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9-10 December 2025, Geneva

The Impact of Global Change on Food Security in 2050: Assessing the Risks Through the Lens of Food Trade

By

PROF KENNETH STRZEPEK, MIT Jameel Water & Food Systems Lab and Center for Sustainability Science and Strategy

The views expressed are those of the author and do not necessarily reflect the views of UNCTAD.

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Recent developments, challenges, and opportunities in agriculture commodity markets

UNCTAD Multi-year Expert Meeting on Commodities and Development, sixteenth session

9 –December 2025, Palais des Nations, Geneva

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Food and Climate Systems Transformation Alliance

INTERNATIONAL FOOD POLICY RESEARCH INSTITUTE

IFPRI

The Jameel Index Development Team

MIT 10 J-WAFS
Celebrating 10 years of impact

Gregory Sixt, Kenneth Strzepek, Chris Maynard, Maurico Darcourt, Jensen Fiskin, Janusz Strzepek, Carolyn Pinter, Nicholas Pasinella, Renee Robins, Rohit Karnak

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Keith Wiebe, Tim Thomas, Tim Sulser, Faaiqa Hartley, Sherwin Gabriel, Dirk Willenbockel, Rehab Osman, Mark Rosegrant

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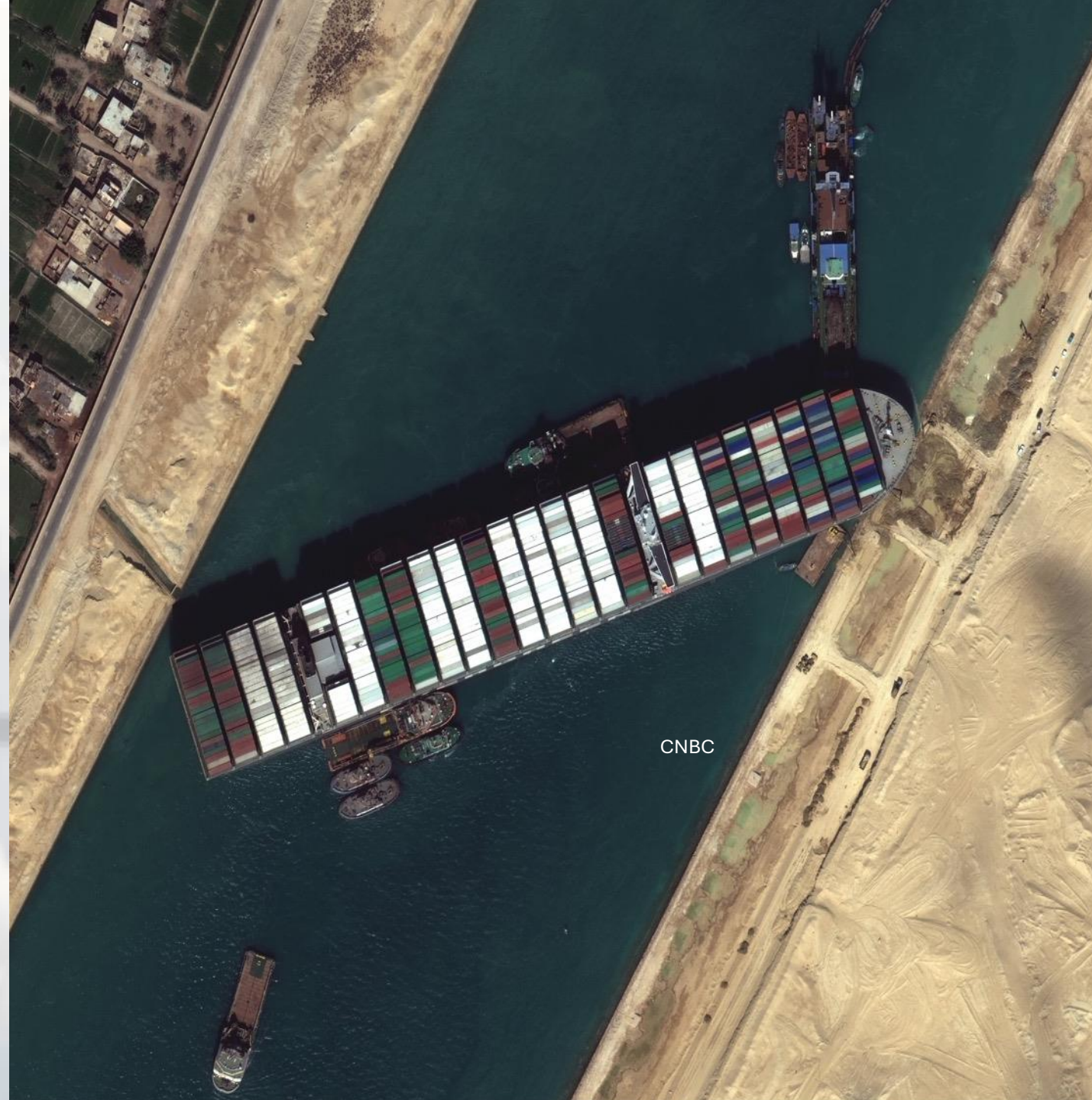
Nathaniel Daudrich, Tim Spiridonov, Nader Diab, Hala El Masri

Food Trade Vulnerability

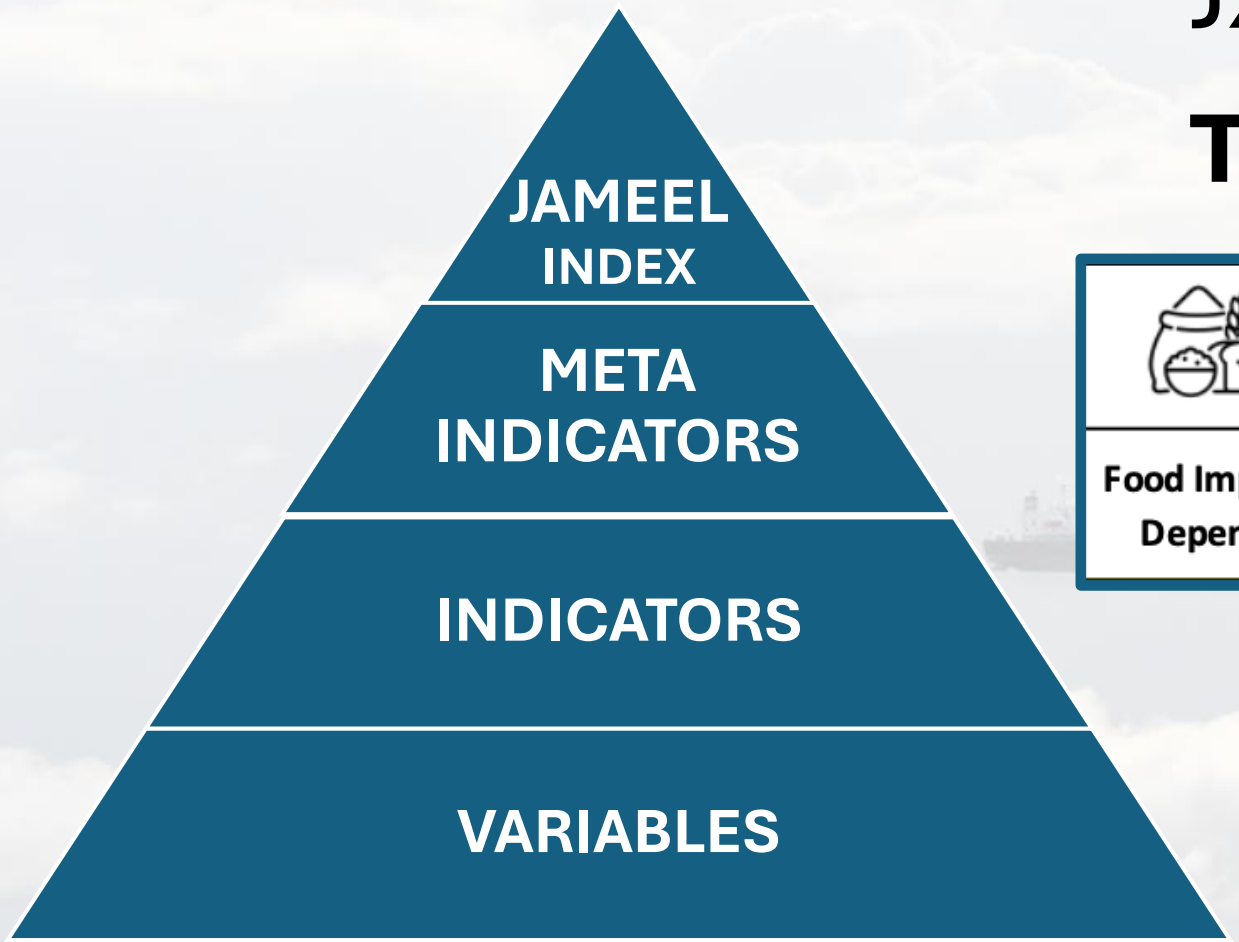
- Food trade can improve food security
- The interconnected food trade system can also transmit shocks from trade disruptions, war, climate, etc. to food security
- Climate change poses a threat to the interconnected food trade system
- There is no comprehensive metric that links food trade and food security and the vulnerability to future global shocks



