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THE IMPACT OF CLIMATE CHANGE ON INDIA'S AGRICULTURE, FOOD SECURITY, AND AGRICULTURAL TRADE

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SPECIAL RISK REPORT

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Summary

Estimates predict that India will become a country that is highly vulnerable to climate change. As climate change accelerates, India's farmers face a number of hardships brought about by adverse climate events, including drought, heavy rainfall, floods, extreme temperatures, and storms. Climate risks negatively affect agricultural production, food availability, and social security. India's agricultural imports are projected to increase as crop yields diminish, which is why securing vital trade routes will be important for India's food security. In order to prevent hunger, poverty, rural exodus, and social tensions, India must also seek to reduce greenhouse gas emissions and invest in climate-smart farming.

List of Abbreviations

<i>DAP</i>	Diammonium phosphate
<i>FAO</i>	Food and Agriculture Organization of the United Nations
<i>GDP</i>	Gross domestic product
<i>NAPCC</i>	National Action Plan on Climate Change
<i>UN</i>	United Nations
<i>UNDP</i>	United Nations Development Program
<i>WEBCIS</i>	Weather-Based Crop Insurance Scheme

BOLTS: OPERATIONAL, FINANCIAL, COMPLIANCE, STRATEGIC.

TAGS: AGRICULTURE, AGRICULTURAL EXPORT, AGRICULTURAL IMPORT, AGRICULTURAL PRODUCTION, AGRICULTURAL TRADE, CLIMATE CHANGE, FARMING, FERTILIZERS, FOOD SECURITY, HUNGER, INDIA, POVERTY, UNITED NATIONS.

Contents

Introduction	8
The Extent of Climate Change in India	8
The Influence of Climate Change on India's Agricultural Production, Trade, and Economy	10
Food Security	11
Vital Trade Routes	12
Risk Mitigation Initiatives and Solutions	14
Strategic Summary	16
Tactical Breakdown	17
Conclusion.....	18
Maps	20

Introduction

The risks and effects of climate change are gaining increasing relevance in the media and international diplomatic discussions as the global temperature has risen by about 1.1° Celsius (34° Fahrenheit) since the pre-industrial age.¹ Temperatures have continued to climb in recent years, hitting record highs. An acceleration of climatic shifts in the future foreshadows grave implications for agricultural production, food availability, agricultural trade, and food security. Some regions in the world are expected to benefit from climate transformations while other regions will experience devastating consequences. Agricultural yields are expected to rise or fall over the next decades, depending on the region. Currently warmer areas will suffer losses, whereas colder areas may be able to grow new types of crops due to rising temperatures.

India, alongside Pakistan, the Philippines, and Bangladesh, will be among the countries that are projected to be most vulnerable to climate change.² India's vast size of 3.3 million km² (1.3 mi²) and large population of 1.3 billion people will experience different types of climate-related agricultural risks. Droughts, floods, and heavy storms will cause a drop in crop yields and this, in turn, will likely lead to increasing product prices and mass migration to cities as the outlook of a life as a farmer may become increasingly bleak. India's level of agricultural self-sufficiency is expected to fall and, as a consequence, agricultural imports are likely to increase, impacting India's economy.

The Extent of Climate Change in India

More intense or volatile climate conditions can breed poverty, migration, and social tensions. Drought, heat waves, and variable rainfall are major stressors for Indian farmers. Unpredictable rainfall damages even sturdier crops and floods fields that are parched by heat waves. Intense droughts result in water shortages – a crisis that is predicted to strip 40% of India's population of

¹ Wood, J. (2019): Indian cities are running out of water, *World Economic Forum*. Available at: <https://www.weforum.org/agenda/2019/06/this-city-in-india-is-running-out-of-water/> (Accessed: July 10, 2019).

