

Climate Change and Natural Disasters in India and Brazil

Joseph Bisaccia

Abstract

This article looks at the effects that climate change has on the developing world based on recent experiences in Brazil and India. Both of these countries have vastly growing economies, but climate change and the natural disasters that it causes are hindering further progress. Based on a UNICEF report by Cabral et al. (2009), millions of deaths of children and adolescents in Brazil are a result of climate change. Similarly, a World Bank report by Hallegatte et al. (2016) concluded that climate change could negate India's progress, as it may push almost 50 million people into extreme poverty over the next 15 years. This article analyzes the effects that climate change had on Brazil and India, focusing on floods, droughts and food production.

I. Introduction

Although climate change from greenhouse gas emissions is an international issue, its environmental effects hit the developing world much harder than the rest of the world. The developing world is geographically and socioeconomically more vulnerable to natural hazards from global warming than the industrialized world. Brazil and India are two countries within the developing world that are experiencing poverty reduction and economic development, but climate change is impeding further progress.

While Brazil and India have many similarities with regards to the impact of climate change, there is a major difference in the source of greenhouse gas emissions in these two countries. After China, India leads the developing world in greenhouse gas emissions from burning fossil fuels, while Brazil leads the developing world in emissions from deforestation and other land use. With that being said, although deforestation and a loss of biodiversity are major issues, this article will only address deforestation to the extent of its effect on Brazil's development. In both countries, the majority of the population living in urban and rural areas are suffering from natural hazards and a subsequent shortage of agricultural products.

Following this introduction, the next section covers a brief review of the literature. The subsequent section provides an empirical background of the countries in question. The discussion section will

focus on two major effects of climate change in these two countries (floods and droughts) as well as examine the impacts of climate change on agriculture and forestry. The final section will be the conclusion, which summarizes the main points and poses some potential solutions to the issue.

II. Brief Literature Review

Given the serious implications of climate change in developing countries, there is a relatively large literature examining various effects of climate change in Brazil and India. This brief literature review focuses on four recent contributions, two for each country. Cabral et al. (2009) and Marengo (2009) focus on Brazil, while Hayden (2016) and World Bank (2013a) focus on India. In each case, the authors look at the current situation of the country and assess the effects that climate change is having on the country as well as what can be done to reduce these effects.

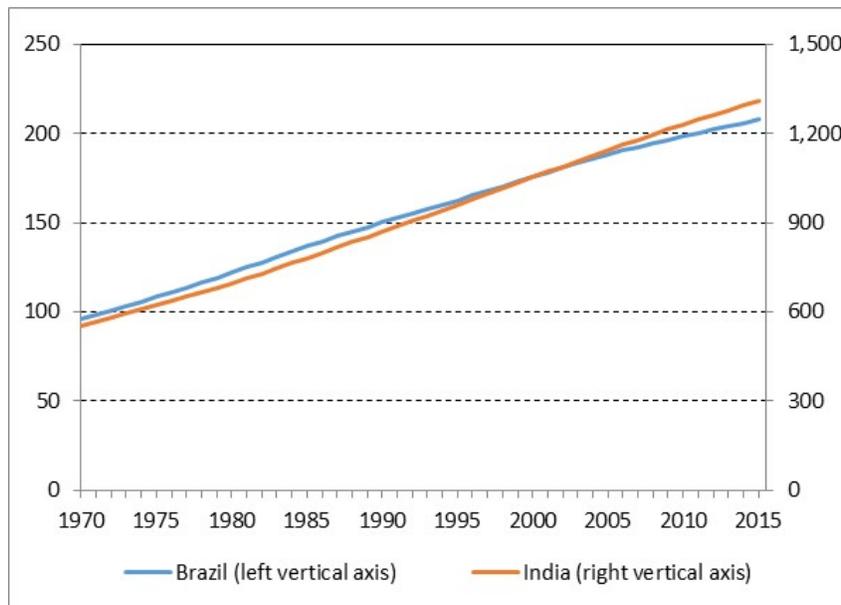
- Based on data for the early 2000s, Cabral et al. (2009) ranked Brazil among the four largest polluters in the world, representing five percent of the global emissions. Unlike most other countries, whose main source for greenhouse gas emission is the burning of fossil fuels, in Brazil 75 percent of emissions occur in land-use activities such as deforestation and burning for agriculture use. They examine how growing rates of desertification and deforestation in Brazil are driving the country into poverty. Finally, Cabral et al. (2009) provide a number of proposals for the construction of another world, especially through the participation of children and adolescents.
- Hayden (2016) explains the present and future dangers that India faces due to climate change and suggests that solar fuel can help alleviate some of the problems that the India people will face. The article details that 44 percent of India's energy came from coal in 2013. The article describes the assertions of Prime Minister Narendra Modi, who has pledged to source 40 percent of the country's electricity from renewable and low-carbon sources by 2030. Although this plan will help lower carbon emissions in the cities and more wealthy areas of India, we also need to keep in mind that 300 million Indians live currently without electricity.
- Marengo (2009) illustrates the growing frequency and intensity of natural disasters in Brazil, especially in the second half of the 20th century and into the 21st century. The article explicates the consequences and implications of extreme weather events, such as floods and landslides, and how they will affect the future of Brazil's economy. Marengo (2009) states that climate studies have projected that precipitation is expected to increase in the southern, western Amazonia and the coastal regions of Brazil, while lower rainfall is to be expected in the remaining regions. In addition to this, the article describes that by 2030, the dominant pattern of rainfall shows a reduction in rainfall in areas such as the tropical regions, but also shows a pattern of increasing rainfall in southern Brazil. Ultimately, this article illuminates the increasing frequency of extreme weather events and how they could potentially affect many of Brazil's people, businesses and companies, which affects the entirety of the economy overall. Marengo (2009) suggests that the insurance industry plays a vital role in contributing to the efforts against global warming by offering innovative cost solutions and green investments.
- A Press Release by the World Bank (2013a) focuses on the implications climate change has on India, based on a report written for the World Bank by the Potsdam Institute for