The Framework

Very Low	Low	Medium	High	Extreme

$$Jx = \left\{ \prod_m (MWm * VULm) \right\}^{(1/m)}$$



The Meta Indicators

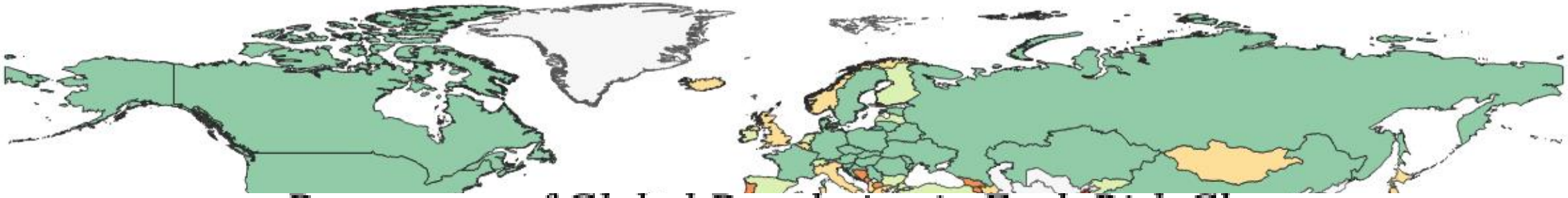
Food Import Depend	Feed Import Depnd	Foreign Exch	Supply Chain Reliab	Supply Chain Robust

FAOSTAT – Food Balance Sheet; Trade Matrix
COMSTAT – Trade Matrix
HARVARD - The Atlas of Economic Complexity

The Jameel Index Methods

Jameelindex.mit.edu

Global Risk of Food Trade Vulnerability

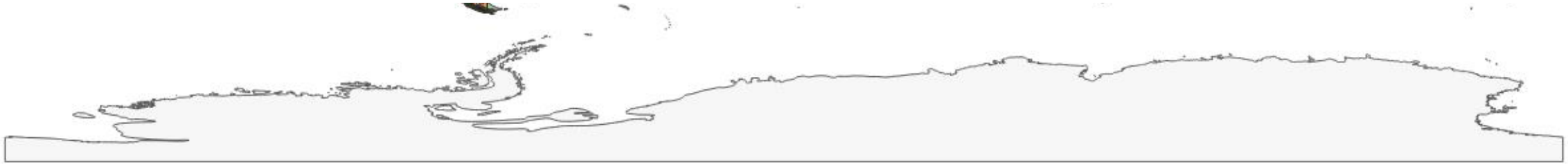


Percentage of Global Population in Each Risk Class

Very Low	Low	Medium	High	Extreme	kcal	GDP Per Capita
72.2%	11.7%	7.3%	8.1%	0.7%	2979	11,557

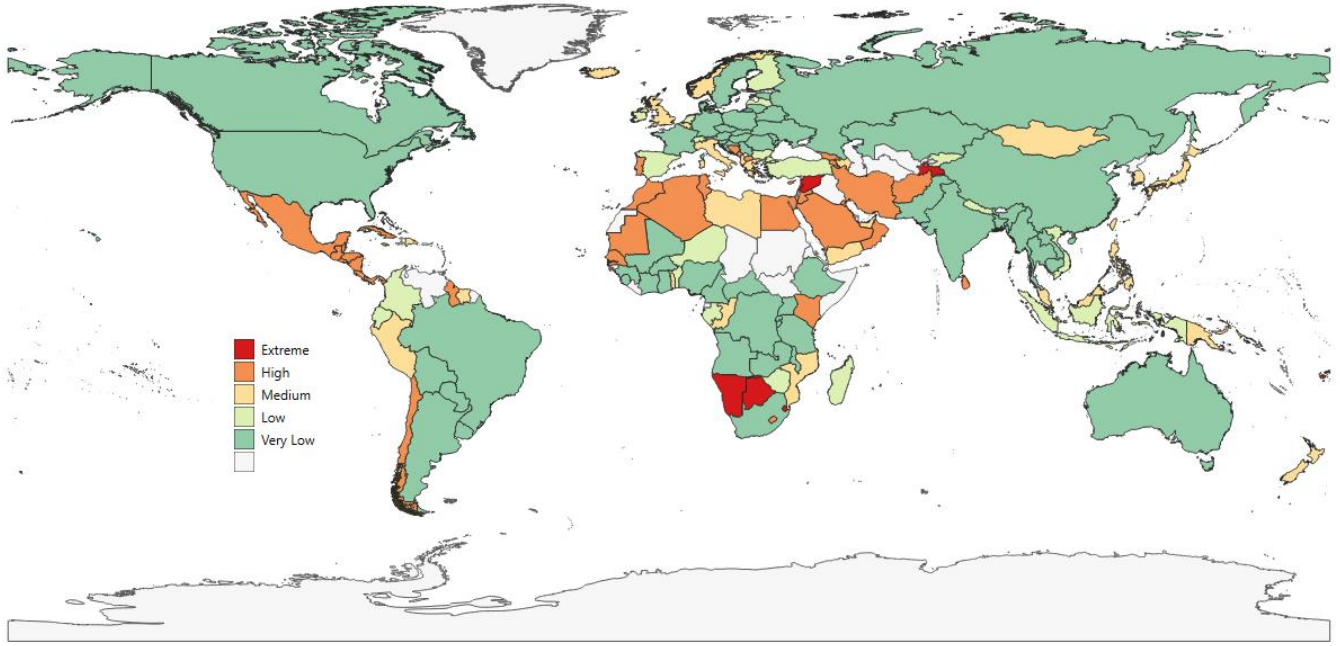
Percentage of Global Countries in Each Risk Class

