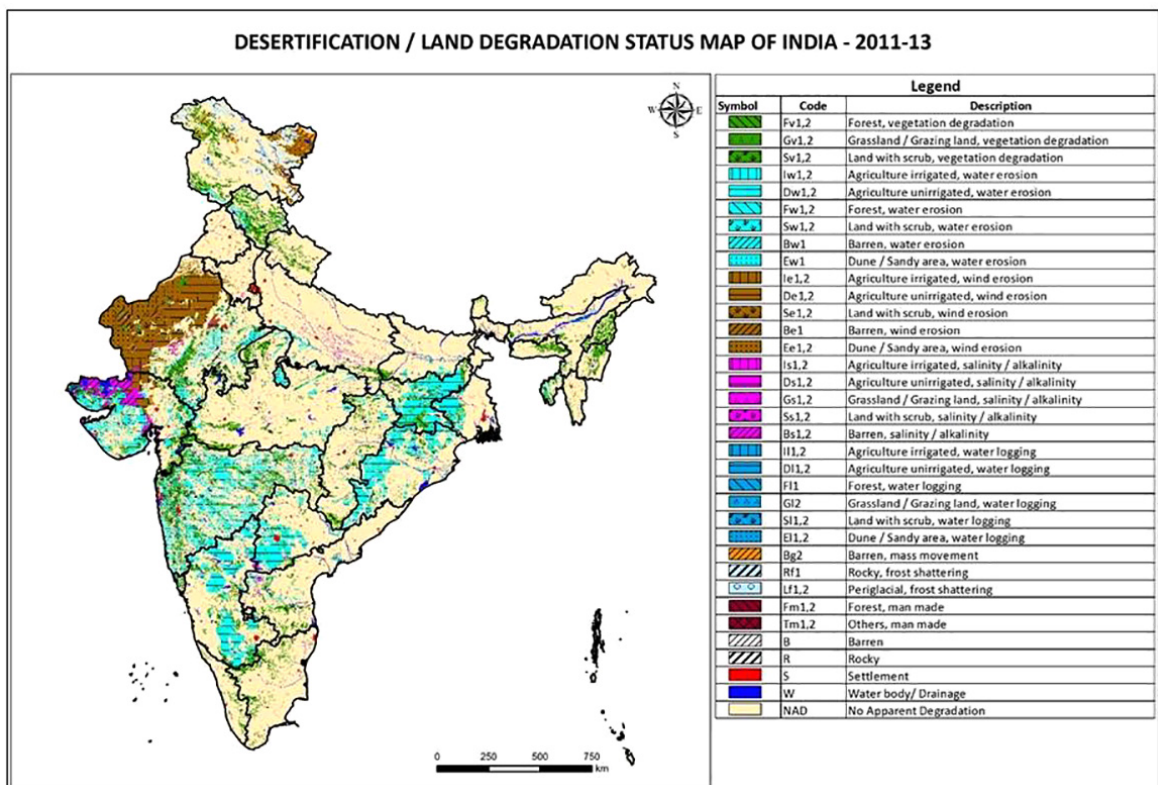


infrastructure. The effect will be that India is seen seriously as a major trading partner in the agriculture sector worldwide. Below author showed the status of Indian land degradation (fig. 3). Unhealthy soil is a major problem in India since it is used for so much of food people eat. Soil health is declining, which is a major problem because soil is used for approximately 95% of all food produced worldwide. **Deforestation**, improper or excessive use of agrochemicals, and natural disasters all contribute to soil degradation, which is a major obstacle to long-term food security. About a third of Earth's soil is in poor condition (Drishtias, 2022).

**Dangers of Invasive Plants:** India has been hit by more than ten major invasions of exotic pests and weeds during the past 15 years.

In 2018, a pest called the fall armyworm almost completely wiped out the country's maize crop. Damage sustained in 2018 by the infestation necessitated maize imports by India in 2019. Districts in Rajasthan and Gujarat suffered a locust infestation in 2020.

**Figure 3, Desertification of India (2011-2013)**



Source: Drishtias, 2022

**Unreliable Management System** India's food security isn't guaranteed by any kind of reliable management structure. Food grain leaks and diversion, inclusion/exclusion mistakes, phony subsidized food, and a lackluster grievance redressal and social audit system are just a few of the problems plaguing the Public Distribution System. Food grain leaks and diversion, inclusion/exclusion mistakes, phony subsidized food, and a lackluster grievance redressal and social audit system are just a few of the problems plaguing the Public Distribution System.

Problems with Purchasing Farmers have stopped growing coarse grains to focus on growing rice and wheat because of a guaranteed price. In addition, incorrect accounting and lack of sufficient storage facilities lead to a yearly loss of roughly Rs. 50,000 crores.

When it comes to climate change, it's important to remember that the monsoon is responsible for watering around 60 percent of India's net sown land and providing about 70 percent of the country's yearly rainfall (Dagdeviren, 2021). India's agricultural output is already declining due to the increasing frequency and severity of severe weather patterns like heatwaves and floods, which poses a major danger to the country's ability to provide food for its population (Kumari. 2020). India's agricultural output is already declining due to the increasing frequency and severity of severe weather patterns like heatwaves and floods, which poses a major danger to the country's ability to provide food for its population. The government of India had prohibited the export of rice in an effort to boost local availability in the face of low Kharif Crop yield in this year (Gulati, 2020).

### 3.3 Environment Protection

#### 3.3.1 Reasons

**Figure 4, The usual train route in India**



Source: Business Insider, 2022

In order to describe the conditions in which India finds itself in terms of food safety and development, it is important to understand that it can be influenced both from within and from without. Therefore, it is important to describe the internal context of the situation and the external one. It makes its presence known both within the borders of the nation and on the world stage. In terms of the situation within the borders of the country, the most prominent example is the Maoist insurgents' participation in anti-government actions. It is a covert insurgency, but it has expanded to more than two-thirds of the states in India, and the authorities in New Delhi frequently refer to it as the most severe danger to the safety of the country's citizens (Verghese, 2021).

The eastern and central regions of India are the heartland of the insurgency (Damodaran, 2023). These regions also contain the majority of the country's coal deposits, which are India's most commonly utilized source of energy. New Delhi has a strong incentive to crack down on these rebels given the energy needs of the country. This has already been done with a heavy show of force, which has resulted in civilian casualties and the recruitment of new

recruits into the ranks of the rebels. Given the energy needs of the country, New Delhi has a strong incentive to do it (Raghutla, 2022).

In addition, one of the primary motivating elements behind the insurgency is the limitation of natural resources. Discontentment among less fortunate people living in rural areas is a fuel for Maoist recruitment, because the rewards of large-scale extraction of natural resources, in particular coal, do not always make it to the villages where the resources were extracted. Intense coal mining in these regions not only compels local populations to abandon their homes, but it also poisons the environment for those who choose to stay behind, which further supports the insurgency (Fair, 2022).

The relationship that India has with Pakistan reveals some of the external expressions of the link between India's resource issues and its security concerns. India has increased the number of hydroelectric projects it operates on the western rivers that drain into the Indus basin in response to the rising need for various forms of electricity. In accordance with the terms of the Indus Waters Treaty, these waters are to be transferred to Pakistan. However, India is permitted to utilize these waters for the building of dams and other hydroelectric projects that are not designed to store water. On the other hand, a lot of people who live in Pakistan hold a contrary viewpoint and assert that India is "robbing" Pakistan of its water supply. When brought up by organizations such as Lashkare Taiba (LeT), an anti-Indian terrorist group that has vowed to conduct attacks against India in response to allegations of water theft, such claims constitute a security risk (Hamid, 2022).

The relationship between India and China provides another illustration of the connection between the country's resources and its level of security as seen from the outside. Because it does not have sufficient energy reserves in its own country to supply the enormous demand there, India is searching for energy resources in other countries. As a consequence of this, there is a possibility that India and China, both of which are increasing their regional and global footprint, may engage in a furious battle, with the primary objective being the acquisition of natural resources.

**Figure 5, Nathu La in India**



Source: War on the Rocks, 2022

Several experts in the field of national security point to the Bay of Bengal as a region that might serve as a flashpoint for future war between India and China. We are discussing a region located off the shore of India's east coast, where China is making investments in various forms of energy assets (India recently discovered significant deposits of natural gas there). China has made a significant agreement about natural gas with Burma, and it is possible that China may make a similar agreement with Sri Lanka. India's attempts to negotiate these treaties have thus far been fruitless. The fact that China was successful led some people in India to believe that China was "edging closer" toward India (Phillips, 2022).

Water, on the other hand, is one of the primary sources of contention in the border regions between India and China. One of the few places in the area that is fortunate enough to have an abundance of water, specifically the state of Arunachal Pradesh, is in the epicenter

of this conflict. China, like India, has a problem with its water supply being unreliable. There is a significant lack of water on the North China Plain, which is one of China's most important breadbaskets, with just 225 cubic meters of water available per inhabitant on an annual basis. As a result, the relevance of the water-rich state of AP from a strategic perspective extends far beyond the question of land. Lastly, India is extremely concerned about China's plan to build a dam on rivers in the Tibetan Plateau. One of these rivers is the Brahmaputra, which flows directly into India's territory from downstream (Phillips, 2022).