Climate Impact Research and Analytics.¹ The press release states that the warming climate poses a significant risk to India’s agriculture and water resources. Basing its analysis on the Potsdam Institute’s prediction that the world would warm four degrees above pre-industrial levels by the end of this century, the press release declares that India will be affected more than any other country due to its geographic location, its already high poverty rate, and its high population. The press release concludes with offering prospects for the future, where the World Bank has partnered with the government of India to support rural livelihood projects and the development of environmentally sustainable hydropower.

III. Empirical Background

In 2015, India and Brazil were, respectively, the second and fifth most populous countries in the world. As illustrated in Figure 1, in 1970, the population of Brazil was 96 million while the population of India was 554 million. As of 2014, the population of each country has more than doubled. The population of Brazil in 2014 was 206 million people and the population of India was 1.3 billion. Though both countries’ population growth has declined by half overtime, India’s average annual population growth is with currently 1.2 percent higher than that of Brazil’s 0.9 percent. Given that Brazil has nearly three times the amount of land mass as India but one-sixth of the population, Brazil’s population density is currently 25 people per square km, while India’s is 441 people per square km.²

Figure 1: Total Population (in millions), 1970-2015



Source: Created by the author based on the World Bank (2016).

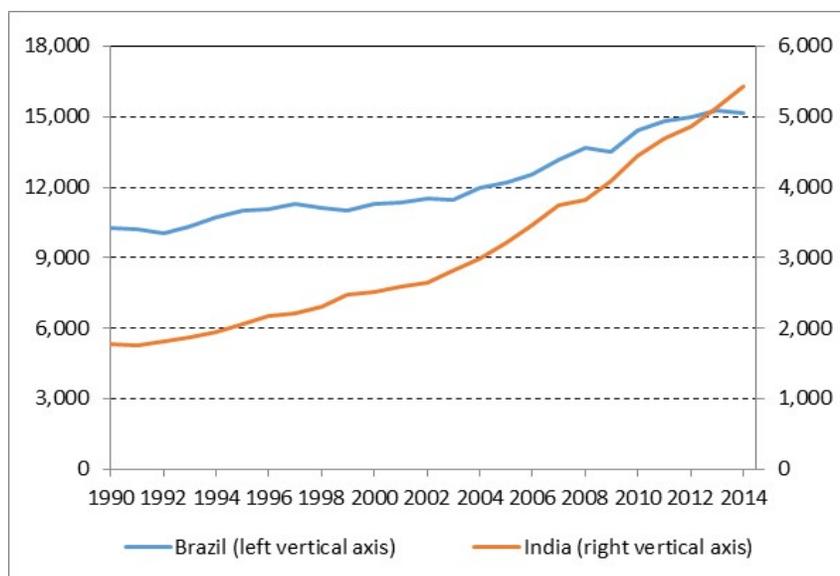
Figure 2 depicts the evolution of Gross Domestic Product (GDP) per capita of India and Brazil in the constant 2011 international \$ adjusted for purchasing power parity (PPP). While Brazil’s GDP

¹ See Adams et al. (2013).

² The data of this paragraph is based on World Bank (2016).

per capita was more than five times that of India in 1990, it was slightly less than three times that of India in 2014. As is clearly visible in Figure 2, Brazil's GDP per capita has started to stagnate in recent years while that of India continued to grow, which can be partially explained by the different impact the 2008 international recession had on these two countries. Although both countries have overall experienced positive GDP per capita growth over the past two decades, it does not take into account the loss or lack in GDP per capita growth due to health issues, natural disasters, and the loss of agriculture and forests from greenhouse gas emissions.

Figure 2: GDP per capita, PPP (constant 2011 international \$), 1990-2014



Source: Created by the author based on the World Bank (2016).