Very Low	Low	Medium	High	Extreme	kcal	GDP Per Capita
35.0%	16.0%	14.1%	30.7%	4.3%	2979	11,557

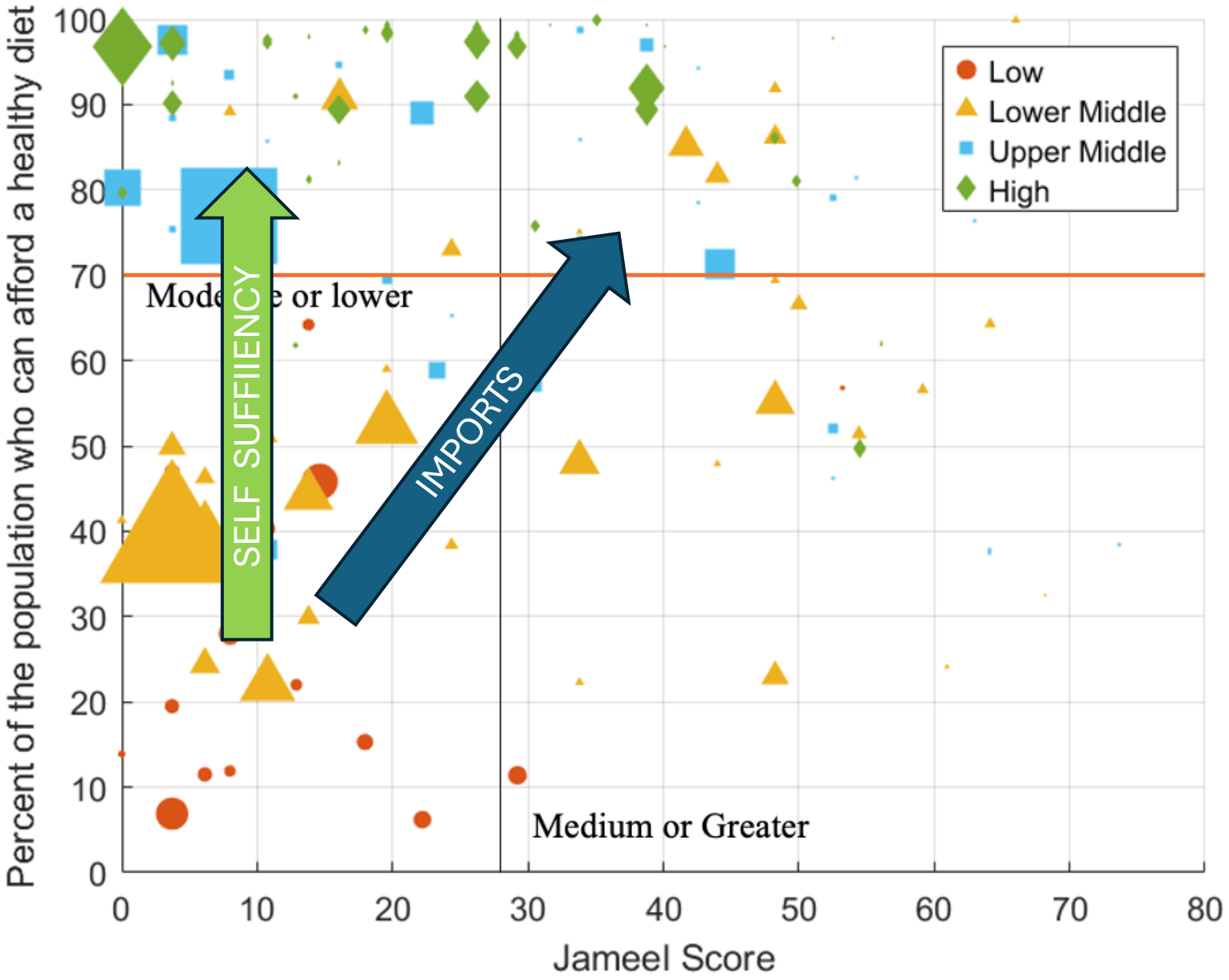


Jameel Index by UN Regions (2019)

UN Region	% of Countries by Jameel Index Classification					% Global Pop.	Avail. kcal	GDP Per Capita (US$)
	Very Low	Low	Medium	High	Extreme			
Africa	37.8	17.8	6.7	31.1	6.7	19	2,610	2,045
Asia	30.8	12.8	23.1	28.2	5.1	59	2,916	7,125
Europe	51.3	20.5	12.8	15.4	0.0	9	3,414	29,109
Latin Am. & Carib.	16.7	13.3	13.3	53.3	3.3	8	3,116	8,729
Northern America	100.0	0.0	0.0	0.0	0.0	5	3,872	63,575
Oceania	12.5	12.5	25.0	37.5	12.5	1	3,107	39,122



The Role of Food Trade in Food Security



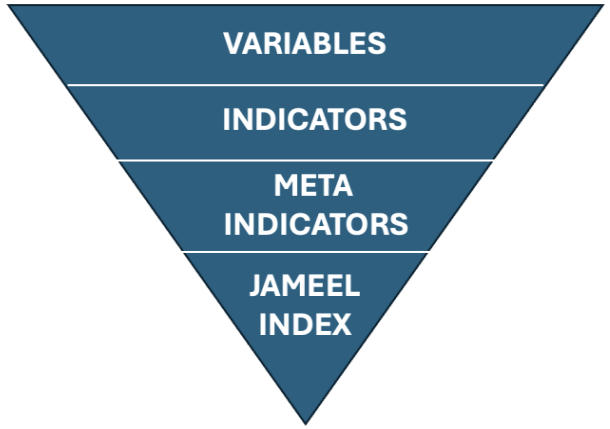
FINDING 1 - NO EASY PATH FORWARD

- **NO EASY PATH TO FOOD SECURITY for LOW and LOWER MIDDLE-INCOME NATIONS**
  - Self-sufficiency or imports ?
- **WHICH PATH IS SUSTAINABLE and at WHAT COST?**
- **SELF-SUFFICIENCY MEANS CLOSING YIELD GAP**
  - Increased inputs
  - Env impacts
- **IMPORTING FOOD NEEDS MEAN GENERATING EXPORTS**
  - Need energy
  - Need human capital
  - Need investments

LOOKING BACKWARD

Historic Global Production and Trade Data

FAOSTAT – Food Balance Sheet; Trade Matrix
COMSTAT – Trade Matrix
HARVARD - Atlas of Economic Complexity