### **3.3.2 Action**

As for how to handle this predicament, the first step is to pose a rhetorical question: how may India lessen the danger to national stability caused by a lack of resources? Due to the irreversible nature of climate change, she is somewhat constrained in the actions she may do. Nevertheless, it is conceivable to engage in two different political directions at the same time. To begin, security plan and strategy could think about resource-related elements in a more comprehensive manner. The Indian Navy is making progress toward its goal of modernization, which is being driven in part by the imperative to ensure the safety of remote energy plants located in other countries. An additional objective is to enhance resource management in India and build supply, conservation-based policies that will allow for more effective management of precious resources that are not yet in short supply. Examples include:

- increased attention to detail in the upkeep of water supply
- more equal allocation of resources,
- improved financial and political incentives to implement resource-saving technology and practices
- Even if these steps won't solve the underlying problems that give rise to India's security worries, at least dealing with them will be less difficult.

### **3.3.3 Situation in India**

The scenario in India right now is one that presents many difficulties. It is vital to make note of the whole situation in India, which is based on more than just one of the elements, before discussing all the potential avenues that may be pursued in order to progress and

enhance the recent advancements that are associated with food work. According to research that was issued in the middle of May by the United Nations Department of Economic and Social Affairs, although India's economic growth would be decreasing in 2022, India will still be the fastest growing major economy in the world. This nation's GDP is projected to expand by 6.4% in the year 2022, according to various projections. This is due, among other things, to a somewhat effective economic policy, a big population, a rise in educational qualifications, and the expansion of industry. Additionally, this is because there has been an increase in industrial production (Anwar, 2022).

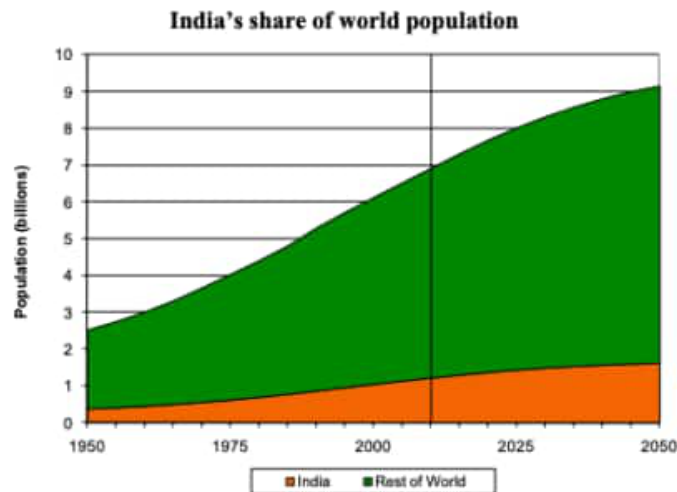
If the proportion of India's merchandise exports that consisted of engineering and pharmaceutical items was 14% before the 21st century began, then by 2012, that proportion had already increased to 42%. However, India continues to hold the top spot in terms of agricultural production. When it comes to the output of this good, the country's second-largest producer is this state. It contributes 17–18% to the overall gross domestic product of the country. Rice, wheat, sugarcane, and sunflowers are the primary agricultural products. When it comes to cattle, India likewise holds the number one spot worldwide (Khushwaha, 2022).

India has begun the process of establishing five industrial corridors in order to raise its overall rate of industrial output and incorporate more outlying regions into the process of achieving sustainable development. The corridor between Delhi and Mumbai will be the most important of them, with expenditures in the building of infrastructure totalling over \$90 billion. Additionally, industrial corridors would be established, including Amristar-Kolkata, Chennai-Bangalore, Vizag-Chennai, and an economic corridor connecting Bangalore and Mumbai.

India is the country with the second most people in all the planet (Fig.4). It is distinguished by a significant population of young people. 45% of the population is comprised of people who are younger than 25 years old. The eradication of poverty and the combating of hunger are currently regarded as two of the most important primary strategic problems facing the state at this moment. From 2015 to 2017, over 15% of the population

struggled with hunger, 43% of the population was working poor, and another 21% lived in extremely low conditions.

**Figure 6, India's share of the world population**



Source: Krishna,2022

It is essential to improve worker productivity in agriculture given that the sector accounts for around 16% of gross domestic product and employs close to 44% of the country's labour force. The so-called "traditional poverty" that is closely tied with one's caste origin is prevalent throughout India. It is challenging to deal with age-old foundations even when significant reforms are put into place. Many initiatives catering to those who were once considered untouchable have been developed by the modern government. They account for more than 20% of the total population. This caste has a long history of slum dwelling and has been responsible for the most unclean jobs. They may now enter top schools and higher education institutes knowing that there is a spot saved for them. Any form of discrimination is in violation of the constitution, which forbids it. If a potential employee is asked about their caste during the employment process, the business may even be subject to a fine (Zuo, 2022).

Overpopulation is another difficulty that modern India must contend with. When it comes to the total number of people living there, this nation is second only to China on the global scale. Despite this, its total landmass puts it just in seventh place among the world's countries. As a direct result of this, the state is currently experiencing high rates of both unemployment and food insecurity. It is far easier to find individuals who are willing to work



the land than it is to find land itself. Program has emerged in the state that allows for the transfer of peasants to various nations in Africa. Where there is a large amount of land but an inadequate number of employees. This provides the local populace with an opportunity to make money while also seeing the world (Pandey, 2022).

#### **3.3.4 Possible threats to Food Security**

If seen in the perspective of the long-term implications of climate change, the connection between resources and stability, in addition to what it implies for India's national security, is even more problematic. It is risky to assume that a causal link exists between the effects of climate change and rising levels of insecurity, although one might speculate about a number of possible outcomes. The first risk is that pre-existing tensions within a country may become much more acute as a direct result of climate change. The effects of climate change might make a lot of issues much worse, including the mass migration of people, the loss of food and water supplies, and the worsening of economic conditions.

The least developed and poorest parts of India, which are also where the majority of India's internal conflicts are situated, would be the most severely affected by these issues. These include the central and eastern parts of the nation, where the Maoists have a large presence, as well as the northeastern area of India, which has separatist insurgent activities that are "festering." There will also be an escalation of conflicts that already exist over resources, such as disagreements between governments on the distribution of water.

The effects of climate change might also make India's worries about the "external" security of the country even more severe. Tensions that already exist with Pakistan and China over water are expected to become even more tense. However, Bangladesh, a country with whom India has been at odds for years over disagreements on the distribution of water along their shared border, may prove to be the greatest threat. Given how susceptible Bangladesh is to the effects of climate change, this will very certainly, over the next several decades, result in significant amounts of floods and losses of agricultural land. It is possible that millions of environmental refugees would cross the border into the northeastern part of India. This is an unstable region that has separatist aspirations in addition to violence. In point of fact, it is arguable that a portion of the violence in the region – including in Assam, which has seen a fresh outbreak of fighting this summer – stems from local resentment toward

Bangladeshis who have immigrated there in recent years. This is because Assam has seen a fresh outbreak of fighting this summer.

### **3.4 International Response**

The lack of resources poses a danger to India's capacity to maintain its stability. Due to the irreversible nature of climate change, India is somewhat constrained in the actions they might do to make everything possible to work and continue to progress forward (Majid, 2020). Nevertheless, it is conceivable to engage in two different political directions at the same time. To begin, security policy and planning might take into consideration resource-related elements in a more comprehensive manner (Andrews-Speed, 2014). The Indian Navy is making progress toward its goal of modernization, which is being driven in part by the imperative to ensure the safety of remote energy plants located in other countries. An additional objective is to enhance resource management in India and devise demand-driven, conservation-based policies that would allow for more effective administration of valuable but as of now unfeasible resources, for example (Karnad, 2021):

- increased focus on preventative water infrastructure repair (40 percent of water in most cities in India is lost due to leaking pipes),
- more equal allocation of resources,
- improved financial and political incentives to implement resource-saving technology and practices

Even if these steps won't solve the underlying problems that give rise to India's security worries, at least dealing with them will be less difficult for now.