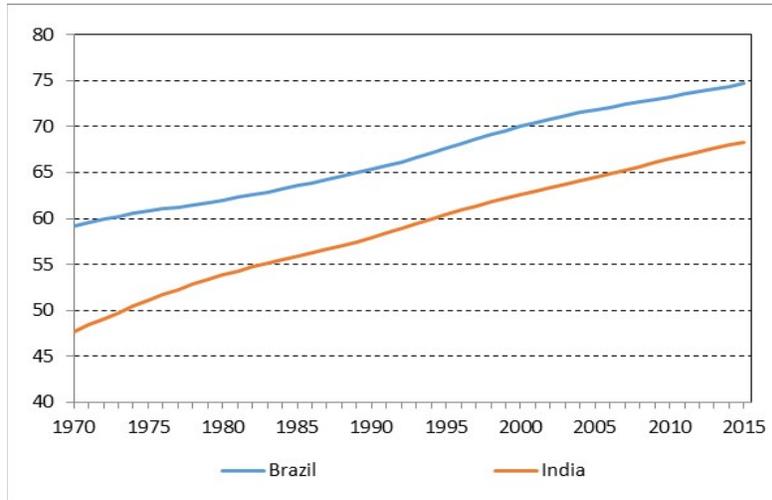
Though data on the incidence of poverty is available for only selected years, it is clear that both India and Brazil have made tremendous progress over the past 30 years with reducing poverty. Brazil's poverty headcount ratio at \$1.90 a day (2011 PPP) was 3.66 percent as of 2014, which is a tenth of what it was in 1983.³ As of 2011, India's poverty headcount ratio was at 21.23 percent, which is 30 percentage points less than it was in 1983.⁴

Figure 3 depicts the life expectancy at birth in India and Brazil from 1990 to 2014. While Brazil's average life expectancy has consistently been higher than that of India, both countries have experienced a similar increase in average life expectancy over the past two decades. In 1990, Brazil's average life expectancy was 65 years while that of India was 58 years, making a difference of 7 years in Brazil's favor. In 2015, Brazil's average life expectancy was 74 years, while India's was 68 years, making a difference of 6 years in Brazil's favor.

³ World Bank (2016).

⁴ World Bank (2016).

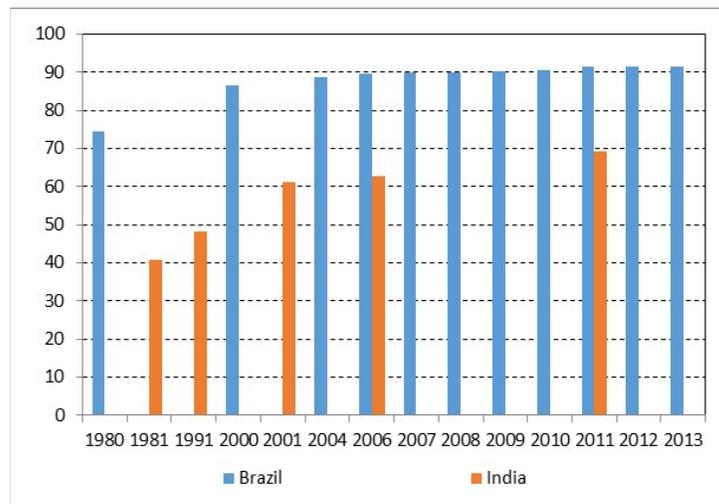
Figure 3: Average Life Expectancy at Birth (in years), 1970-2015



Source: Created by the author based on the World Bank (2016).

Figure 4 depicts the adult literacy rates of Brazil and India from 2000 to 2015. Brazil’s literacy rates are consistently higher than those of India. As of 2015, Brazil’s literacy rate was 93 percent, while India’s was 72 percent. Given that India’s adult literacy rate was slightly less than 41 percent in 1981, while that of Brazil stood at 75 percent in 1980, it makes sense that India’s average adult literacy rate has been growing much faster than that of Brazil.

Figure 4: Adult Literacy Rate of Population 15+ Years (both sexes, %), all available years



Source: Created by the author based on the World Bank (2016).

Figure 5 shows the 15 countries with the highest CO₂ emissions in 2015. India, which emitted 2,274 million tons of CO₂ in 2015, ranked third; while Brazil, which emitted 515 million tons of CO₂ in 2015, ranked 12th. It should be stressed that these are the total emissions by country, not adjusted for population size.

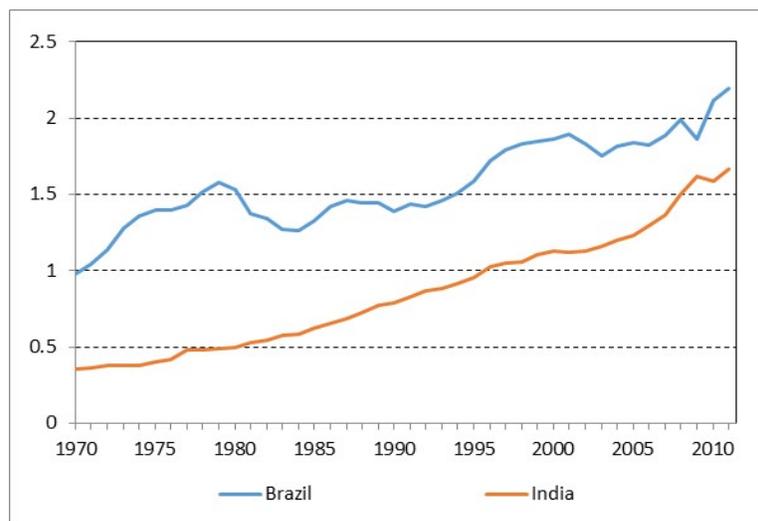
Figure 5: Top 15 Countries of CO₂ Emissions in 2015 (in millions of tons)

Rank	Country	MCO ₂
1	China	10357
2	United States of America	5414
3	India	2274
4	Russian Federation	1617
5	Japan	1237
6	Germany	798
7	Iran	648
8	Saudi Arabia	601
9	South Korea	592
10	Canada	557
11	Indonesia	537
12	Brazil	515
13	Mexico	472
14	South Africa	462
15	United Kingdom	417

Source: World Bank (undated), Global Carbon Atlas, available at: <http://www.globalcarbonatlas.org/en/CO2-emissions>.