2014 -2023 JAMEEL INDEX

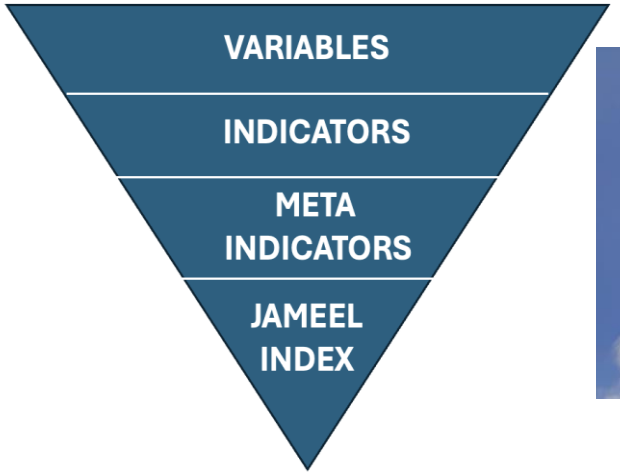
LOOKING FORWARD

FUTURE GLOBAL CHANGE SCENARIOS

*A set of **development pathways** (SSPs) and **atmospheric concentration pathways** (RCPs) with their associated **Climate Change** outcomes*

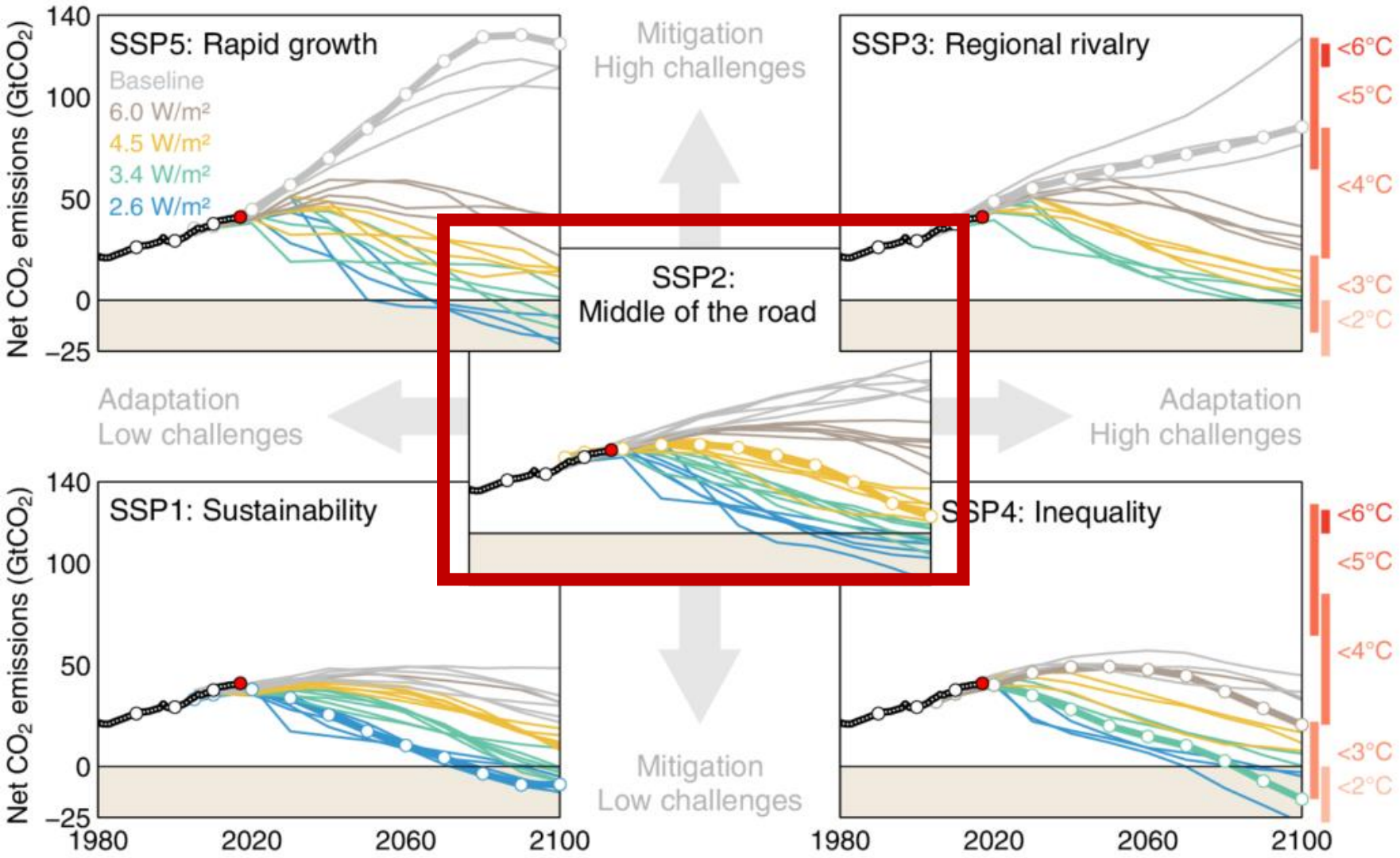
LINKED GLOBAL MODELS

Climate Change Water & Crop Model
Global Macro CGE Economic Model
Global Ag Sector & Trade Model
Global Bi-Lateral Ag Trade Mode