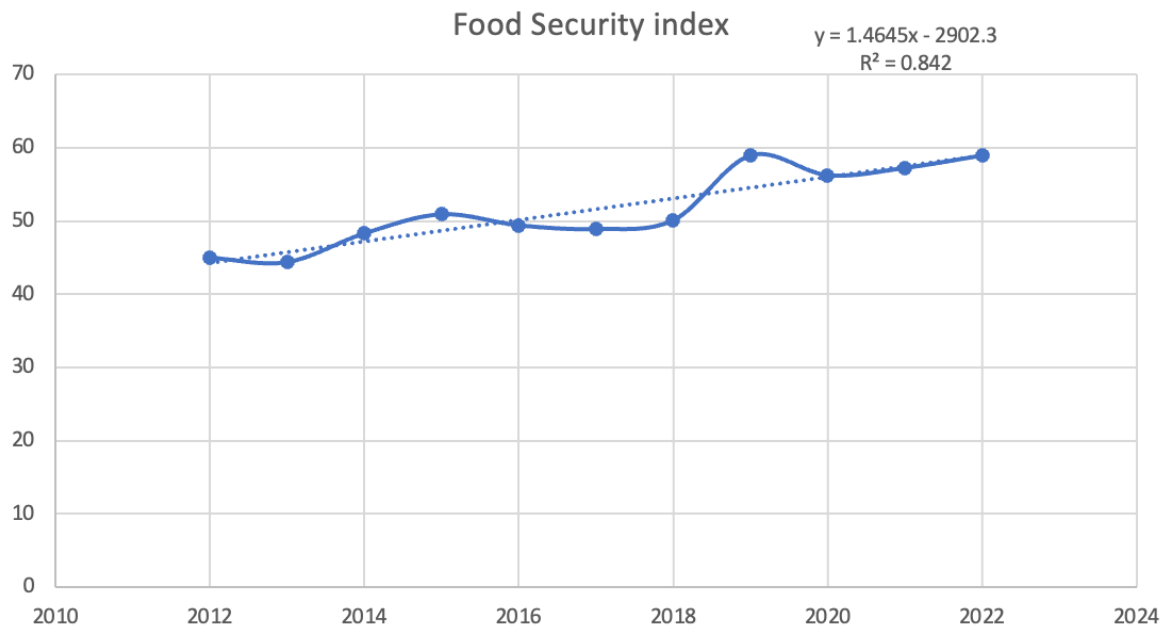
## 4 Practical Part

### 4.1 Time Series Analysis

#### 4.1.1 Food Security

The first variable which will be analyzed by the author is the food security index itself. The author managed to collect data from 2012 to 2022 only for this indicator and this is mostly the main time interval used for the analysis due to the aforementioned reason. The author uses Table 2 from the thesis's appendix to estimate a trend, which will be shown on Figure 7.

**Figure 7, food security index chart**



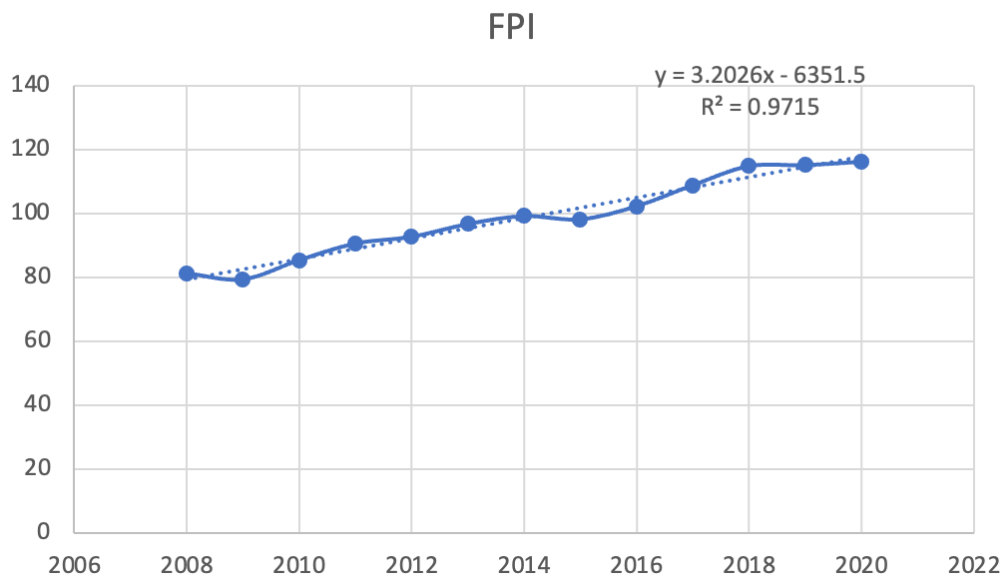
Source: own calculations based on The World Bank, 2023

For sure, it can be said that India is moving in the good direction with positive dynamics occurring for almost every consecutive year despite minor problems in 2013, 2016 and 2017. For other years, the index was returning an increase compared to the previous year, which is a good sign suggesting that the situation with food security in India changes and the population becomes less and less vulnerable to issues related to the phenomenon of food insecurity, malnutrition, etc. The trend also underpins that there is a positive dynamic, since annual increment to the food security index is equal to 1.46 points, which is a fairly good result considering that India was really struggling with this problem in the past, as the author highlighted it in the theoretical part. Average value of the index is equal to 51.65 for the

selected time period consisting of 11 years. As for the average yearly change, it is equal to 3%, which is a very good result. Overall, the situation with food security is surely improving in the country.

After quickly taking a look at the situation on the surface, the author also checks the situation with each of four pillars – availability, access, utilization and stability. For the availability, the author considers food production index as the best indicator that will help to explain the situation with food availability in the country. The dataset used for the analysis of availability is presented in Table 3. Then, the author continues to the trend estimation for the selected indicator, which will be shown in Figure 8.

**Figure 8, food production index chart**

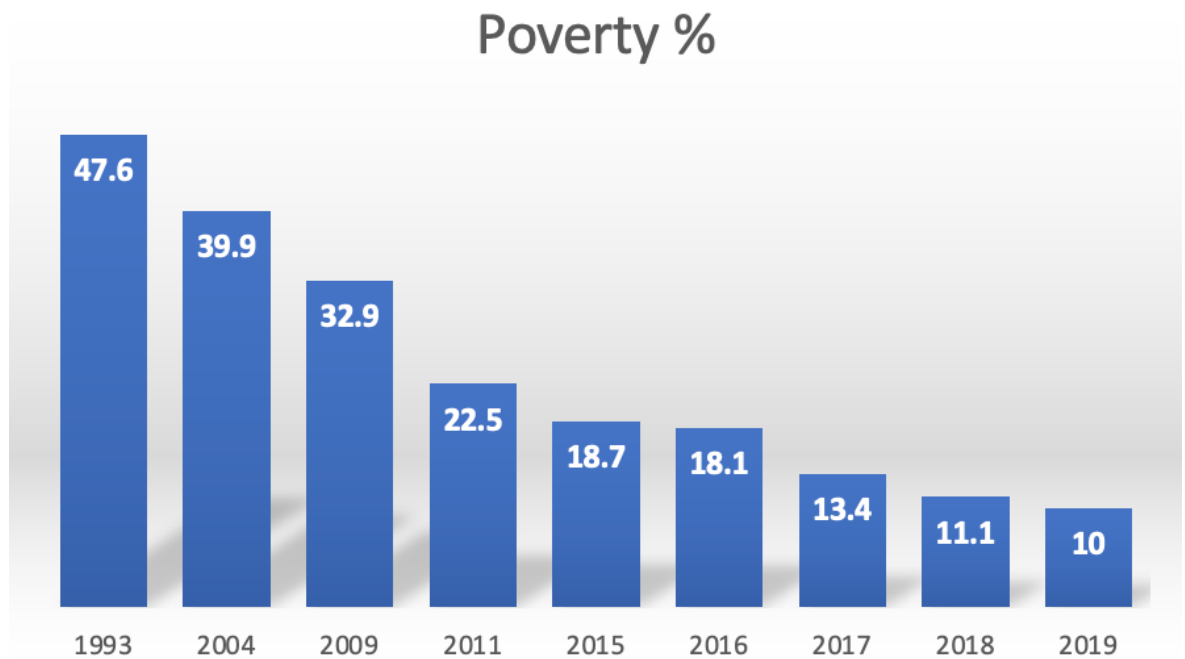


Source: own calculations based on The World Bank, 2023

More or less identical dynamic is also identified in the food production index, where the index was constantly increasing over time. However, it is wise to understand that the evolution of this index is also related to the ongoing expansion of the country's population, so maintaining enough food is essential. However, it definitely seems that the country manages to constantly improve the situation with availability and the country is able to catch ever-increasing figures for the population growth, as the average increment of the index is equal to 3.2 per year, which is a good result. Average increase, according to the chain index, is equal to 3%, which is also an optimistic result. The author suggests that the country does not have problems related to availability.

Then, the author continues to the second pillar – access. The author suggests that the best indicator that will describe access is poverty rate as this is something that can significantly prevent people from being able to afford basic goods and services. The author presents the dataset in the thesis’s appendix in Table 4. Depiction of the development of poverty rate is shown in Figure 9.