Figure 6 depicts the increase in CO₂ emissions per capita in Brazil and India from 1970-2011 (the last year the World Bank (2016) has data for this indicator for both countries). In 1970, an average person in Brazil emitted 0.98 tons of CO₂, about three times as much as an average person in India (0.35 tons of CO₂). Brazil's CO₂ per capita emission doubled between 1970 and 2011, while that of India increased more than five times. In other words, by 2011, India has nearly caught up with Brazil in terms of CO₂ per capita. This makes sense as with socio-economic development, especially an increase in GDP per capita, it is normal to see an increase in CO₂ emissions per capita. Yet, as already stated in the Introduction, most of Brazil's emissions comes from deforestation and other land use, while the main source of India's CO₂ emissions is from burning fossil fuels or industrialization more generally.

Figure 6: CO₂ Emissions (Metric ton per capita), 1970-2011



Source: Created by the author based on the World Bank (2016).

IV. Discussion

As the last section has shown, both India and Brazil have made tremendous progress over the past few decades. Economists predict similar progress in the future, but climate change may be standing in the way of such progress. The frequency and severity of natural disasters has increased tremendously and scientists believe that climate change is to blame.

In Brazil, where an average of 12 disasters took place per year in the first half of the 20th century, the number of disasters reached an all-time high of 350 in 2004.⁵ Similarly, the high impact poverty scenario of climate change by Hallegatte et al. (2016) identifies India as one of the most vulnerable countries to climate change in the world. This assertion was supported by the World Development Report 2014, which stated that 57.3 percent of India's rural population experienced a poverty shock from a natural disaster (drought or flood) within the past year.⁶ This section will address the two main types of natural disasters caused by climate change, floods and droughts, and will then examine how climate change has impacted agriculture and food production in Brazil and India.

IV.1. Flooding

India's monsoon season has been greatly effected by inconstant floods. Three quarters of India's rainfall occurs within a four-month span, causing almost every river to flood and disperse heavy discharge around the 34 million hectares of land liable to floods. While it is normal for India to experience seasonal floods in the form of monsoons, the floods have been anything but normal as of recently. Between 1900-1980, India experienced 52 medium and perilous floods, and from 1980-2013 India experienced 201 of these types of floods. The areas that are liable to flood and that are most affected by floods account for 55 percent of India's population, 46 percent of land area, and the majority of impoverished individuals.⁷

The most recent floods of November and December 2015 killed over 500 people and displaced 1.8 million more.⁸ Hayden (2016) asserts that this type of flooding is expected to increase over time as it has been predicted that major monsoons, which have historically occurred every 100 years, are set to occur every 10 years by 2020. These torrential monsoons/rains have also increased the intensity and frequency of landslide disasters in the mountains, specifically in the Himalayas, which effects 15 percent of India's land area and accounts for 30 percent of land-slide deaths worldwide.⁹

These floods also greatly affect coastal regions in India. Not only are low-lying coastal cities exposed to rising sea levels, but coastal cities like Mumbai are also very susceptible to cyclonic storms and flooding. In July of 2005, an unexpected flood killed 500 people and took a toll on low-income and impoverished peoples with their losses estimated at \$245 million.¹⁰ In addition, tropical cyclones over the coastal regions of India have increased by 20 percent in the last two decades with five cyclones between 2011-2013 causing significant physical and economic damage to the cities of Odisha, Andhra Pradesh and Tamil Nadu.¹¹

⁵ Cabral et al. (2009), p. 8.

⁶ World Bank (2013b).

⁷ The data in this paragraph is based on Mishra (2014), p. 5.

⁸ Hayden (2016).

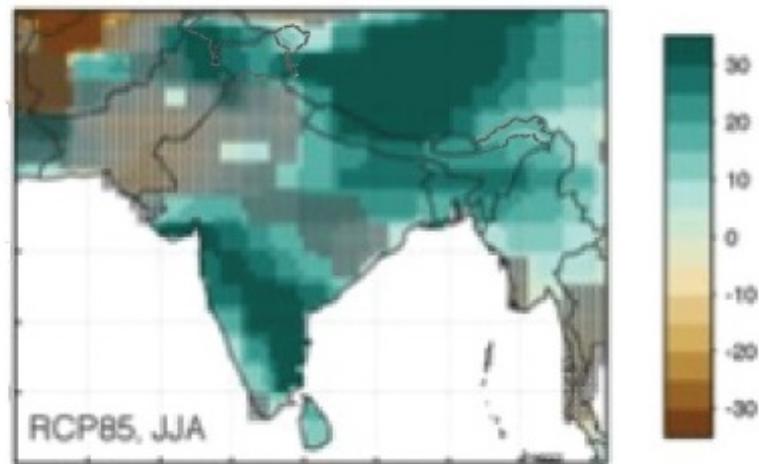
⁹ Mishra (2014), p. 5.