² Reuters (2018): Why India is most at risk from climate change, *World Economic Forum*. Available at: <https://www.weforum.org/agenda/2018/03/india-most-vulnerable-country-to-climate-change> (Accessed: July 10, 2019).

access to clean drinking water by 2030.³ In June 2019, 44% of India already experienced differing degrees of drought as a heat wave blanketed the country. Temperatures in Delhi were recorded at 48° C (118° F), while temperatures climbed to 50° C (122° F) in Churu city in Rajasthan state.⁴ Approximately 600 million people are experiencing serious water shortages, according to findings by governmental think tank NITI Aayog.⁵ If Indians are deprived of basic necessities and cannot access safe drinking water or wash clothes and dishes due to extreme heat, they are even less likely to use the little water available for tending to corn, soy, rice, or vegetable fields. Plantations will dry out and farmers are likely to leave in search of better sustenance and employment opportunities in other areas. The population count in urban centers of India has been rising, gradually surpassing the population count of rural areas.⁶

The United Nations (UN) predicted the following impacts of climate change in India:⁷

- **Abating water flow in rivers** such as the Ganges and the Brahmaputra, which rely on melting snow, as snow cover dwindles
- **Volatile monsoons** negatively affecting agriculture, peninsular rivers, water, and electricity supply
- **Decreased wheat production** as temperatures rise
- **Rising sea levels** posing risks to freshwater resources, mangrove ecosystems, and densely populated shores
- **Increased flood frequency and intensity** threatening coastlines as well as barren and semi-barren areas
- **An alteration of forest types** afflicting biodiversity, the availability of forest products, and regional climate dynamics

³ Wood, J. (2019): Indian cities are running out of water, *World Economic Forum*. Available at: <https://www.weforum.org/agenda/2019/06/this-city-in-india-is-running-out-of-water/> (Accessed: July 10, 2019).

⁴ Ibid.

⁵ NITI Aayog (2018): *Composite water management index: A tool for water management*. Available at: https://niti.gov.in/writereaddata/files/document_publication/2018-05-18-Water-index-Report_vS6B.pdf (Accessed: July 11, 2019).

⁶ Borpujari, P. (2018): India's farmers march to the hollow halls of parliament, *The Diplomat*. Available at: <https://thediplomat.com/2018/12/indias-farmers-march-to-the-hollow-halls-of-parliament/> (Accessed: July 10, 2019).

⁷ United Nations Development Program [UNDP] (n.d.): *Climate change adaption: India*. Available at: <https://www.adaptation-undp.org/explore/india> (Accessed: July 10, 2019).

The Influence of Climate Change on India's Agricultural Production, Trade, and Economy

Farmers in India grow enormous amounts of edible and non-edible agricultural produce. According to the Food and Agriculture Organization of the United Nations (FAO), India produced approximately 275 tons of food grains and ranks as the world's largest producer (25% of global production), consumer (27% of global consumption), and importer (14% of global imports) of pulses. Moreover, the country accounts for 10.9% of global fruit harvests and 8.6% of global vegetable harvests, ranking as the world's second-largest fruit and vegetable producer. Finally, India is also the world's second-largest producer of rice, wheat, sugarcane, cotton, and groundnuts.⁸

The Global South is more prone to a declining agricultural production due to climate shifts, whereas northern regions of the world will tend to experience increasing crops growth and production. Canada and Russia, for instance, will benefit from climate change, according to a 2018 report by the FAO. Conversely, West Africa and India will struggle with decreasing farming yields. The FAO estimates that harvest will fall by 2.6% in India by 2050.⁹

Declining farming yield will cause a shift in import and export rates of agricultural products. Forecasts estimate that India will raise its net imports by 20.4% by 2050 due to harvest shortages. For this same reason, net exports are projected to decrease by roughly 20% by 2050. At the same time, India's food purchasing power will drop by 6.2%. In addition, people in India will experience a 4.6% increase in food consumer prices as domestic yield levels fall and import levels rise.¹⁰ In contrast, average global food prices will not significantly suffer from climate change and remain relatively stable, according to the FAO.¹¹

⁸ Food and Agriculture Organization of the United Nations [FAO] (n.d.): *FAO in India: India at a glance*. Available at: <http://www.fao.org/india/fao-in-india/india-at-a-glance/en/> (Accessed: July 10, 2019).