**Figure 9, development of poverty rate over time**

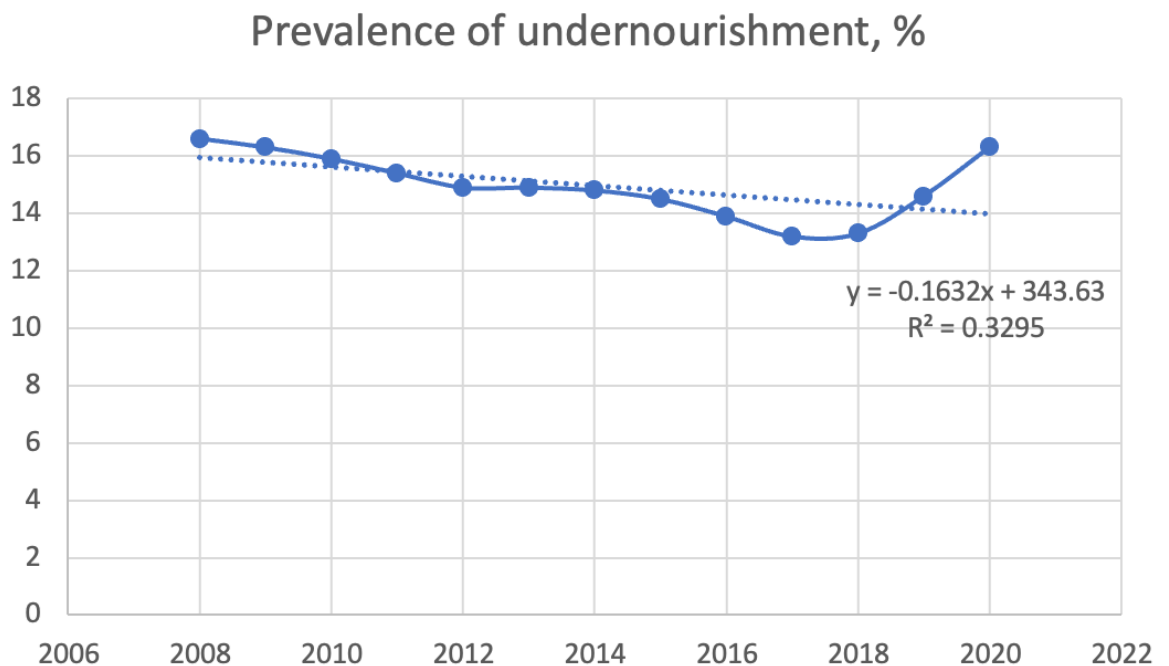


Source: own calculations based on The World Bank, 2023

Despite the fact that there are significant gaps in data, the author still manages to capture some observations starting from 1993 and finishing in 2019 due to unavailability of data. The author considers the percentages of people living below the level of 2.15 USD a day. Consequently, it is pretty visible that the country managed to decrease the poverty by 37.6 percentage points over the course of nearly 30 years, which is a tremendous result. Base index suggests that the decrease in 2019 compared to 1993 is equal to 79%. Yet, the author believes that 10% is still a high level and the government has to continue to fight against poverty. However, it is also wise to say that it will be significantly harder as the government needs to create new policies as the old ones used in the times of astonishing poverty of the 90s and 00s are over and old measures could not be so effective in the new circumstances of the 20s. All in all, the author suggests that the situation with this pillar is improving, but it could have been significantly better.

The third pillar is utilization, where the author considers the variable of prevalence of undernourishment in % available in Table 5 in the appendix of the thesis. The author continues to the time series analysis presented in Figure 10 below (The Economist, 2023).

**Figure 10, prevalence of undernourishment chart**



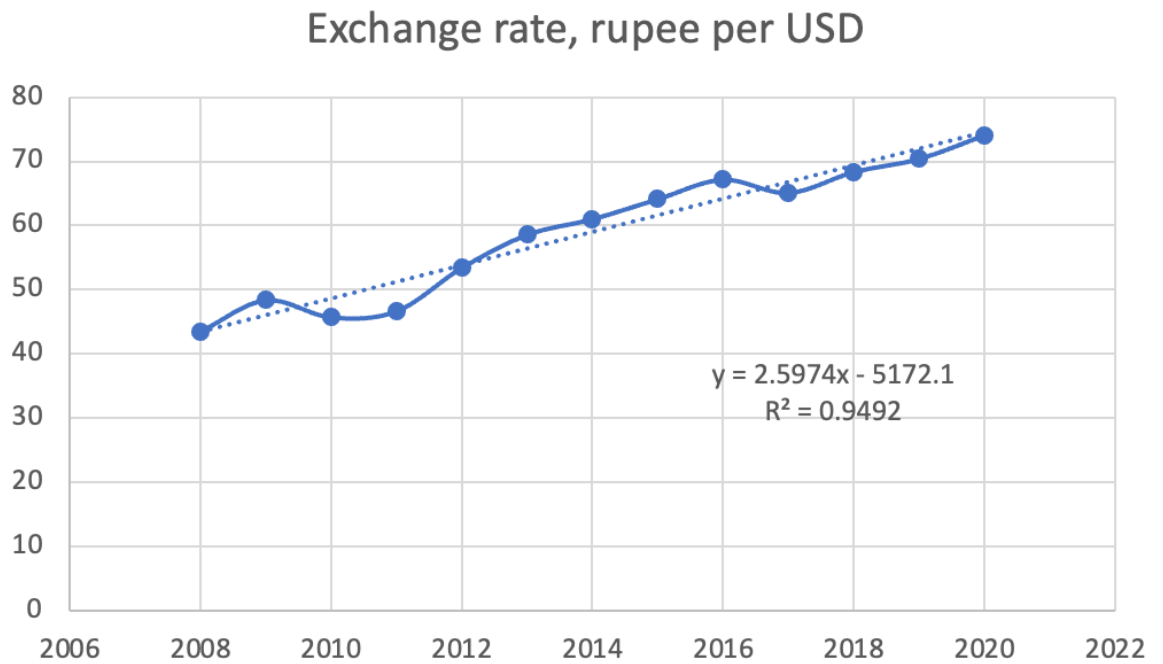
Source: own calculations based on The World Bank, 2023

The development of this indicator is rather ambivalent with the overall situation being relatively optimistic, as the indicator was diminishing from 2008 until 2017 but something changed in 2017, where the share of undernourished people started to increase again eventually reaching the figures almost similar to the level of undernourishment in 2008. Therefore, it can be said that the recent increment of people suffering from undernourishment technically erased all the progress achieved in the middle of the 10s. The author believes that utilization is a troubled component for India, but the situation was significantly worsened by the pandemic of the coronavirus, which drove the indicator to the same heights of 2008. The author believes that the pandemic worsened the position of India in terms of food utilization.

Finally, the fourth component, the database for which is available in Table 6 deals with the stability domain. Of course, measuring food stability is a complicated task and for this purpose, the author tries to express potential changes in the food stability using macroeconomic indicators, which are often treated as the ones suitable for such instances,

especially given the fact that internal troubles and instabilities are directly reflected on the development of macroeconomic indicators. The author selects exchange rate variable, GDP per capital variable, unemployment variable and inflation variable. The author starts with exchange rate variable, whose development is indicated in Figure 11 (Díaz-Bonilla, 2015).

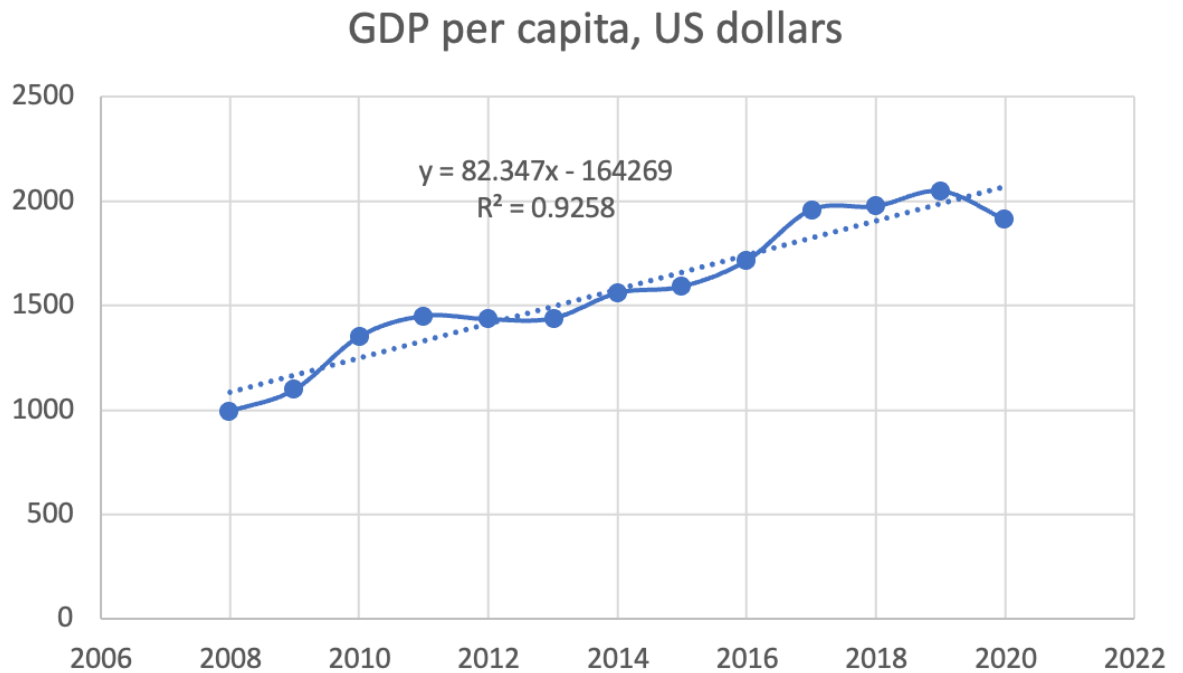
**Figure 11, exchange rate chart**



Source: own calculations based on The World Bank, 2023

For sure, there is a tendency of depreciation of India rupee, which is not really good for domestic consumers as it is expected that the country is likely to suffer from an increase in the price of inputs. Therefore, it might be suggested that this will have a negative consequence on the price of food and therefore, on the food security of the country. According to the trend, the country's domestic currency is depreciating by 2.59 rupees annually. Then, the author proceeds to the variable of GDP per capita, available in Figure 12.