¹⁰ Hallegatte et al. (2016), p. 106.

¹¹ Mishra (2014), p. 5.

Figure 7 shows the projected percentage change in precipitation during the wet season (June, July and August) in India by 2071–99 relative to 1951–80 for the case of further increases in global greenhouse gas emissions (the so-called RCP 8.5 scenario). The scale on right goes from plus 30 percent (the dark turquoise at the top) to minus 30 percent (the dark brown at the bottom). It clearly shows a significant increase in the projected precipitation during the wet season, which is very likely to increase flooding.

Figure 7: Projected Increase in Precipitation during the Wet Season



Source: Adams et al. (2013), Figure 5.6, bottom right chart, p. 115.

Brazil has experienced similar forms of flooding in which experts name climate change as the culprit. Since the 1950s, Brazil has experienced random and severe floods in the Amazon and coastal regions. Although there have been numerous floods within the past 30 years, which have caused significant damage, the most catastrophic natural disaster in Brazil's history occurred in 2008. In Southern Brazil, heavy rainfall affected Santa Catarina State causing severe flooding and deadly mudslides, which affected 1.5 million people, resulted in 120 casualties and left 69,000 people homeless.¹² Mudslides and flooding caused by the storms blocked almost all the highways in the region and cut off water and electricity to thousands of homes. Ultimately, there were 120 casualties and 69,000 individuals were left homeless.

Since the 2008 disaster, the Amazon and Northeast Brazil regions have experienced intense rainfall and floods, setting record high water-levels in Rio Negro. These floods killed 44 people and left 376,000 people homeless as of July 2009.¹³ Attributed to the changing air and water temperature and pressure from CO₂ emissions, these floods have separated entire villages and communities, which have prevented over 400,000 children from going to school.¹⁴ Brazil's deforestation has allowed floods to travel farther and reach villages and cities taking thousands of people from their homes.

¹² Marengo (2009), p. 7.

¹³ Marengo (2009), p. 11.

¹⁴ Marengo (2009), p. 11.

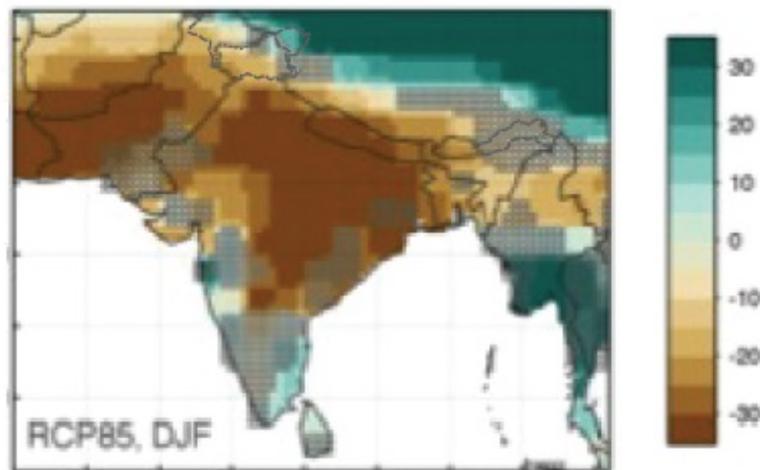
IV.2. Droughts

Both countries have also experienced more severe droughts in recent years, which are considered to be a result of climate change. While floods and heavy rainfall have accompanied monsoon season in India in the past 50 years, monsoon rains have been lacking in 2015, causing more than 2,000 deaths in the southern states of Telangana and Andhra Pradesh.

In the northern states like Punjab and Haryana, fights erupted over ownership of river waters. Water availability in India's 91 reservoirs was at its lowest in a decade, with stocks at 29 percent of their total storage capacity.¹⁵ The 2015 drought was combined with a heat wave that hit 118 degrees Fahrenheit in May 2015. Elderly people and homeless individuals were the most vulnerable to this drought and heat wave, with 900 of the victims from the city of Andhra Pradesh being elderly or low-income.¹⁶

In the subsequent year, the Indian government reported that 330 million people spread across 256 districts were affected by another severe drought in April 2016, with temperatures reaching 120 degrees Fahrenheit.¹⁷ These recent droughts were intensified by the melting and total disappearance of many glaciers in the Himalayas, which constitute a large majority of the India's fresh water reserves.¹⁸

Figure 8: Projected Increase in Precipitation during the Dry Season



Source: Adams et al. (2013), Figure 5.6, center right chart, p. 115.

Figure 8 shows the projected percentage change in precipitation during the dry season (December, January, and February) in India by 2071–99 relative to 1951–80 for the case of further increases in global greenhouse gas emissions (the so-called RCP 8.5 scenario). It clearly shows a significant less precipitation during the dry season, which is very likely to increase droughts.

¹⁵ BBC (2016).

¹⁶ Hallegatte et al. (2016), p. 119.

¹⁷ BBC (2016).

¹⁸ Mishra (2014), p. 13.