⁹ Food and Agriculture Organization of the United Nations [FAO] (2018): *The state of agricultural commodity markets: Agricultural trade, climate change and food security*. Available at: <http://www.fao.org/3/I9542EN/i9542en.pdf> (Accessed: July 10, 2019).

¹⁰ Ibid.

¹¹ Ibid.

A major risk of the effects of climate change on agriculture could be a growing cleft between developed countries in the Northern Hemisphere and developing countries in the Global South. Developing countries that will struggle the most with climate-related agricultural shifts are also likely to see their gross domestic product (GDP) decrease. The agricultural sector accounted for 44% of employment in India in 2018, indicating the significance of agricultural shifts.¹² Only an estimated 15.4% of India's GDP, however, relied on agriculture in 2016.¹³ While climate change could potentially impact employment in agriculture, estimates by the International Monetary Fund show that India's real GDP will continue to increase, reaching a 7.7% growth in 2024.¹⁴

Food Security

As climate conditions shift, so will the level of food security, which includes food availability, access, utilization, and stability.¹⁵ Poor weather conditions affect not only the quantity but also the quality of agricultural products. A lack of food of sufficient quality and quantity can lead not only to hunger but also poor nutritional health and disease. Climate conditions and food insecurity can therefore indirectly influence labor productivity, as farmers are unlikely to produce large amounts of harvest when they are ill. Furthermore, unfavorable climatic shifts may also foster plant diseases that damage crops and reduce harvest quantities.

In order to maintain a stable level of food security, the international flow of staple items such as rice, wheat, soybean, or corn must be guaranteed. The United Nations, therefore, seeks to promote agricultural free trade policies that balance food availability patterns across the world to guarantee

¹² The World Bank (2019): *Employment in agriculture (% of total employment)*. Available at: <https://data.worldbank.org/indicator/sl.agr.empl.zs> (Accessed: July 10, 2019).

¹³ Central Intelligence Agency [CIA] (n.d.): *World Factbook: GDP Composition, by sector of origin*. Available at: <https://www.cia.gov/library/publications/the-world-factbook/fields/214.html> (Accessed: July 10, 2019).

¹⁴ International Monetary Fund [IMF] (2019): *World Economic Outlook (April 2019): Real GDP growth*. Available at: https://www.imf.org/external/datamapper/NGDP_RPCH@WEO/OEMDC/ADVEC/WEOWORLD (Accessed: July 11, 2019).

¹⁵ See Maeng, M. H. (2012): Climate change, food security and conflict, *Stockholm International Peace Research Institute* [SIPRI]. Available at: <https://www.sipri.org/commentary/blog/mon-10-01-2012-14-00/climate-change-food-security-and-conflict> (Accessed: July 10, 2019).

that food is transported without obstacles from regions with agricultural surpluses to regions with deficits.¹⁶ The aim of such policies is to stabilize food security.

Yet growing international agricultural trade comes with numerous risks. Disruptions in food supply chains to India will have serious effects on the Indian population. If countries that are rich in agricultural produce experience a bad harvest and possess only limited stock, the effects of supply shortages will be particularly felt in regions that are vulnerable to food security disruptions such as India or West Africa. Similarly, trade wars and bans on agricultural imports and exports will also elicit disastrous results. Food prices may rise to levels that are unaffordable to poorer communities. This could then lead to riots, social unrest, hunger, and death. Humanitarian non-profit organization DARA estimates that 225,000 people died in 2010 due to climate-related food insecurity. This number is expected to rise to 380,000 deaths in 2030. DARA states that infants and children are especially vulnerable and will account for half of these deaths. Furthermore, the organization assesses that such risks are the highest in India.¹⁷