**Figure 12, GDP per capita chart**

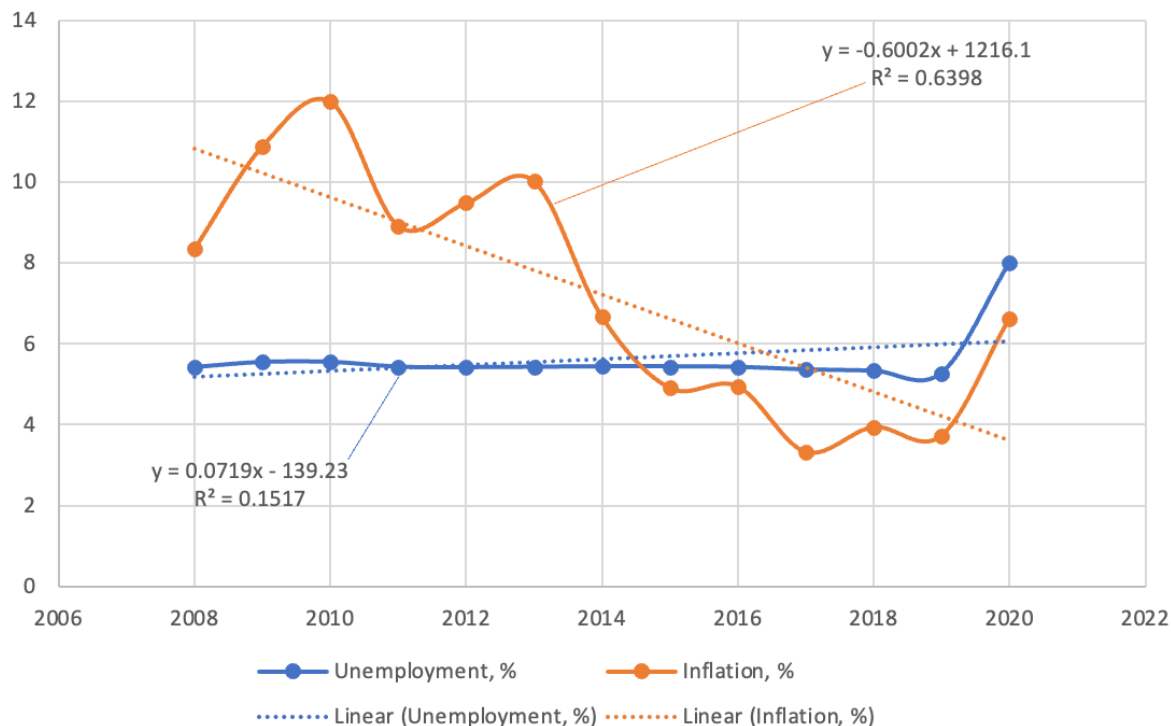


Source: own calculations based on The World Bank, 2023

The country's economic development over the course of selected 13 years was positive, as the GDP per capita increased significantly by almost twice, when comparing the figures for 2008 and 2020. However, the pandemic slightly worsened the situation in terms of economic development of the country. Overall, the author believes that the dynamic is positive, which is a necessarily good result. Finally, the author proceeds to Figure 13, where the author depicts inflation and unemployment on the same chart.



**Figure 13, unemployment and inflation chart**



Source: own calculations based on The World Bank, 2023

The situation with unemployment is rather interesting as the indicator was not really developing at all. Apart from the surge that happened in 2020 and brought unemployment to the level of 8%, the indicator was returning a steady value of approximately 5% for the whole decade, which is an acceptable level. As for inflation, the country’s inflation was gradually decreasing over the course of the last decade, but covid significantly changed the situation. However, the author believes that the overall dynamic of the development of two variables is positive, and the country does not experience serious problems with neither of them (Krivonos, 2015).

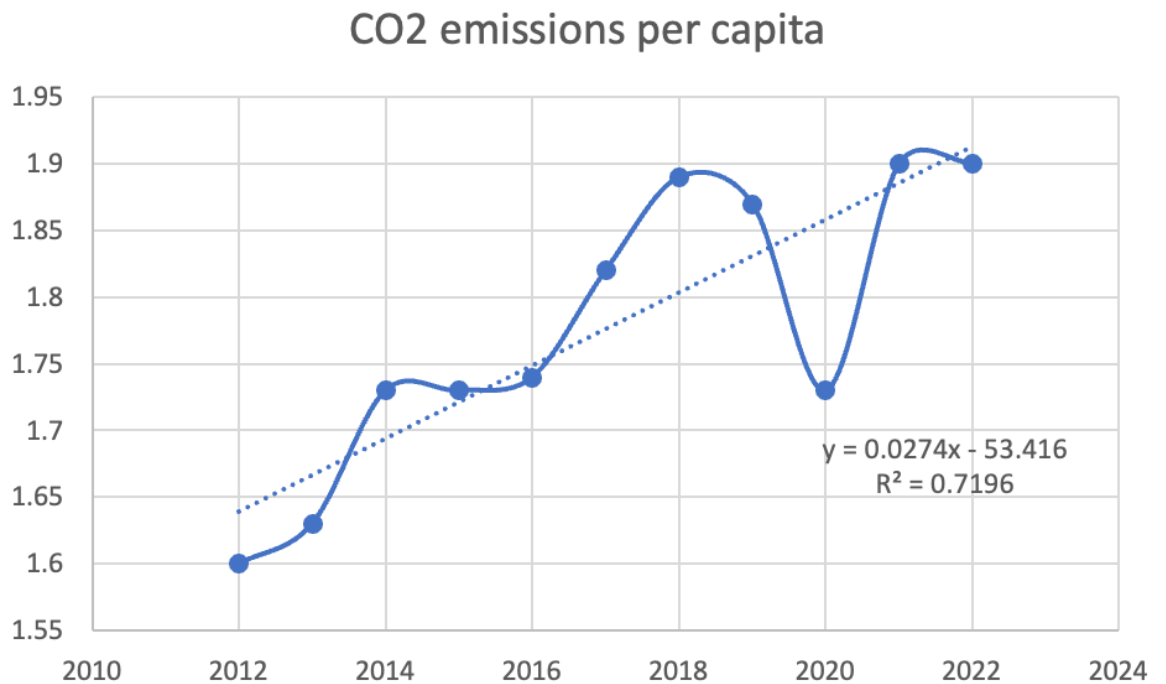
Finally, the author believes that the most problematic pillar for India is the second and the third ones – access and utilization, as their development over time was not so good. Nevertheless, the situation is improving and if not for the pandemic of coronavirus, it would have been significantly better in 2022.

#### 4.1.2 Environmental Issues

Then, the author proceeds to the environment and issues related to the phenomenon. For this purpose, the author selected three variables, which are available in Table 7 alongside the

food security index. The author considers the following variables: emissions of carbon dioxide, renewable sources percentage from the total energy output of the country and India crude oil imports in barrel per day. First, the author starts with the variable of carbon dioxide emissions, whose development over time is shown in Figure 14.

