

Comparative Study On Food Security and Climate Change Related Food and Water Vulnerability in India and Thailand

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Abstract- Global food security is a major challenge of the twenty-first century, particularly amid climate change, climatic variability, population pressure and increasing competition for natural resources. Food insecurity is multidimensional, requiring improvements in food availability, economic access, utilisation and stability, especially among vulnerable populations. Although India and Thailand are important agricultural economies in Asia, comparative evidence on their food security and climate-related vulnerabilities remains limited. Against this background, this study compares food security and climate change-related food and water vulnerability in India and Thailand. The study is descriptive and based on secondary data from the Global Food Security Index (GFSI) published by the Economist Intelligence Unit/Economist Impact and the Food Vulnerability and Water Vulnerability indicators of the Notre Dame Global Adaptation Initiative (ND-GAIN). GFSI data for 2012–2022 and ND-GAIN data for 2001–2024 are analysed using mean, standard deviation, coefficient of variation and annual growth rate. The findings show that Thailand maintained a comparatively stronger food-security position than India, recording a higher average GFSI score. India also exhibited substantially higher average Food Vulnerability (0.604) than Thailand (0.451). However, mean Water Vulnerability was slightly higher in Thailand (0.524) than India (0.516), while India's score showed a gradual long-term decline. Overall, Thailand demonstrates stronger food security and lower food-sector vulnerability, whereas India shows improvement in water vulnerability. The findings emphasise climate-resilient agriculture, sustainable water management, improved food access and institutional adaptation, with relevant policy lessons from Thailand for India.

Keywords- Food Security, GFSI, Food Vulnerability Index, Water Vulnerability Index

I. Introduction

Food security is one of the major development challenges facing developing countries today. The problem has become more complex because of climate change, environmental degradation, population growth and increasing competition for land and water resources. Food security is generally understood as a situation in which people have reliable physical and economic access to sufficient, safe and nutritious food that meets their dietary requirements and enables them to lead healthy and active lives.

Although many developing countries have made considerable progress in agricultural production and poverty reduction, food insecurity and malnutrition remain important concerns. Climate change has added another layer of uncertainty to the food-security situation. Changes in temperature and rainfall can influence agricultural productivity, food prices, household incomes and the stability of food systems. Extreme weather

events such as droughts, floods, cyclones and heat waves can further increase these risks.

The connection between food security and water availability is particularly important because agriculture depends heavily on water. Changes in rainfall patterns, prolonged dry periods and rising temperatures can reduce crop yields and affect livestock and fisheries. At the same time, water scarcity can restrict irrigation and create difficulties for households whose livelihoods depend on agriculture. These changes can therefore affect all four major dimensions of food security: availability, access, utilisation and stability. However, the extent to which countries experience these effects depends on their geographical conditions, agricultural practices, socioeconomic circumstances, infrastructure and capacity to respond to climatic shocks.

India provides an important case for examining these issues. The country has a large population, and agriculture and allied activities continue to support the livelihoods of a substantial section of the rural population. Indian agriculture is exposed to a range of climatic risks, including irregular monsoon rainfall, drought, flooding, heat stress and changing temperature patterns. Water stress has also become a concern in several parts of the country because of groundwater depletion, changing rainfall patterns and competing demands from agriculture, industry and households. These pressures can directly influence agricultural production and the ability of vulnerable households to obtain adequate and nutritious food.

Thailand provides a useful comparison because agriculture also remains important to its economy and rural population, while the country is exposed to floods, droughts and variations in rainfall and temperature. Its dependence on agriculture and water resources makes the food system sensitive to climatic conditions. At the same time, differences in irrigation facilities, agricultural practices, disaster-management systems, infrastructure and institutional responses may influence the country's ability to deal with climate-related risks. Comparing India and Thailand can therefore provide a better understanding of how two Asian agricultural economies respond to similar challenges under different demographic and institutional conditions.

The comparison is particularly relevant because the two countries differ substantially in population size, resource availability, climatic exposure and agricultural structure. India faces considerable pressure from its large population and uneven distribution of water resources. Thailand, despite having a much smaller population, remains exposed to floods, droughts and climatic variability affecting agricultural production. These differences provide a useful basis for examining food security alongside vulnerability to climate-related food and water risks.