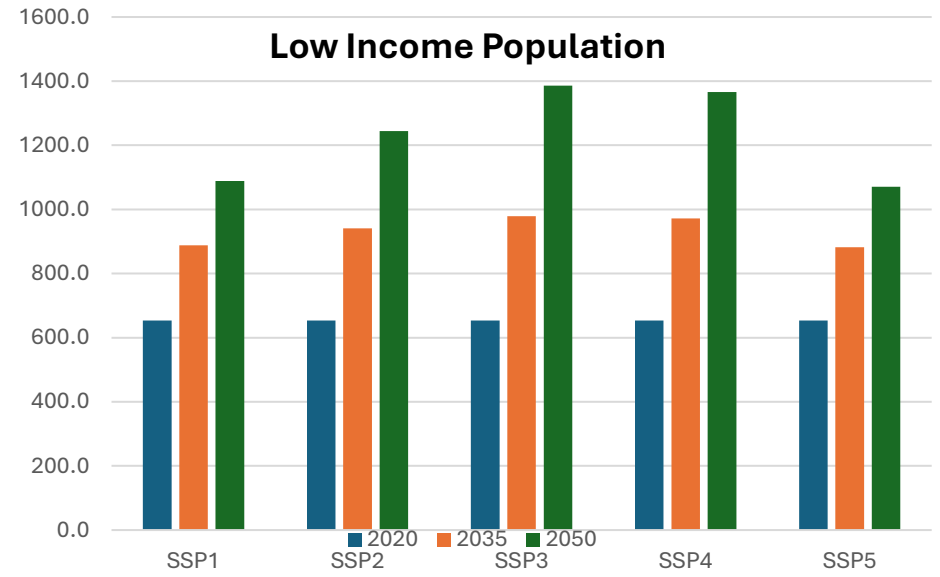
2035 & 2050 JAMEEL INDEX

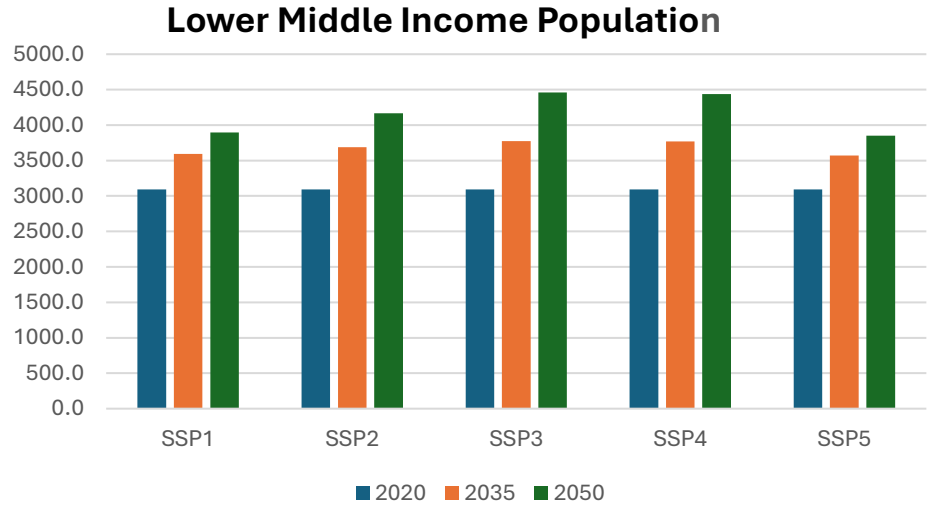
SSP DEVELOPMENT SCENARIOS



Global Carbon Project

SSP 2 POPULATION PROJECTIONS





Upper Middle and High Income Have No significant Population Increase

An Overview of the Global & Climate Change Analysis

Class Changes	Percent of Countries Changing Jx Ranking 2020-2050 (SSP2)	
	Global Change	CC Only
-2	1%	
-1	6%	
0	64%	
1	22%	
2	5%	
3	2%	

Change in Jx vulnerability class under broad global change 2020-2050 under SSP2

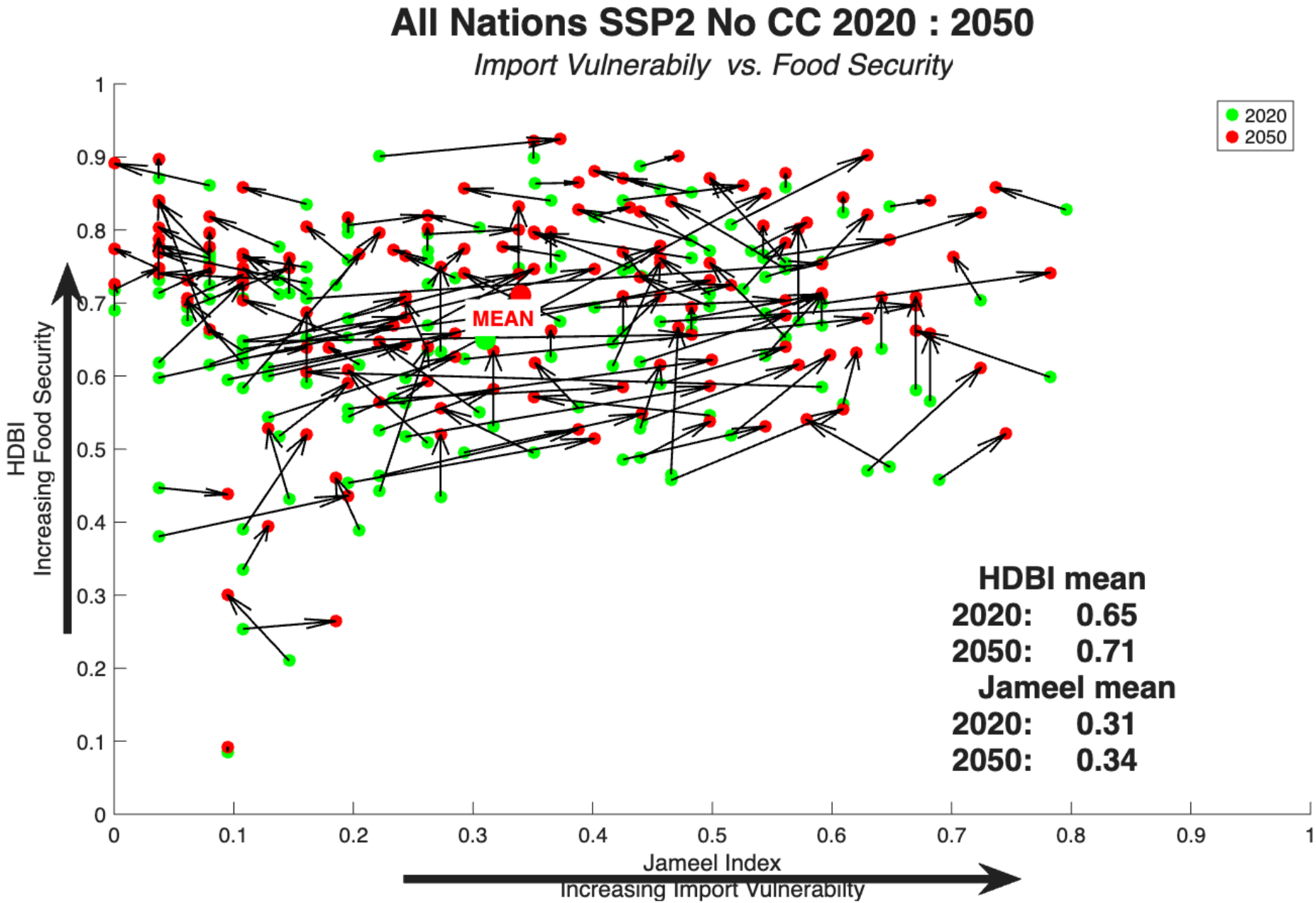
GLOBAL CHANGE SSP2 2050

$$HDBI = 1 - \frac{1}{6}\sum_{i=1}^{6}\left|\frac{q_i - Q_i}{Q_i}\right| \forall\, q_i < Q_i \qquad (1)$$