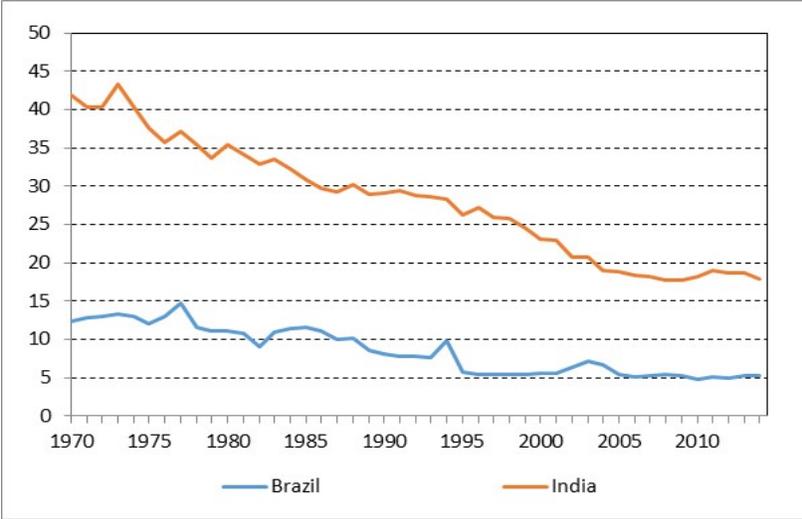
Brazil has experienced a similar drought pattern in recent years. While, Brazil’s Amazon region has become accustomed to perilous and frequent droughts due to El Nino since the early 1900s, in 2005 the most intense drought of the past one-hundred years occurred in the southwest region of the amazon which has been attributed to anomalously warm conditions in the North Atlantic. The Amazon River and its tributaries reached historic low levels, suspending navigation and isolating hundreds of small villages that relied on the rivers.¹⁹ As the rainforest dried, serious wildfires broke out damaging hundreds of thousands of hectares of forests. This implies an about 300 percent increase in forest fires from the dry season of the previous year.²⁰ The lack of water and the unsafe condition created by the smoke caused Brazil to declare a state of public calamity in September of 2005.

Unlike the droughts in the past, which have affected the Amazon region, the drought of 2014 hit the northeast region of Brazil, which contains a quarter of the country’s population. 700 cities declared a state of emergency, including the cities of Rio de Janeiro and Sao Paulo. The main water supply of Sao Paulo, which experienced the worst effects of the drought, ran on emergency reserves with a third of the water that it usually contained. The poor living in the slums of Sao Paulo, which constitute a large majority of the city’s population, experienced the drought worst, with numerous death and injuries occurring due to fights over water. Marengo, Torres and Alves (2017) predicted that there will be longer and hotter drought periods in the future.

IV.3. Impact of Climate Change on Agriculture and Food Production

Figure 9 depicts the share of agriculture to GDP for India and Brazil from 1970 to 2012. During this time span, agriculture has decreased by over half in both countries agriculture accounting for 5.2 percent of Brazil’s GDP and 17.0 percent of India’s as of 2015. India has historically and still does rely heavily on agriculture in comparison to Brazil.

Figure 9: Agriculture, Value Added (percent of GDP), 1970-2014



Source: Created by the author based on the World Bank (2016).

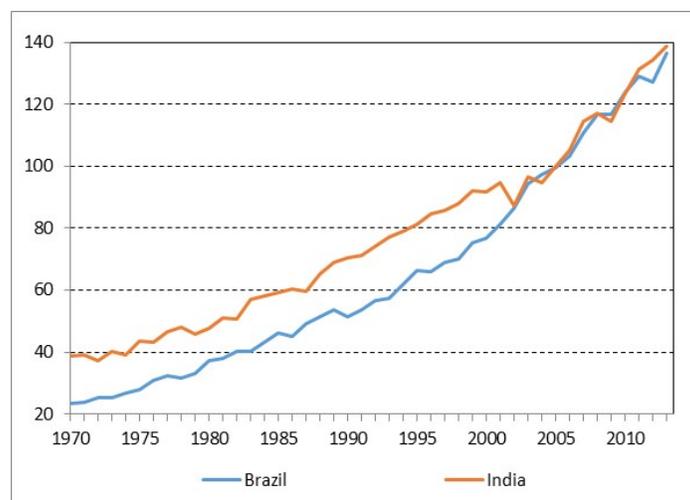
¹⁹ Marengo (2009), p. 10.
²⁰ Marengo (2009), p. 10.

Although the World Bank (2016) data shows that agriculture accounts currently for only about five percent of Brazil’s GDP, this data has limitations. The World Bank (2016) metadata clarifies that in developing countries a large share of agricultural output is either not exchanged (because it is consumed within the household) or not exchanged for money. Hence, this data may not account for individuals living below the poverty line in the northeast Amazon villages and the southwest rural slums that live off their land and survive through bartering. Furthermore, the share of agriculture does not account for farm inputs, such as farm machinery, seed supply, and workers.

In any case, Brazil’s GDP is – with 2.4 trillion U.S. dollars as of 2014 – the 8th largest in the world.²¹ Therefore, Brazil’s agricultural sector amounts to more than 100 billion U.S. dollars a year. Cabral et al. (2009, p. 5) lists Brazil as one of the largest food producers in the world, with “agribusiness” accounting for 33 percent of Brazil’s GDP, 42 percent of the country’s exports, and employing 37 percent of its labor force.