Vital Trade Routes

Securing international agricultural trade routes will become increasingly important if climate change aggravates food availability. Diplomatic conflict could block trade routes, which could in turn result in losses for importing as well as exporting states. Coastal and inland trade chokepoints, which constitute key trade connection points, in the agriculturally rich regions of Brazil, the United States, and the Black Sea will be critical for the international trade of corn, soybean, and wheat.¹⁸ Globally, the following **maritime trade chokepoints** are critical for agricultural product transfer:¹⁹

¹⁶ Food and Agriculture Organization of the United Nations [FAO] (2018): *The state of agricultural commodity markets: Agricultural trade, climate change and food security*. Available at: <http://www.fao.org/3/I9542EN/i9542en.pdf> (Accessed: July 10, 2019).

¹⁷ DARA (2012): *Climate vulnerability monitor: A guide to the cold calculus of a hot planet*, 2nd edition. Available at: <https://daraint.org/wp-content/uploads/2012/10/CVM2-Low.pdf> (Accessed: July 12, 2019).

¹⁸ Bailey, R. & Wellesley, L. (2017): Chokepoints and vulnerabilities in global food trade, *Chatham House*. Available at: <https://www.chathamhouse.org/sites/default/files/publications/research/2017-06-27-chokepoints-vulnerabilities-global-food-trade-bailey-wellesley-final.pdf> (Accessed: July 10, 2019).

¹⁹ Ibid.

- Panama Canal
- Strait of Gibraltar
- Dover Strait
- Turkish Straits
- Suez Canal
- Strait of Bab al-Mandab
- Strait of Hormuz
- Strait of Malacca

The following **non-traditional trade chokepoints** are also relevant:²⁰

- Cape Horn
- Cape of Good Hope
- Danish Straits
- Northern Sea Route close to the Arctic
- East China Sea
- South China Sea

International trade chokepoints that could be relevant to India's agricultural trade are the Strait of Malacca, the South China Sea, the Strait of Hormuz, the Strait of Bab al-Mandab, the Suez Canal, the Turkish Straits, the Strait of Gibraltar, and the Cape of Good Hope (see Map 1). Diplomatic agreements with coastal states at narrow sea trade chokepoints could also secure agricultural deliveries and reduce shipment costs. Chabahar Port in Iran has become a crucial trade point for

²⁰ Bailey, R. & Wellesley, L. (2017): Chokepoints and vulnerabilities in global food trade, *Chatham House*. Available at: <https://www.chathamhouse.org/sites/default/files/publications/research/2017-06-27-chokepoints-vulnerabilities-global-food-trade-bailey-wellesley-final.pdf> (Accessed: July 10, 2019).

India, which is why India signed the *Chabahar Port Agreement* with Iran and Afghanistan to facilitate trade. The first phase of the cooperation project was commenced in late 2017.²¹

China will play a key role in international trade as it expands its area of influence through numerous global routes with the Belt and Road Initiative. India is already heavily reliant on China in terms of its plant fertilizer supply. As the world's second-largest consumer of phosphate fertilizers and the world's largest importer of diammonium phosphate (DAP) fertilizer, India obtains roughly half of its DAP from China. The Strait of Malacca between Malaysia and Indonesia is a critical sea route for India since 100% of its DAP supply is transferred on this path.²² Thus, fostering diplomatic ties and trade agreements with China are important methods with which India can sustain agricultural security in times of climatic strain.