A considerable amount of research has examined food security, climate change, agricultural vulnerability and water stress. However, much of this work focuses on individual countries or on particular aspects of the problem. Comparatively fewer studies bring food security, food vulnerability and water vulnerability together within a common framework for India and Thailand. Such a comparison is important because food security cannot be judged only by the quantity of food produced. People's access to food, the stability of food systems, water availability and the capacity to cope with climatic shocks also matter.

The present study therefore attempts to examine these dimensions together. It compares the food-security performance of India and Thailand, assesses their food and water vulnerability in relation to climate-related risks and identifies the broad differences in their performance over the study period. The study also seeks to draw policy lessons that may contribute to climate-resilient agriculture, sustainable water management and improved food security.

II. Methods and Materials

The present study adopts a descriptive and comparative research design based on secondary data. Data on food security were obtained from the Global Food Security Index (GFSI) published by the Economist Intelligence Unit (EIU) for the period from 2012 to 2022. Data on climate change-related food vulnerability and water vulnerability were obtained from the ND-GAIN Country Index, published by the University of Notre Dame, for the period from 2001 to 2024. The study focuses on the comparative assessment of India and Thailand in terms of their food-security performance and vulnerability to climate-related risks affecting food and water resources. The collected data were systematically compiled and analysed using descriptive statistical measures, particularly the mean and standard deviation (SD), to assess the level, variation and relative stability of food security, food vulnerability and water vulnerability in the two countries. The comparative analysis helps identify differences in the overall status and variability of these indicators between India and Thailand and provides insights into their relative exposure to climate-related food and water risks.

III. Results and Discussion

(i) Food Security in India and Thailand

Over the years, measuring and assessing food security has proved to be a challenging and complicated task as it demands combination of indicators to capture its multi-faceted nature. Food security is generally broken down into four different components –availability, accessibility, utilization and safety. In order to know the existing status of food security in India and Thailand, the Global Food Security Index (GFSI) of the two countries are presented in the table1.

Table 1
Global Food Security Index of India and Thailand

Year	Global Food Security Index (Overall Score)	
	India	Thailand
2012	52	58
2013	51	59
2014	50	59
2015	52	59
2016	52	59
2017	51	58
2018	50	59
2019	59	65
2020	60	64

2021	57	65
2022	59	60
Mean	53.66	60.43
SD	3.54	2.71
CV	6.55	4.48

Source: Global Food Security Index (GFSI) Reports 2022

From table 1, it is noted that Thailand consistently recorded a higher level of food security than India throughout the study period. India's GFSI score remained relatively low during 2012–2018, fluctuating between 50.0 and 52.0, whereas Thailand's score remained within a relatively narrow range of 58.0 to 59.0. A noticeable improvement in India's food-security performance occurred in 2019, when its overall GFSI score increased to 58.9 from 50.0 in 2018. However, the score declined to 56.2 in 2020 before improving marginally to 57.2 in 2021 and 58.9 in 2022. Thailand also recorded relatively strong performance, increasing from 59.0 in 2018 to 65.1 in 2019, followed by a decline to 64.0 in 2020 and a marginal increase to 64.5 in 2021 before falling to 60.1 in 2022. The 2022 GFSI data confirm that India recorded an overall score of 58.9, while Thailand achieved 60.1, indicating a continued advantage for Thailand, although the gap between the two countries narrowed considerably compared with the earlier years.

The descriptive statistics further highlight differences in the level and stability of food security between the two countries. During 2012–2022, Thailand recorded a higher mean GFSI score of 60.43 compared with 53.56 for India, indicating a comparatively stronger overall food-security position. The standard deviation was 2.71 for Thailand and 3.51 for India, suggesting that India's GFSI scores experienced greater variation over the study period. The coefficient of variation was 4.48 per cent for Thailand compared with 6.55 per cent for India, indicating that Thailand's food-security performance was relatively more stable, while India's performance showed comparatively greater fluctuations. Overall, the findings suggest that Thailand maintained a relatively stronger and more stable food-security position than India during 2012–2022, although India's performance showed considerable improvement after 2018.