Although the share of agriculture in GDP has decreased in Brazil and India, Figure 10 shows that food production has overall increased during the last four decades. The index, which is set to 100 for the food production during the years 2004-2006, shows very similar increases for Brazil and India, especially since the early 2000s. In 2012, Brazil had increased its food production by 36.7 percent compared to 2004-2006, while India increased its food production by 38.8 percent compared to 2004-2006. Given that the populations of both Brazil and India have also increased from 2004-2006 to 2012, the food production per capita has increased less, though it has still been positive.²²

Figure 10: Food Production index (2004-2006 = 100), 1970-2012



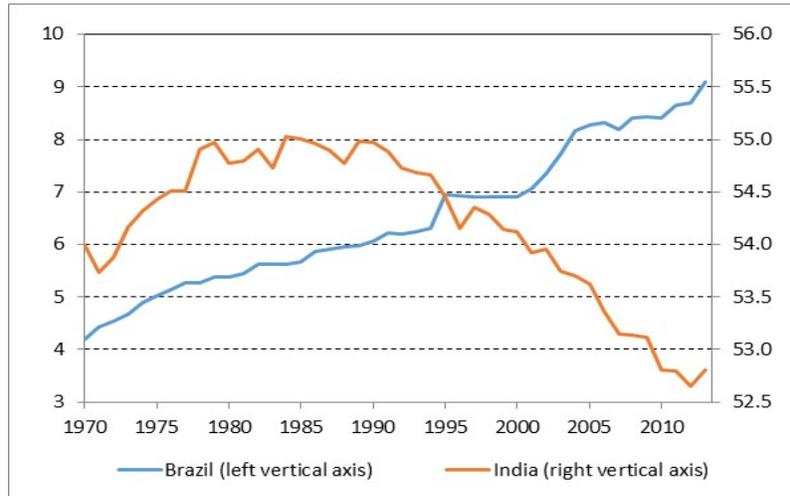
Source: Created by the author based on the World Bank (2016).

²¹ World Bank (2016).

²² Based on calculations by the author from population data provided by World Bank (2016), Brazil’s population increased by 7.4 percent from 2004-2006 to 2012, while India’s population increased by 10.4 percent during the same time period. In other words, per capita food production increased by 29.3 percent in Brazil and by 28.4 percent in India during 2004-2006 to 2012.

While per capita food production has increased in both countries, Figure 11 shows that the percentage of arable land to total land has started to decrease in India since the mid-1980s. It will only be a matter of time that Brazil will also be faced with a decrease in arable land, especially as deforestation should end.

Figure 11: Arable Land in India and Brazil (percent of land area), 1970-2012



Source: Created by the author based on the World Bank (2016).

While the decrease in arable land in India may seem relatively small, it can have serious implications in the event of a natural catastrophe. Growing more food on less land means that a single natural disaster can destroy more food and therefore effect a larger amount of the population. And experts are aware of this growing issue. The World Bank (2013a) predicts a 2-degree increase in temperature by 2040, which, with 60 percent of cropland being rain-fed, would lead to a 12 percent decrease in crop production and 63 million people would no longer be able to meet their caloric demand. Additionally, childhood stunting is supposed to increase by 35 percent by 2050, resulting from a decrease in food production.²³

Brazil does not seem to be as vulnerable to natural disasters as India. However, a report by the Wharton School of the University of Pennsylvania (2007) asserts that recent droughts across Brazil could reduce the grain production by half in the next century. The report predicts that if the temperature rises even a single degree, grain crops like coffee (which account for 5 percent of Brazil's agriculture business) will see a 90 percent decline in production, costing the government over \$600 million.²⁴ Similarly, a separate UNICEF study found that climate change may cause agricultural losses of \$7.4 billion in grain crops in Brazil, in 2020.²⁵ And there is evidence that these changes in temperature and drought have already had a tremendous impact on Brazil's economy. Soy production dropped by over 10 percent in 2006 and caused significant damage to the economy as soy is important to various food chains of domestic animals.²⁶

²³ World Bank (2013a).

²⁴ Wharton School of the University of Pennsylvania (2007).

²⁵ See Cabral et al. (2009).

²⁶ Wharton School of the University of Pennsylvania (2007).

V. Conclusion

While Brazil and India have some of the fastest growing economies in the world, further progress is contingent on immediate mitigation. Climate change from greenhouse gas emissions is hindering significant progress in India and Brazil. Brazil and India have been greatly affected by drought and flooding over the past century. In both countries, droughts and floods have taken many lives and displaced many more. With many individuals in both countries being isolated by either floods or droughts, individuals no longer have access to food, water, health services, or education. While human development has increased significantly over the past 50 years, these natural disasters are and will continue to prevent further progress. With projected temperatures increases of 2-3 degrees by 2050, natural disasters will become more frequent and intense.

- The World Bank's high impact scenario from its 2016 report on climate change and poverty differentiates between a poverty scenario and a prosperity scenario. In the poverty scenario, climate change would push 50 million people into poverty in India. In the prosperity scenario, climate change would push two million of India's people into poverty.²⁷
- Similarly, the impoverished peoples living in the low-lying slums of Brazil's major cities are extremely vulnerable to extreme weather events. One major natural catastrophe, like the drought of 2014, could kill thousands of people and displace many more. Given that both India and Brazil still rely on agriculture, these frequent natural disasters will not only continue to hurt the agricultural sector but will also result in broader economic damages.