Risk Mitigation Initiatives and Solutions

Slowing down climate change will reduce risks for India's agriculture. The Indian government has undertaken several steps to counter the effects of climate change and support its agricultural sector. In 2008, India's former Prime Minister Manmohan Singh released the *National Action Plan on Climate Change* (NAPCC) to respond to the challenges of climate change. The NAPCC is still in place today, yet the country is struggling to reach its goals. The NAPCC encompasses the following eight priorities, which the responsible ministries endeavor to implement:²³

- Solar energy
- Energy efficiency
- Sustainable habitat
- Water management

²¹ Farooq, K. O. (2019): Chabahar Port: A step toward connectivity for India and Afghanistan, *The Diplomat*. Available at: <https://thediplomat.com/2019/07/chabahar-port-a-step-toward-connectivity-for-india-and-afghanistan/> (Accessed: July 12, 2019).

²² Bailey, R. & Wellesley, L. (2017): Chokepoints and vulnerabilities in global food trade, *Chatham House*. Available at: <https://www.chathamhouse.org/sites/default/files/publications/research/2017-06-27-chokepoints-vulnerabilities-global-food-trade-bailey-wellesley-final.pdf> (Accessed: July 10, 2019).

²³ Government of India (2008): *National Action Plan on Climate Change*. Available at: <http://moef.gov.in/wp-content/uploads/2018/04/Pg0152.pdf> (Accessed: July 12, 2019).

- Protection of the Himalayan ecosystem
- Reforestation to support a "Green India"
- Sustainable agriculture
- Strategic knowledge for climate change

In order to mitigate climate-related risks for farmers, the Indian government introduced the *Weather-Based Crop Insurance Scheme* (WBCIS). The WBCIS provides farmers with insurance protection against unfavorable climate events such as heavy downpours, excess drought, extreme temperatures, or humidity.²⁴ Further security for farmers is reportedly guaranteed by the Food Corporation of India, which has set a minimum support price for paddy, wheat, and coarse grains each year since 2006.²⁵ This regulation buttresses the National Food Security Act of 2013, which aims to ensure the basic provision of food for India's people.²⁶

Farmers in India are also looking for practical solutions to protect their plantations against adverse climate events. Smaller-sized greenhouses with breathable aluminum-coated cloth constitute a comparatively low-cost solution to farmers, who cannot afford standard greenhouses of half an acre that start at a price of 30,000 USD. Smaller greenhouses of 250 to 550 square yards are available for a fraction of that price.²⁷ These small aluminum-equipped greenhouses reflect the sun and hence lower inside temperatures. Moreover, they protect crops against heavy rainfall. Although these greenhouses do not present a viable solution for expansive rice, wheat, or corn fields, they can be utilized for smaller vegetable farms.

Additional drip-irrigation systems used to water plants can save water and lower costs for farmers. Drip-irrigation systems slowly release smaller amounts of water into the soil from directly above or

²⁴ Government of India (2007): *Weather-Based Crop Insurance Scheme*. Available at:

<https://www.india.gov.in/weather-based-crop-insurance-scheme-wbcis?page=1> (Accessed: July 12, 2019).

²⁵ Food Corporation of India (2019): *Minimum support price of paddy, wheat and coarse grain*. Available at:

<http://fci.gov.in/procurements.php?view=89> (Accessed: July 12, 2019).

²⁶ Government of India (2013): *National Food Security Act, 2013*. Available at: <https://dfpd.gov.in/nfsa-act.htm> (Accessed: July 12, 2019).

²⁷ Cantieri, J. (2018): Innovative greenhouses help farmers adapt to climate change, *National Geographic*. Available at:

<https://www.nationalgeographic.com/environment/future-of-food/telangana-india-agriculture-greenhouses/> (Accessed: July 10, 2019).

below the ground through a network of pipes and valves. The advantage of a drip-irrigation system in comparison to a sprinkler irrigation or surface irrigation system is that it limits evaporation and uses water sparingly. This could prove useful when water becomes scarce in times of drought.