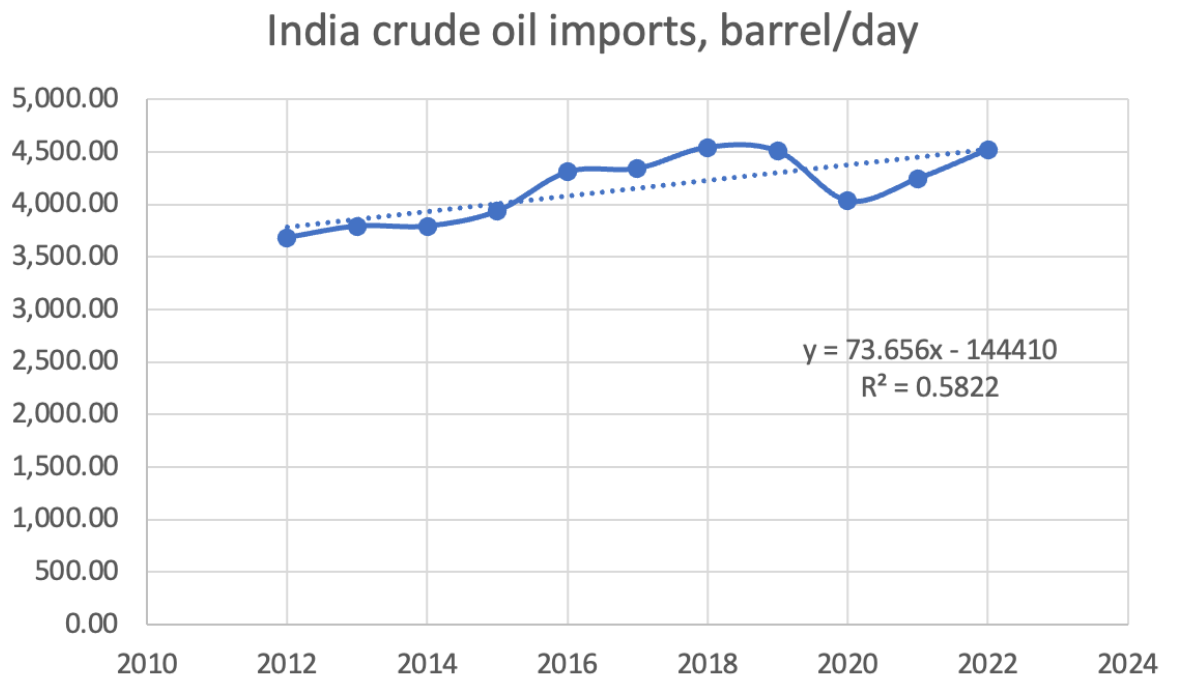
**Figure 14, carbon dioxide emissions per capita chart**



Source: own calculations based on The World Bank, 2023

The dynamic is positive, which technically means that the level of carbon emissions per person was increasing over time in the country, which is not good, and this is primarily explained by the ongoing increase in the overall total level of carbon emissions, which drives the mentioned indicator up. The annual increase in the total level of emissions is so high that even despite the growth in population per year, this still not stops the indicator per capita from increasing, which means that the country's carbon footprint increases on the annual basis, which is not good at all. According to the trend, this annual increase is equal to 0.027 kt per person per year, while the base index suggests that the increase in 2022 compared to 2012 is equal to 18.75%, which is a lot. The author proceeds to the variable of India's crude oil imports in Figure 15.

Figure 15, crude oil imports chart

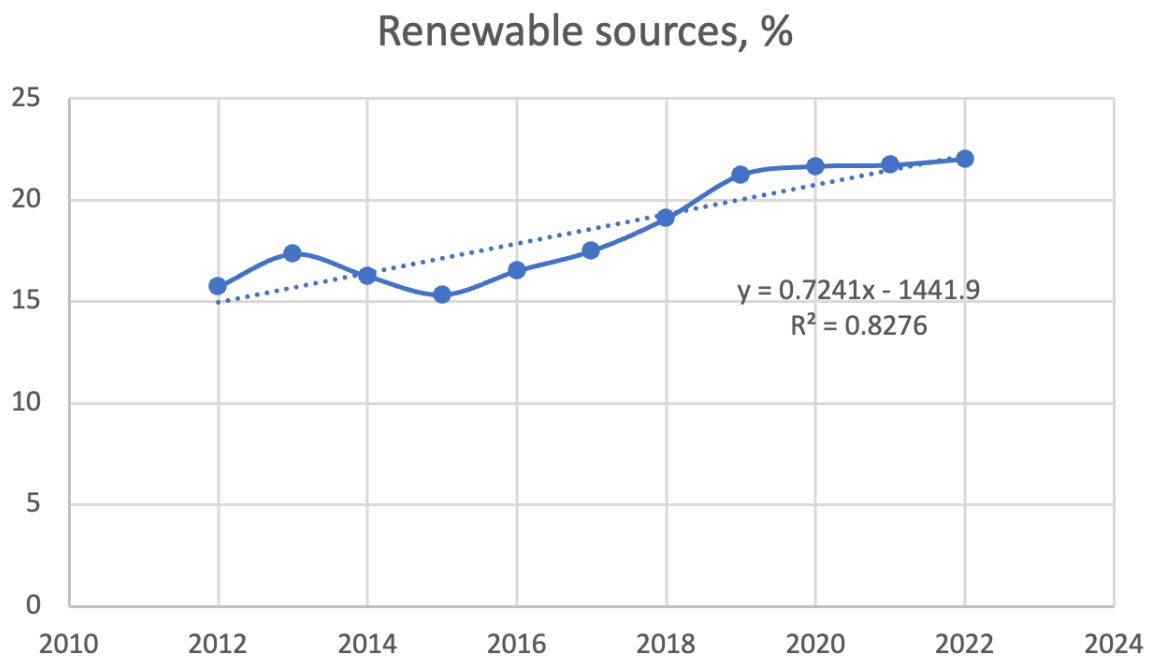


Source: own calculations based on The World Bank, 2023

The situation with the crude oil imports is also not good – the country is increasing its utilization of oil and oil-related products, which inevitably has a negative impact on the environment and ecology of the country. According to the trend created for the variable, the increase is equal to 73.65 barrel/day annually, which is a very negative result, but a very common for a developing country focused on industry and trying to increase the share of industry.

Finally, the author continues to the share of renewables in the country's total energy output. The chart for the variable is indicated in Figure 16.

**Figure 16, renewable share in total energy output**



Source: own calculations based on The World Bank, 2023

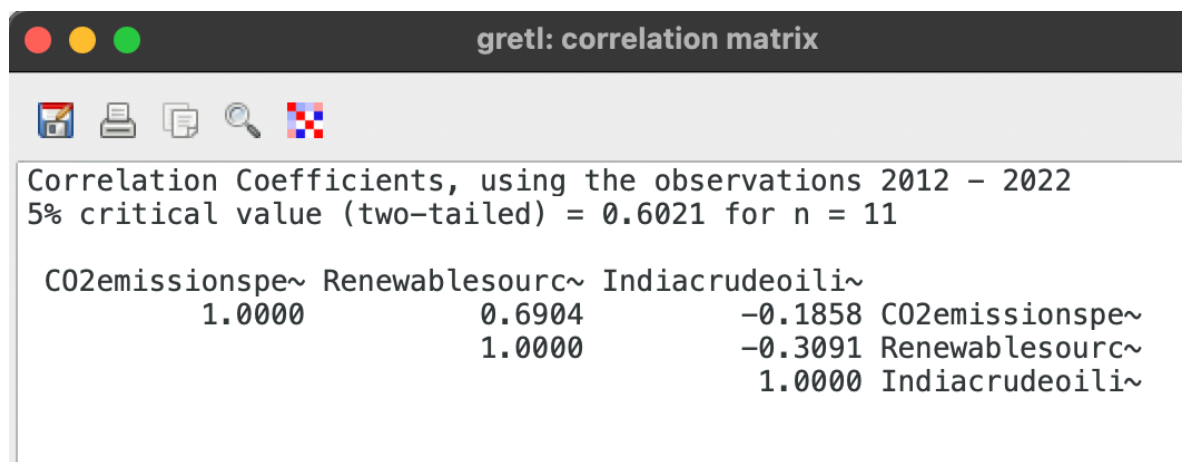
The dynamic of this variable is good – the country is constantly increasing the output of renewables and the country managed to increase it by 40.02% in 2022 compared to 2012, while the difference in percentage points is equal to approximately 7, which is a good result. Despite negative tendency of emitting carbon dioxide and importing and utilizing oil, the still manages to explore alternative sources of energy and decrease the burden that energy sector has on the country, which is a good sign.

Overall, the author believes that the country is fighting with the most common phenomena of developing countries – the country is in need of economic expansion that will help to increase the wellbeing of population and decrease vulnerability to food insecurity, but at the same time, the country also generates a lot of pollution which seems too impossible to avoid under the mentioned circumstances. However, the country is exploring alternative sources of energy, which might serve as a good foundation for green transition in the future, when the period of rapid economic expansion will be finished.

## 4.2 Linear Regression Analysis

Finally, the author continues to the creation of the model mentioned in the foreword to the thesis' practical part. First, it is essential to test if there is a problem of multicollinearity in the dataset. The author uses Grel application and for this purpose, the author generates a correlation matrix (Figure 17) that indicates correlation coefficients between independent variables. Below, the author presents the output for the multicollinearity analysis based on Table 1.

**Figure 17, correlation matrix**



Source: own calculations based on The World Bank, 2023

Given the fact that the author considers the level of 0.75 as an acceptable level of multicollinearity, it can be said that there is no multicollinearity for this dataset, which is also underpinned by the P value of 0.6, which additionally proves that there is no significant correlation between the independent variables of the dataset. Now, the author can proceed to the parameter estimation, which is indicated in Figure 18.