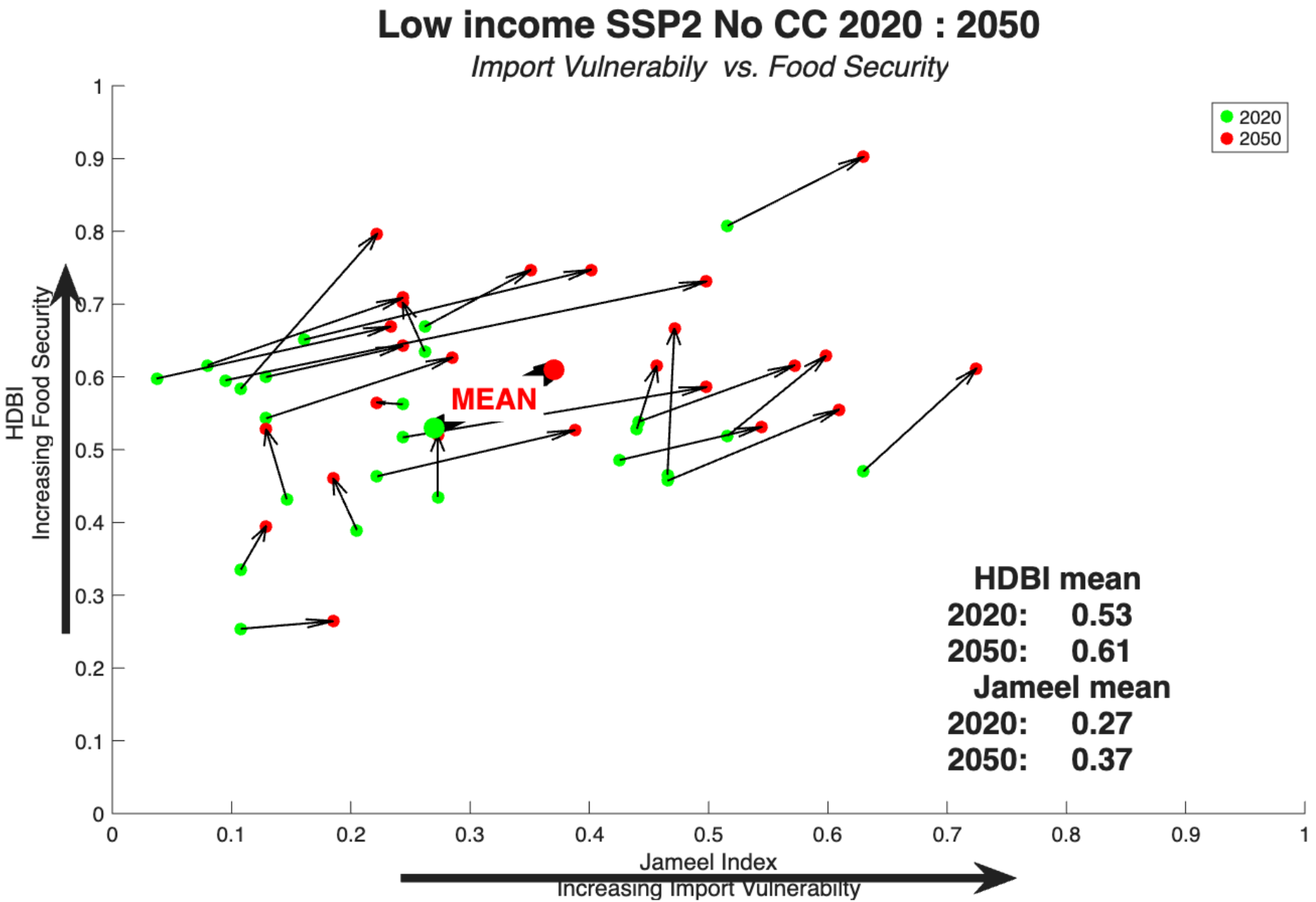
Table 1
Healthy Diet Basket (HDB) amounts per capita.

Food Group	Target intake (kcal/day)
Starchy staples	1160
Fruits	160
Vegetables	110
Animal-source foods	300
Legumes, nuts, and seeds	300
Oils and fats	300
Total	2330

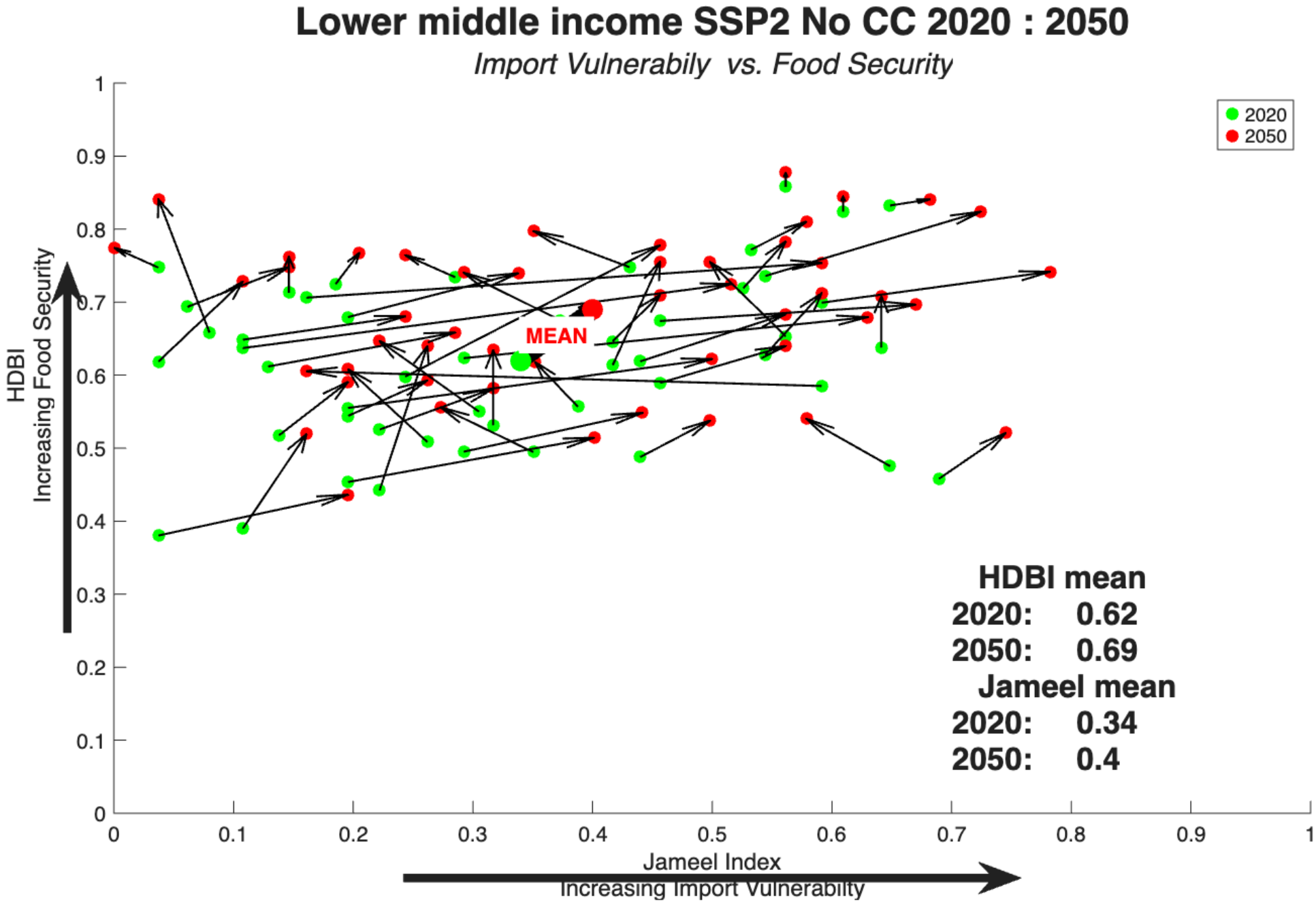
Source: Herforth et al., 2022.