Initiatives by non-profit organizations such as Kheysi, which aims to provide farmers with smart greenhouses and drip-irrigation systems, can reduce agricultural deficiencies for local farmers and facilitate self-sufficiency.²⁸ The cooperation between non-profit organizations and banks to give farmers the opportunity to purchase greenhouses and other climate-smart farming equipment can decrease climate-related risks. A joint project by the Society for Elimination of Rural Poverty, the World Bank, and the Indian government has been initiated to support low-income farmers with loans and fund programs.²⁹ Finally, the key to sustaining local agriculture in India is a strong connection between farmers, banks, charitable organizations, supportive government regulations, and consumer markets.

Strategic Summary

Opportunities

- As climate change poses increasing risks to India's agricultural self-sufficiency, banks, non-profit organizations, and the government can aid farmers with smart solutions, supportive legal regulations, loans, and funding programs.
- Stakeholders may make a greater effort to create innovative financial, operational, strategic, and regulatory solutions for farmers, the stability of India's agricultural sector, and the food supply chain.

²⁸ Cantieri, J. (2018): Innovative greenhouses help farmers adapt to climate change, *National Geographic*. Available at: <https://www.nationalgeographic.com/environment/future-of-food/telangana-india-agriculture-greenhouses/> (Accessed: July 10, 2019).

²⁹ Ibid.

Risks

- India, alongside Pakistan, the Philippines, and Bangladesh, are projected to become the countries that are most vulnerable to climate change.
- Drought, heat waves, and variable rainfalls will become major stressors for India's agricultural production. As the country's agricultural self-sufficiency drops, food imports and product prices are expected to increase.
- Increasingly precarious conditions for farmers resulting from climate change will likely boost mass migration to the cities, creating challenges such as urban overpopulation.

Tactical Breakdown

Strategic

- As food imports are projected to increase in India, trade chokepoints such as the Strait of Malacca, the South China Sea, the Strait of Hormuz, the Strait of Bab al-Mandab, the Suez Canal, the Turkish Straits, the Strait of Gibraltar, and the Cape of Good Hope may become strategically important for India to guarantee food security.
- Particularly China and the Strait of Malacca are vital for India's procurement of fertilizer. Therefore, maintaining friendly diplomatic relations with China will be critical for India's agricultural sector.

Operational

- India is one of the world's largest producers of pulses, grains, rice, cotton, sugarcane, and groundnuts, yet aggravating climate conditions and resulting diseases may decrease labor productivity in the agricultural sector, impacting India's agricultural self-sustenance.
- The impact of climate change will also likely cause, riots, social unrest, hunger, and death.
- The government and non-profit organizations should aim to provide farmers with solutions such as smart greenhouses and irrigation systems. Furthermore, banks should cooperate in this supportive effort and grant loan and fund programs for farmers.

Financial

- The impact of climate change will significantly lower India's agricultural net exports and purchasing power. Simultaneously, agricultural imports and consumer prices are projected to rise. Employment in the agricultural sector may also decrease as farmers abandon rural areas and move to urban areas, hoping for better employment opportunities there.
- Despite climate-related risks India's GDP will continue to grow, reaching an estimated 7.7% in 2024.
- Global food prices are projected to remain largely unaffected by climate change.