Rapid, inclusive, and climate-informed development is required to remove the long-term threat that climate change creates for poverty eradication. Steps have been taken in both countries to help solve this global issue such as Brazil's Terra Legal program formal process of recognizing indigenous lands and granting land titles to about 300,000 smallholders conditional on compliance with the Brazilian Forest Code, or India's ratification of the Paris agreement to limit the Earth's warming to less than two degrees Celsius. While progress and acknowledgements are being made a predicted increase in the frequency and severity of natural disasters might make the path to further development longer and more difficult to persist.

References

- Adams, Sophie; Florent Baarsch; Alberte Bondeau; Dim Coumou; Reik Donner; Katja Frieler; Bill Hare; Arathy Menon; Mahe Perette; Franziska Piontek; Kira Rehfeld; Alexander Robinson; Marcia Rocha; Joeri Rogelj; Jakob Runge; Michiel Schaeffer; Jacob Schewe; Carl-Friedrich Schleussner; Susanne Schwan; Olivia Serdeczny; Anastasia Svirjeva-Hopkins; Marion Vieweg; and Lila Warszawski (2013). *Turn Down the Heat: Climate Extremes, Regional Impacts, and the Case for Resilience* (Washington DC: The World Bank); available at: <http://documents.worldbank.org/curated/en/975911468163736818/Turn-down-the-heat-climate-extremes-regional-impacts-and-the-case-for-resilience-full-report>.
- BBC (2016). *India Drought: 330 Million People Affected*. BBC News Story of April 20, 2016; available at: <http://www.bbc.com/news/world-asia-india-36089377>.

²⁷ Hallegatte et al. (2016), p. 33.

- Cabral, Antonio Carlos; Fabio Atanasio de Moraes; Ida Pietricovosky de Oliveira; and Roshni Basu (2009). *Climate Change and Children in the Brazilian Amazon Region*. Brasília, Brazil: UNICEF Brazil; available at: https://www.unicef.org/sitan/files/SITAN_Climate_Change_and_Children_in_the_Brazilian_Amazon_Region.pdf.
- Hallegatte, Stephane; Mook Bangalore; Laura Bonzanigo; Marianne Fay; Tamaro Kane; Ulf Narloch; Julie Rozenberg; David Treguer; and Adrien Vogt-Schilb (2016). *Shock Waves: Managing the Impacts of Climate Change of Poverty* (Washington, DC: The World Bank Group); available at: <https://openknowledge.worldbank.org/bitstream/handle/10986/22787/9781464806735.pdf>.
- Hayden, Michael Edison (2016). *How Climate Change is Hitting India* (Queens, NY: National Geographic); available at: <http://yearsoflivingdangerously.com/learn/news/how-climate-change-is-hitting-india/>.
- Marengo, Jose A. (2009). Climate Change, Extreme Weather and Weather Events in Brazil. In: Lilia Giannotti (ed.) *Climate Change and Extreme Events in Brazil* (Rio de Janeiro, Brazil: Fundação Brasileira para o Desenvolvimento Sustentável (FBDS), pp. 5-19.
- Marengo, Jose A.; Roger Rodrigues Torres; and Lincoln Muniz Alves (2017). Drought in Northeast Brazil—Past, Present, and Future. *Theoretical and Applied Climatology*, Vol. 129, No. 3-4 (August), pp. 1189-1200.
- Mishra, Ashutosh (2014). An Assessment of Climate Change-Natural Disaster Linkage in Indian Context. *Geology and Geoscience*, Vol. 26, No. 5 (July), pp. 1-15.
- Rocha, Jan (2016). *Climate Change Worsens NE Brazil's Drought* (Sao Paulo, Brazil: Climate News Network, October 2); available at: <http://climateneutralnetwork.net/climate-change-worsens-ne-brazils-drought/>.
- Wharton School of the University of Pennsylvania (2007). *Global Warming and its Impact on Brazilian Agriculture*. Philadelphia, Pennsylvania: Wharton University of Pennsylvania, Knowledge@Wharton; available at: <http://knowledge.wharton.upenn.edu/article/global-warming-and-its-impact-on-brazilian-agriculture/>.
- World Bank (2013a). *Warming Climate in India to Pose Significant Risk to Agriculture, Water Resources, Health, says World Bank Report*. Washington, DC: The World Bank, Press Release of June 19, 2013; available at: <http://www.worldbank.org/en/news/press-release/2013/06/19/warming-climate-india-pose-significant-risk-agriculture-water-resources-health-says-world-bank-report>.
- World Bank (2013b). *World Development Report 2014: Risk and Opportunity — Managing Risk for Development* (Washington, DC: The World Bank); available at: http://siteresources.worldbank.org/EXTNWDR2013/Resources/8258024-1352909193861/8936935-1356011448215/8986901-1380046989056/WDR-2014_Complete_Report.pdf.
- World Bank (2016). *World Development Indicators / Global Development Finance Database* (Washington, DC: The World Bank); as posted on the World Bank website: <http://data.worldbank.org/data-catalog/> (downloaded on June 28, 2016).