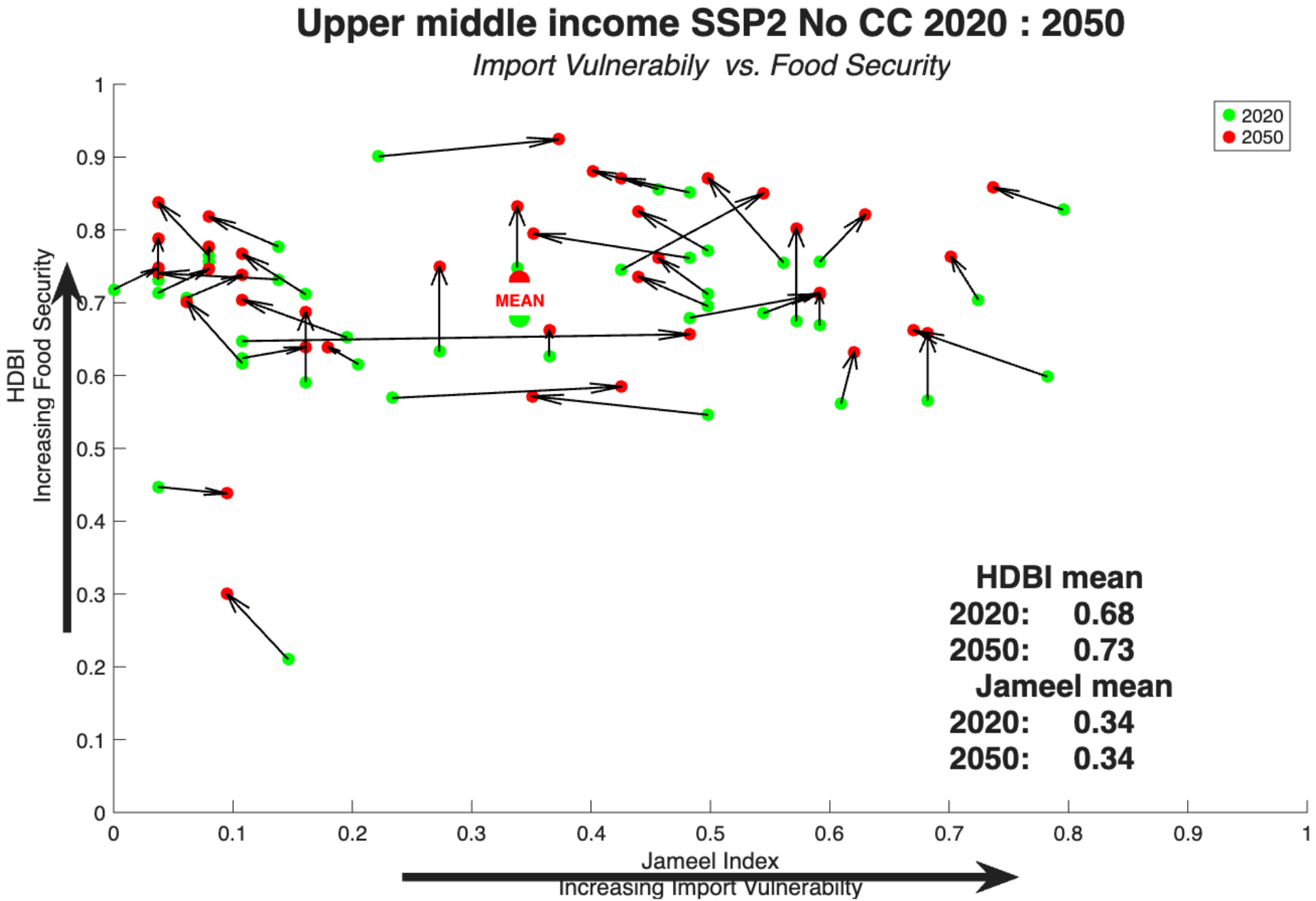
Low Income


Low income SSP2 No CC 2020 : 2050
Import Vulnerabily vs. Food Security
2020
2050
MEAN
HDBI
Increasing Food Security
Jameel Index
Increasing Import Vulnerability
HDBI mean
2020: 0.53
2050: 0.61
Jameel mean
2020: 0.27
2050: 0.37
0
0.1
0.2
0.3
0.4
0.5
0.6
0.7
0.8
0.9
1