**Figure 18, parameters for the model**

	coefficient	std. error	t-ratio	p-value
const	2.68503	16.4912	0.1628	0.8753
C02emissionsperc~	14.8934	11.6279	1.281	0.2411
Renewablesources	1.27164	0.486862	2.612	0.0348
Indiacrudeoilimp~	-0.000300492	0.000742150	-0.4049	0.6976
Mean dependent var	51.65455	S.D. dependent var	5.293650	
Sum squared resid	56.60514	S.E. of regression	2.843668	
R-squared	0.798003	Adjusted R-squared	0.711433	
F(3, 7)	9.217980	P-value(F)	0.007916	
Log-likelihood	-24.61845	Akaike criterion	57.23690	
Schwarz criterion	58.82848	Hannan-Quinn	56.23363	
rho	0.081339	Durbin-Watson	1.834152	

Source: own calculations based on The World Bank, 2023

In fact, the model which is created by the author is not perfect, as the coefficient of determination is equal to just 0.79, while the adjusted one is equal to 0.71. Regardless, the author is able to create the following model based on the results of the OLS estimation for the case of India:

$$y_t = 2.68 + 14.89X_{1t} + 1.27X_{2t} - 0.0003X_{3t} + \epsilon_t$$

According to the model, the following can be said:

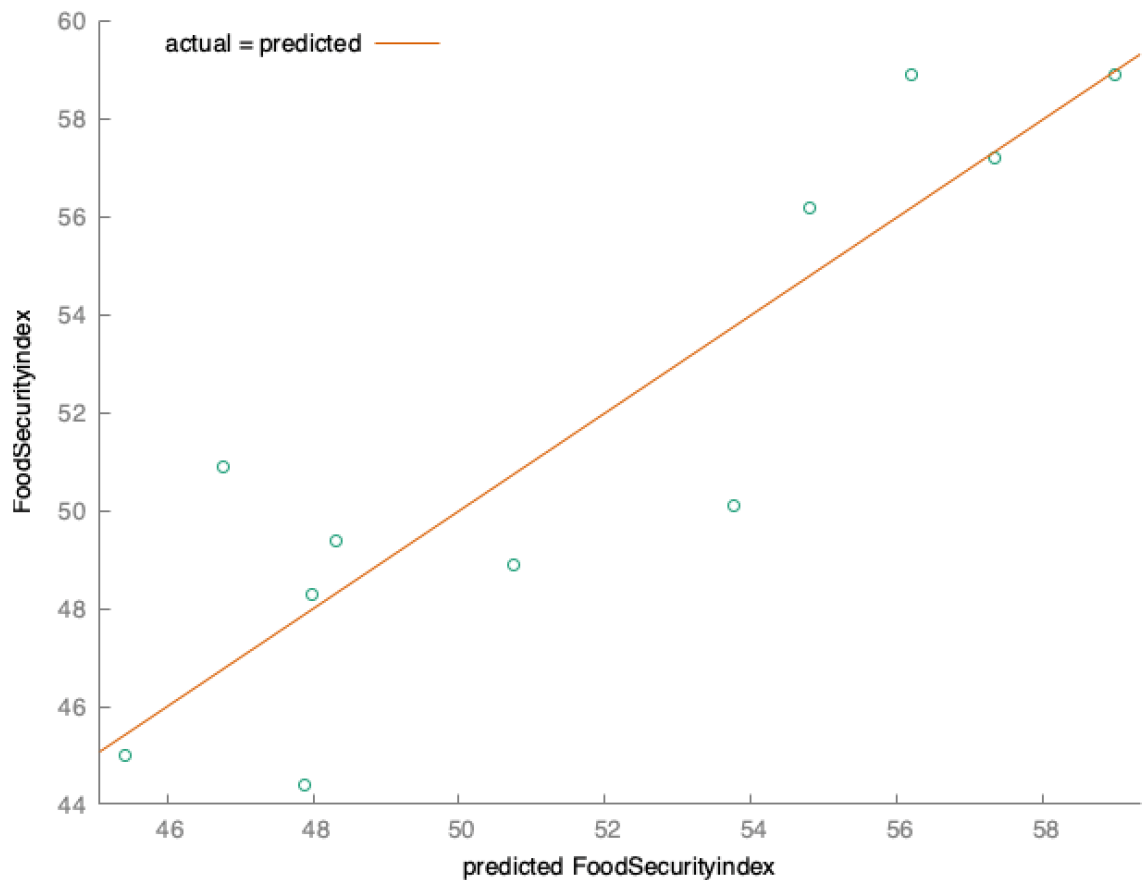
- When the level of carbon dioxide emissions increases by 1 kt per person, food security index increases by 14.89 points. This does not at all seem logical, but this primarily comes from the fact that both indicators were constantly developing over time. Yet, the author believes that this variable can actually be deleted from the model due to its statistical insignificance at 0.24 greater than 0.05 (significance level).
- When the share of renewable sources of energy increases by 1 percentage point, food security index in India increases by 1.27 points. This seems logical, but the author still thinks that variables are not directly related to each other – rather both indicate that the country is currently going through a transition in all domains and this transition is quite

positive in terms of the effect on the country's development. The variable is significant at 0.03 lower than 0.05.

- When the number of barrels imported to India increases by 1 barrel/day, food security index decreases by 0.0003 points. The predictor is not significant at 0.69 greater than 0.05.

In Figure 19, the author presents the scatterplot of fitted values versus observed ones.

**Figure 19, fitted versus observed**



Source: own calculations based on The World Bank, 2023

Of course, the model is not perfect, but it seems to describe the development of the indicator in a correct direction.

Then, the author proceeds to F test, which underpins that the model is relatively acceptable with it being significant at  $0.007 < 0.05$ . The author already discussed the significance of individual predictors, where there is just one, which is identified as a significant one.

Finally, the author proceeds to the econometric verification of the model, where the tests mentioned in the foreword to the practical part will be delivered. Output is indicated in Figure 20.

**Figure 20, econometric verification of the model**

```
White's test for heteroskedasticity -  
  Null hypothesis: heteroskedasticity not present  
  Test statistic: LM = 10.7513  
  with p-value = P(Chi-square(9) > 10.7513) = 0.293145  
  
Test for normality of residual -  
  Null hypothesis: error is normally distributed  
  Test statistic: Chi-square(2) = 0.364832  
  with p-value = 0.833255  
  
LM test for autocorrelation up to order 1 -  
  Null hypothesis: no autocorrelation  
  Test statistic: LMF = 0.0419843  
  with p-value = P(F(1, 6) > 0.0419843) = 0.844424
```

Source: own calculations based on The World Bank, 2023

Consequently, based on the testing procedure for each domain (homoscedasticity, normality and autocorrelation), the author suggests that the model does not experience any problems with the econometric verification and the model can be characterized as BLUE – best linear unbiased estimator. The author continues to the interpretation of his results in the next chapter.



## **5 Results and Discussion**

### **5.1 Effect of Environmental Issues on Food Security**

The author, based on his analysis, believes that it is not likely that environmental issues and in general the environment domain has any direct implication on the food security in India as of 2020-2022. The author draws the following conclusion based on the linear regression estimation and also on reflections related to both concepts. In fact, the case of India can be characterized as a case of a typical developing country, which is currently in the transition, However, there are still specific aspects that characterize the current development of India and one of them is the country's constant fight with poverty, which seems to be rather successful, as the author has identified it. The author suggests that one of the main changes that happen with the country is the decrease of the role that agriculture in general plays in the country's economy, which is also suggested by Singh (2015). The author believes that a need for economic transition and shifting focus from agriculture is something that defines the country's actions with regard to ecology. Unfortunately, economic transitions and especially when it comes to such a huge and resource abundant country in India requires structural changes, urbanization and shift of focus from one sector to another. Clearly, agrarian sector is the one which is often characterized by having the lowest value added compared to other two – industry and services, and the author believes that one of the main factors that actually increased the level of food security index for the country is the structural changes and the overall policy of the Indian government that helped to become less agrarian and more industrial and service-oriented country. Despite the fact that agrarian sector still employs the largest percentage of people, this share is rapidly diminishing forcing people to move to urban areas and occupy industrial and service-related jobs, which are better paid. Consequently, the author believes that these are the most important driving forces behind the improvement of the food security status for the country. However, another author's research – Saxena (2018) suggests that the situation in terms of food security has improved for those who shift from rural area to urban ones and those who on average live better than ordinary people from rural areas. According to the author of the article, the general picture might have improved significantly, but the situation with disparities has worsened as people who live in rural areas have worse access to basic needs and the

government does not seem to care about inequalities at this point, as the economic expansion and transition are the most important aspects.