(ii) Climate Change related Food Vulnerability and Water Vulnerability in India and Thailand

The frequency and intensity of climate-related extreme events, such as floods and droughts, have increased in many regions in recent decades, posing significant challenges to agricultural production, water resources and food security (Molua, 2002). In this context, vulnerability analysis has emerged as an important analytical approach for understanding the potential impacts of climate change on food security and associated livelihood systems. The concept of vulnerability was initially developed in the context of poverty and livelihood analysis (Holzmann and Jorgensen, 2000) and has subsequently been applied more broadly to food insecurity, health, infrastructure, habitat, ecosystems and water resources (Lovendal, Knowles and Horii, 2005).

In the context of food security, vulnerability is generally understood in relation to the likelihood of experiencing adverse outcomes such as food insecurity, hunger or famine as a consequence of exposure to climatic, environmental and socioeconomic stresses. Climate change can influence food security through multiple pathways, including changes in crop productivity, fluctuations in food availability and prices, deterioration of agricultural resources and increasing pressure on water resources. Food vulnerability and water vulnerability are therefore closely interconnected with the overall resilience of food systems.

The Notre Dame Global Adaptation Initiative (ND-GAIN) provides sector-specific vulnerability indicators that capture countries' exposure and sensitivity to climate-related risks and their capacity to adapt to such risks. In this study, the Food Vulnerability and Water Vulnerability scores of India and Thailand obtained from the ND-GAIN Country Index are used to assess and compare their relative vulnerability to climate-related risks. The corresponding trends and descriptive statistics for Food Vulnerability and Water Vulnerability in India and Thailand are presented in Tables 2 and 3, respectively.

Table 2
Food Vulnerability in India and Thailand

Year	Food Vulnerability Index (Score)			
	India	Annual Growth Rate (in %)	Thailand	Annual Growth Rate (in %)
2001	0.6745	--	0.5458	--
2002	0.6755	0.15	0.5387	-1.30
2003	0.6769	0.21	0.5317	-1.30
2004	0.6789	0.30	0.5285	-0.60
2005	0.6814	0.37	0.5260	-0.47
2006	0.6831	0.25	0.5241	-0.36
2007	0.6781	-0.73	0.5206	-0.67
2008	0.6742	-0.58	0.5193	-0.25
2009	0.6679	-0.93	0.5218	0.48
2010	0.6628	-0.76	0.5232	0.27
2011	0.6566	-0.94	0.5295	1.20
2012	0.6501	-0.99	0.5329	0.64
2013	0.6449	-0.80	0.5432	1.93
2014	0.6403	-0.71	0.5267	-3.04
2015	0.6774	5.79	0.5233	-0.65
2016	0.6767	-0.10	0.5198	-0.67
2017	0.6759	-0.12	0.5185	-0.25
2018	0.5934	-0.21	0.4451	-1.23
2019	0.5973	0.66	0.4518	1.51
2020	0.6050	1.28	0.4548	0.66
2021	0.6032	-0.29	0.4519	-0.62
2022	0.6017	-0.26	0.4487	-0.73

2023	0.6012	-0.09	0.4488	0.03
2024	0.6016	0.07	0.4459	-0.64
Mean	0.6037	—	0.4514	—
SD	0.0114	—	0.0091	—
CV	1.90	—	2.02	—

Source: ND Global Adaptation Initiative (GAIN) Index Report-2026 AGR calculated by the Author

Table 2 shows that India consistently recorded a higher food vulnerability score than Thailand throughout the study period, suggesting that India was relatively more vulnerable to climate-related risks affecting the food sector. India's food vulnerability score increased marginally from 0.6153 in 2001 to 0.6179 in 2003 and subsequently declined to 0.5800 in 2014. A sharp increase was observed in 2015, when the score rose to 0.6216, followed by a gradual decline to 0.5947 in 2017. During the recent period, India's score increased from 0.5934 in 2018 to 0.6050 in 2020 and then declined marginally to 0.6012 in 2023 before increasing slightly to 0.6016 in 2024. Since a lower score indicates lower vulnerability, the long-term decline in India's score indicates an overall improvement in its food-sector resilience, although considerable year-to-year fluctuations were observed.