Compliance

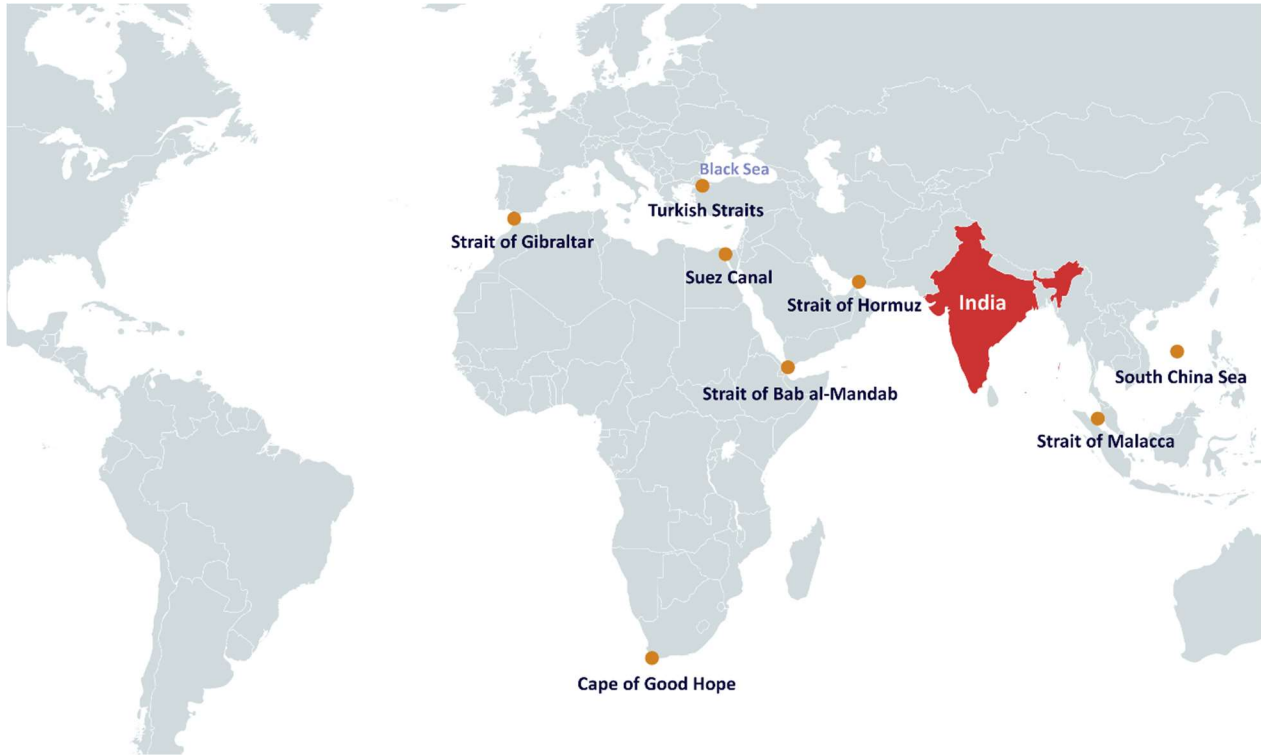
- In order to create a stable level of food security and supply, the UN seeks to strengthen global agricultural free trade policies. This will facilitate a transfer of food from regions with an agricultural surplus to regions with deficits.
- India has implemented several policies to mitigate risks of climate change and support its people, including the NAPCC, the National Food Security Act of 2013, and a minimum support price for crucial grains.
- The government and international organizations must seek to actively implement food security and supply regulations as agricultural risks associated with climate change become an increasingly pressing issue.

Conclusion

Climate change is a central stressor for India's agriculture and will increasingly affect India's harvest production, agricultural yield, and food security. Adverse effects on agricultural food stock are likely to result in reduced employment in farming, hunger, social unrest, migration into cities, and a population strain on urban areas. Another associated challenge that India must meet is its reduced agricultural self-sufficiency as climate change aggravates. Agricultural trade is projected to become an increasingly important factor for India's food availability, access, and security. International cooperation strategies to secure the supply chain of agricultural deliveries, including fertilizers, will also be essential in this context.

As a country that is highly vulnerable to climatic shifts, India must pursue climate-smart farming and reduce greenhouse gas emissions. As India's population and financial wealth grow, however, so will energy demands. The issue with this situation is that the country largely depends on coal as primary energy supplier, producing an enormous amount of greenhouse gases and perpetuating the agricultural crisis. While environmentally-friendly energy initiatives have gained much attention in India, and coal-based power production in India is likely to fall within the next decades, renewable energy sources are not expected to take center stage in the country's energy mix in the near future. Therefore, India must look for various solutions to adapt its farming and food supply strategies to anticipated agricultural challenges.

Maps



Map 1: Potential chokepoints for India's agricultural trade.



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