As for the fact that one variable related to environmental domain was characterized as significant, the author believes that in general, food security and the share of renewable sources of energy might be related to each other, but not directly dependent and the author believes that the fact of statistical significance is explained by the fact that economic reforms of the country have increased the amount of money available to the government, which seeks to explore new opportunities in energy sector by increasing the share of renewables and decreasing the degree of dependency on imports from other country. At the same time, economic reforms also generated a significant amount of money not only for the government, but also for people occupying industrial and service-related jobs, so their vulnerability to food insecurity has decreased as well. Ultimately, these two indicators, according to the author, were developing simultaneously and were necessarily caused by the same factor – economic expansion and inflow of money in Indian economy.

The author believes that at this stage, when the country is just shifting from the agrarian sector and urbanizes the country, environmental issues are not likely to influence the production of agrarian commodities much, as the country still possesses a high abundance of natural resources, including land. In addition to that, the author believes that historically low level of industrialization of India did not put the situation with environment on the verge of being classified as catastrophic as of 2022, but if the country will continue at the same pace, it is expected that in the nearest future, those environmental issues will start to have a serious effect on the food security of the country. Finally, the author believes that the situation can significantly change in the future, but as of 2022 and the previous decade, the country is not yet at the stage when their environment and ecology are almost destroyed thus making any food production almost impossible. Similar aspects of the country's development with regard to economic growth, population growth and environment issues was highlighted by Chopra (2016) who ultimately suggests somewhat similar as the author of the bachelor thesis does – the situation is not catastrophic and the ongoing series of environmental reforms helps the country to maintain the balance, despite the fact that India is still far beyond developed countries when it comes to sustainability. Overall, the author's final suggestion is that despite common belief about the country's overpopulation and

pollution, the country actually manages to handle the situation better than other developing countries.

## **5.2 Future of Food Security**

As for the future of food security, the author of this bachelor thesis believes that the situation will continue to improve but as Saxena (2018) mentioned it, it is essential not to forget about disparities and the actual differences between rural and urban areas, where the first ones are more vulnerable to environmental issues and problems. All in all, the author believes that the country is likely to decrease the share of poor people even more thus making food more and more accessible to its population. However, in order to continue in the same way, the country needs to conduct a series of successful social policies and not just economic ones, which are being discussed the most in the country under the current prime minister Narendra Modi, which is also highlighted by Schöttli (2016).

Following this, it can be suggested that reaching a relative success the economic growth in one thing, while eradicating disparities and inequalities is something which is complicated and needs good industrial basis for the eradication of disparities, which seem to be the main driving forces behind the problems with food security of the country. Therefore, the author concludes that the situation will step by step me improving from 2022 onwards, but in order to achieve a significant progress and improvements, it is essential to create new kind of policies and restructure current institutions of the country, as these are the most important aspects that can eradicate hunger in India, which is, according to the government of the country, is its one of the main agendas for the upcoming decade.

## **5.3 Recommendations**

For the recommendations, the author suggests conducting a similar kind of analysis in the beginning of the next decade to actually evaluate if the country has managed to achieve a significant progress in eradicating hunger and related problems. In addition to that, the author suggests that the country should not stress too much important on the the economic growth and economic expansions, because after all, the GDP does not really show the quality of people's live and given the increase in the population, the country's government needs to

make sure that all those newly born people will have a place to sleep and what is more important, something to eat.

## **6 Conclusion**

To conclude, the author is able to underline that according to his analysis and reflections relying on the empirical evidence, the author suggests that environmental issues and food security are not directly related in India as of the second decade of the 21<sup>st</sup> century. Instead the author believes that all possible phenomena and changes in both domains are caused by the ongoing structural, social and economic change of the country, where the country is focused on finally breaking free from its high dependency on agrarian sector.

In addition to that, the author suggests that the situation with food security has improved significantly in the country, but the author recommends the government of the country to focus on eradication of disparities, which start to occur more and more often as more and more people shift to urban areas and abandon rural ones, which are expected to experience a serious crisis if no measures related to eradication of inequality and poverty will not be taken on the part of the government.

As for the environmental domain, the author believes that the situation with India is slowly becoming more and more concerning, but it cannot anyhow be avoided as the country needs to industrialize and also needs to use various fuels that will accelerate the country's economic growth and transition. In that regard, the author believes that India is a perfect example of a developing country's behaviour in the 21<sup>st</sup> century. At the same time, the country's situation with environment is not so bad as believed by many people – the government is constantly fighting all issues and what is more important, the country seems to understand the potential that renewable sources of energy have and thanks to the country's abundance of natural resources, it all helps the country to slowly shift and become more and more dependent on alternative sources of energy, thus decreasing the share of fossil fuels burnt for the sake of energy extraction.

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## 8 Appendix

**Table 1, linear regression dataset**

<b>Year</b>	<b>Food Security index</b>	<b>CO2 emissions per capita</b>	<b>Renewable sources, %</b>	<b>India crude oil imports, barrel/day</b>
2012	45	1.6	15.73297336	3,682.24
2013	44.4	1.63	17.34931383	3,792.58
2014	48.3	1.73	16.25383982	3,791.42
2015	50.9	1.73	15.34305035	3,935.52
2016	49.4	1.74	16.52	4,308.26
2017	48.9	1.82	17.5	4,341.41
2018	50.1	1.89	19.1	4,543.63

2019	58.9	1.87	21.25	4,506.61
2020	56.2	1.73	21.67	4,033.05
2021	57.2	1.9	21.73	4,243.76
2022	58.9	1.9	22.03	4.521

Source: The World Bank, 2023

**Table 2, time series analysis of Food Security**

Year	Food Security index	Chain Index
2012	45	-
2013	44.4	-1%
2014	48.3	9%
2015	50.9	5%
2016	49.4	-3%
2017	48.9	-1%
2018	50.1	2%
2019	58.9	18%
2020	56.2	-5%
2021	57.2	2%
2022	58.9	3%
<b>Average</b>	<b>51.65454545</b>	<b>3%</b>

Source: The World Bank, 2023

**Table 3, time series analysis of availability**

Year	FPI	Chain Index
2008	81.38	-

2009	79.47	-2%
2010	85.48	8%
2011	90.71	6%
2012	92.81	2%
2013	96.82	4%
2014	99.32	3%
2015	98.3	-1%
2016	102.4	4%
2017	109	6%
2018	115	6%
2019	115.3	0%
2020	116.4	1%
<b>Average</b>	<b>101.958182</b>	<b>3%</b>

Source: The World Bank, 2023

**Table 4, time series analysis of access**

<b>Year</b>	<b>Poverty %</b>
1993	47.6
2004	39.9
2009	32.9
2011	22.5
2015	18.7
2016	18.1
2017	13.4
2018	11.1
2019	10
<b>Base Index</b>	<b>-79%</b>

Source: The World Bank, 2023

**Table 5, time series analysis of utilization**

<b>Year</b>	<b>Prevalence of undernourishment, %</b>	<b>Chain Index</b>
2008	16.6	-
2009	16.3	-2%
2010	15.9	-2%
2011	15.4	-3%
2012	14.9	-3%
2013	14.9	0%
2014	14.8	-1%
2015	14.5	-2%
2016	13.9	-4%
2017	13.2	-5%
2018	13.3	1%
2019	14.6	10%
2020	16.3	12%
<b>Average</b>	<b>14.7</b>	<b>-0.03%</b>

Source: The World Bank, 2023

**Table 6, dataset used for stability**

<b>Year</b>	<b>Exchange rate, rupee per USD</b>	<b>GDP per capita, US dollars</b>	<b>Unemployment, %</b>	<b>Inflation, %</b>
2008	43.50518333	993.5037725	5.414000034	8.349267049
2009	48.40526667	1096.63498	5.544000149	10.88235294
2010	45.72581212	1350.634322	5.546000004	11.98938992
2011	46.67046667	1449.601789	5.426000118	8.911793365
2012	53.43723333	1434.018198	5.414000034	9.478996914
2013	58.59784542	1438.05748	5.423999786	10.01787847

2014	61.02951446	1559.864518	5.43599987	6.665656719
2015	64.15194446	1590.173918	5.434999943	4.906973441
2016	67.19531281	1714.280355	5.422999859	4.948216341
2017	65.12156865	1957.968841	5.357999802	3.328173375
2018	68.38946709	1974.377788	5.329999924	3.938826467
2019	70.42034054	2047.232704	5.269999981	3.729505735
2020	74.09956688	1910.421473	7.997000217	6.623436776

Source: The World Bank, 2023

**Table 7, dataset used for environment**

Year	CO2 emissions per capita	Renewable sources, %	India crude oil imports, barrel/day
2012	1.6	15.73297336	3,682.24
2013	1.63	17.34931383	3,792.58
2014	1.73	16.25383982	3,791.42
2015	1.73	15.34305035	3,935.52
2016	1.74	16.52	4,308.26
2017	1.82	17.5	4,341.41
2018	1.89	19.1	4,543.63
2019	1.87	21.25	4,506.61
2020	1.73	21.67	4,033.05
2021	1.9	21.73	4,243.76
2022	1.9	22.03	4,521.23
<b>Base index</b>	<b>18.75%</b>	<b>40.02%</b>	<b>22.78%</b>

Source: The World Bank, 2023