Thailand recorded a comparatively lower food vulnerability score, declining from 0.4802 in 2001 to 0.4410 in 2007. The score fluctuated thereafter, reaching 0.4636 in 2013 before declining again. During 2018–2024, Thailand's score remained relatively stable, moving from 0.4451 in 2018 to 0.4548 in 2020 and subsequently declining to 0.4459 in 2024. The mean food vulnerability score was 0.6037 for India compared with 0.4514 for Thailand. The standard deviation was 0.0114 for India and 0.0091 for Thailand, while the coefficient of variation was 1.90 per cent and 2.02 per cent, respectively. Thus, India had a substantially higher average level of food vulnerability, whereas Thailand maintained a comparatively lower level. However, the relatively low CVs indicate that food vulnerability scores were comparatively stable in both countries over the study period.

Table 3
Water Vulnerability in India and Thailand

Year	Water Vulnerability Index (Score)			
	India	Annual Growth Rate (in %)	Thailand	Annual Growth Rate (in %)
2001	0.4855	--	0.3864	--
2002	0.4837	-0.37	0.3853	-0.28
2003	0.4822	-0.31	0.3845	-0.21
2004	0.4806	-0.33	0.3835	-0.26
2005	0.4791	-0.31	0.3824	-0.29
2006	0.4775	-0.33	0.3816	-0.21
2007	0.4761	-0.29	0.3806	-0.26
2008	0.4745	-0.34	0.3799	-0.18
2009	0.4728	-0.36	0.3792	-0.18

2010	0.4714	-0.30	0.3786	-0.16
2011	0.4694	-0.42	0.3777	-0.24
2012	0.4675	-0.40	0.3771	-0.16
2013	0.4656	-0.41	0.3763	-0.21
2014	0.4636	-0.43	0.3757	-0.16
2015	0.4636	0.00	0.3757	0.00
2016	0.4636	0.00	0.3757	0.00
2017	0.4636	0.00	0.3757	0.00
2018	0.5021	-0.54	0.5260	0.03
2019	0.4993	-0.55	0.5261	0.02
2020	0.4966	-0.56	0.5262	0.02
2021	0.4937	-0.57	0.5263	0.01
2022	0.4909	-0.57	0.5263	0.00
2023	0.4881	-0.57	0.5262	-0.00
2024	0.4852	-0.59	0.5262	0.00
Mean	0.5164	—	0.5240	—
SD	0.0185	—	0.0022	—
CV	3.58	—	0.42	—

Source: ND Global Adaptation Initiative (GAIN) Index Report-2026, AGR calculated by the Author

From the Table 3, it is noticed that a clear contrasting trend is observed between the two countries. India's water vulnerability score declined consistently from 0.5445 in 2001 to 0.4852 in 2024. The decline was particularly consistent after 2004, with the score decreasing from 0.5373 in 2004 to 0.4852 in 2024. Since a lower ND-GAIN vulnerability score indicates lower vulnerability, this continuous decline suggests an improvement in India's relative resilience to climate-related water risks over the study period.

In contrast, Thailand's water vulnerability score increased gradually from 0.5195 in 2001 to 0.5262 in 2024. The annual growth rates were generally positive, although the magnitude of increase was very small. This indicates a gradual increase in Thailand's vulnerability to climate-related water risks. The contrasting trends are particularly important because India started with a higher water vulnerability score than Thailand in 2001, but by 2024 India recorded a lower score than Thailand. The mean water vulnerability score was 0.5164 for India and 0.5240 for Thailand. India's standard deviation of 0.0185 and coefficient of variation of 3.58 per cent were considerably higher than Thailand's corresponding values of 0.0022 and 0.42 per cent. Thus, India's water vulnerability showed a stronger long-term improvement but greater variation, whereas Thailand's water vulnerability remained highly stable but exhibited a gradual deterioration over the study period.

The average GFSI of Food Security and Climate Change related food vulnerability index and water Vulnerability index in India and Thailand are shown in the figure 1.

Figure-1
 Average Food Security and Climate Change related Food and Water Vulnerability
 in India and Thailand Between 2001 and 2024

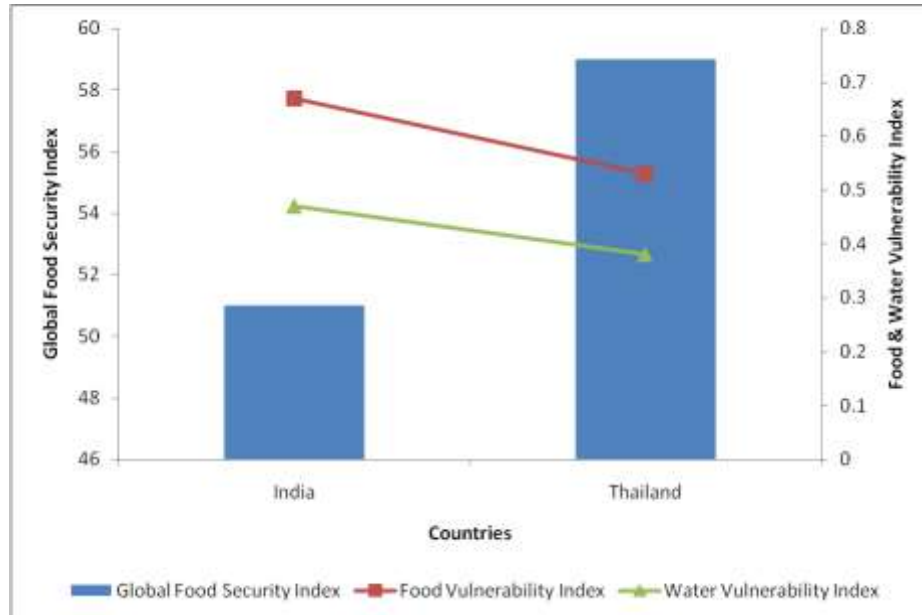


Figure 1 shows that India recorded a comparatively lower average Global Food Security Index than Thailand during the study period. This relatively weaker food-security position is associated with India's higher average Food Vulnerability Index and Water Vulnerability Index compared with Thailand. The findings indicate that India faces greater vulnerability in the food sector, while its water vulnerability is slightly lower than that of Thailand.

Major Findings

- Thailand maintained a higher and relatively more stable level of food security than India. The average GFSI score was 60.43 for Thailand compared with 53.66 for India.
- India recorded considerably higher food vulnerability than Thailand. The average Food Vulnerability scores were 0.6037 for India and 0.4514 for Thailand.
- India's food-security performance improved noticeably after 2018, resulting in a narrowing of the gap between the two countries towards the end of the study period.
- Thailand's food vulnerability remained comparatively low and stable, indicating a stronger position in dealing with climate-related pressures affecting its food system.
- India's average water vulnerability score of 0.5164 was slightly lower than Thailand's score of 0.5240.
- India showed a favourable long-term decline in water vulnerability, indicating improvement in its relative resilience to climate-related water risks.
- Thailand's water vulnerability remained highly stable but increased slightly during the later part of the study period.

- India showed greater variation in water vulnerability, while Thailand's water-vulnerability score was comparatively stable.

Policy Suggestions

- Promote Climate-Smart Agriculture: India and Thailand should strengthen climate-resilient crops, crop diversification, micro-irrigation, weather advisories and climate-smart farming technologies.
- Strengthen Sustainable Water Management: Promote rainwater harvesting, groundwater conservation, efficient irrigation, watershed development and climate-resilient water infrastructure to address drought and flood risks.
- Enhance Food-Security and Climate Cooperation: Strengthen social protection, agricultural insurance, food-storage systems and climate early-warning mechanisms, while sharing successful policies and technologies between India and Thailand.

IV. Conclusion

With the increasing influence of emerging economies in reshaping the global economic order, India and Thailand play important roles in addressing food security, climate change and sustainable resource management in Asia. Both countries have significant agricultural sectors and large rural populations whose livelihoods are closely linked to agriculture and water resources. However, climate change, rainfall variability, droughts, floods, rising temperatures and increasing pressure on water resources pose growing challenges to their food systems. The findings of the present study indicate that Thailand has maintained a comparatively stronger and more stable food-security position, while India continues to face greater food-sector vulnerability. At the same time, India's water vulnerability has shown a favourable long-term improvement, whereas Thailand faces emerging water-related risks.

Therefore, India and Thailand should strengthen bilateral cooperation and share knowledge, technologies and best practices in climate-smart agriculture, sustainable water management, crop diversification, climate-resilient varieties, early-warning systems and agricultural insurance. Learning from each other's successful policy interventions can help both countries strengthen the resilience of their food systems. Such cooperation would contribute to reducing climate-related vulnerability, improving agricultural sustainability and ensuring long-term food and water security in India and Thailand.

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