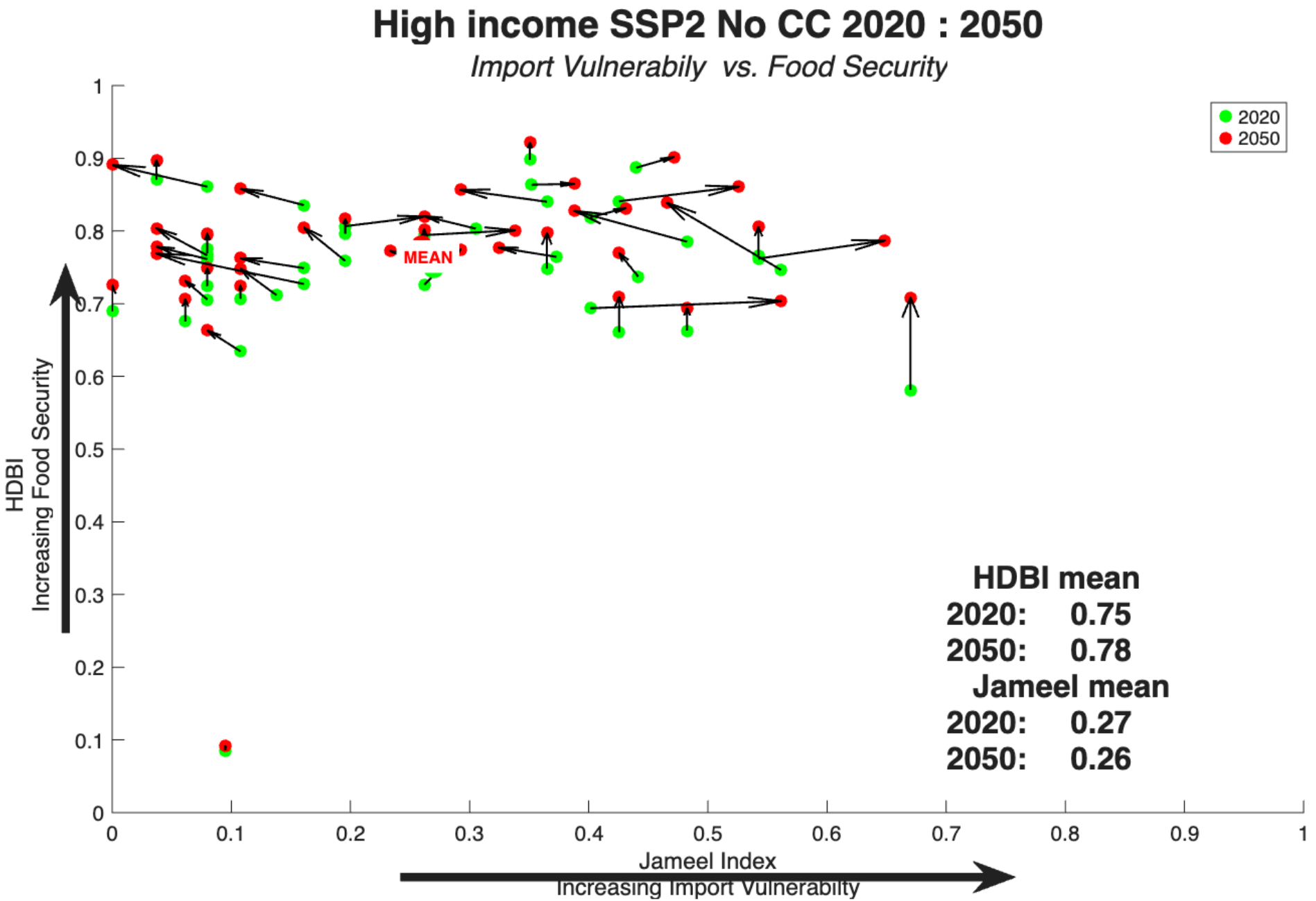
Lower Middle Income



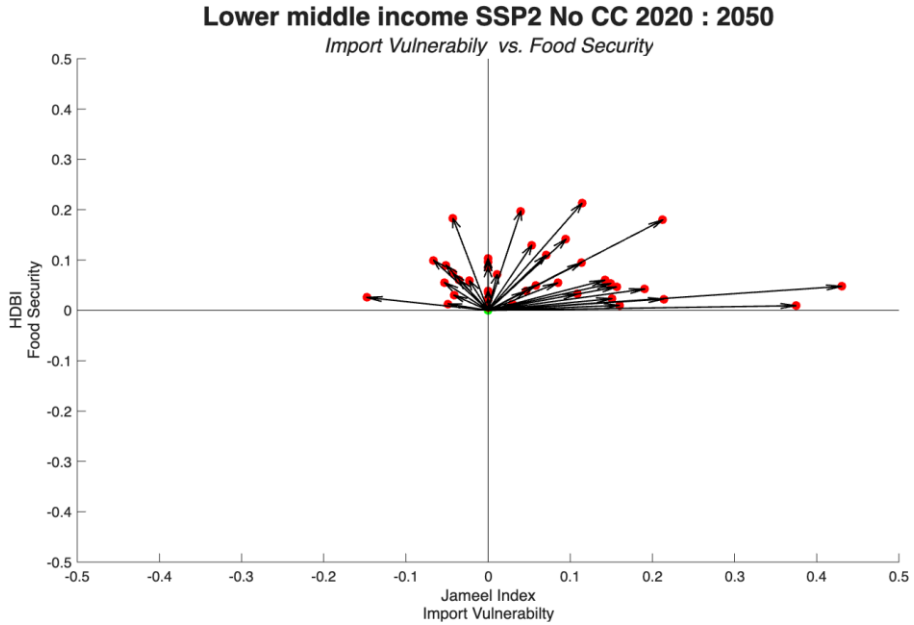
Upper Middle Income

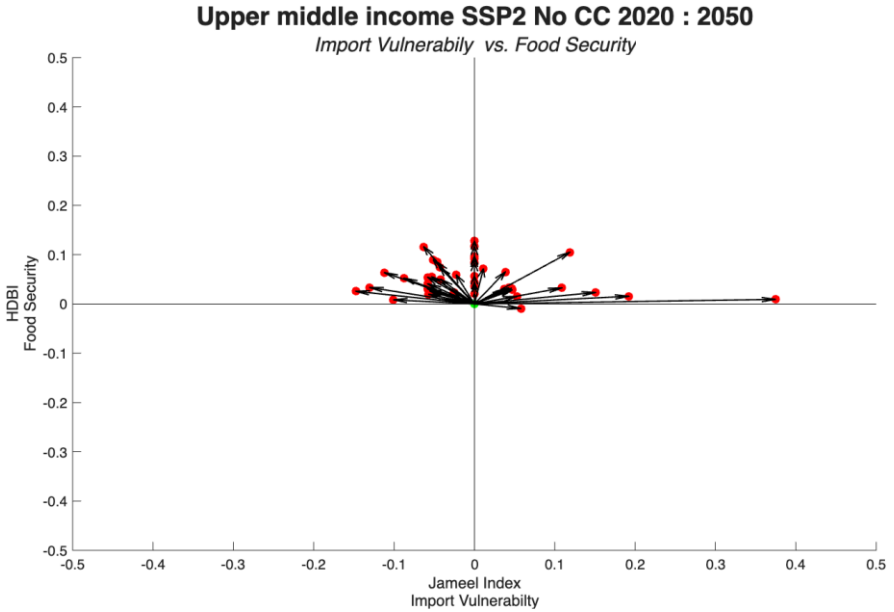


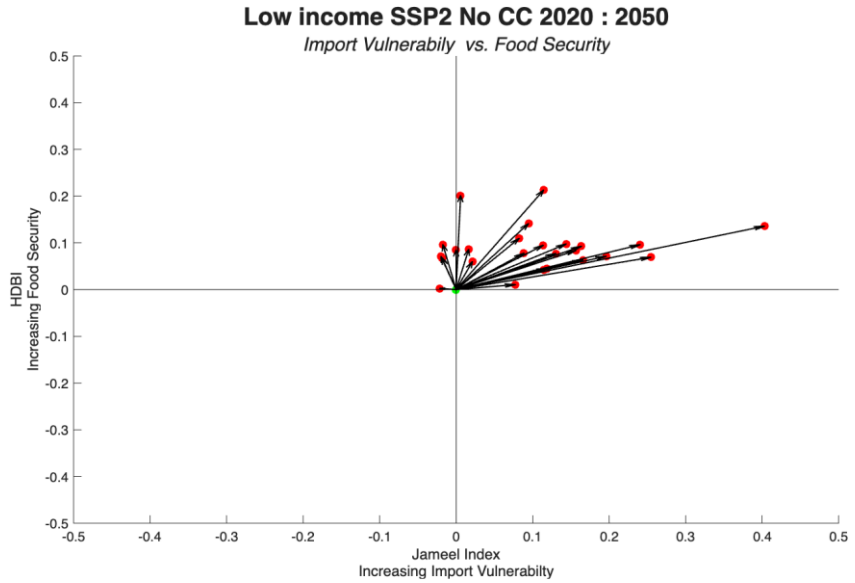
High Income

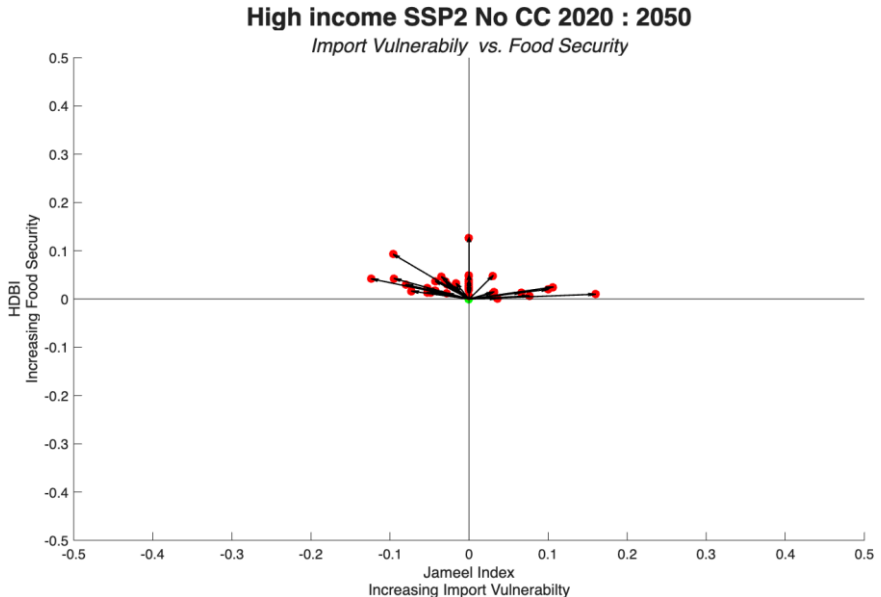

High income SSP2 No CC 2020 : 2050
Import Vulnerabily vs. Food Security
2020
2050
MEAN
HDBI
Increasing Food Security
Jameel Index
Increasing Import Vulnerability
HDBI mean
2020: 0.75
2050: 0.78
Jameel mean
2020: 0.27
2050: 0.26

GLOBAL CHANGE SSP2 2050 - RELATIVE CHANGE

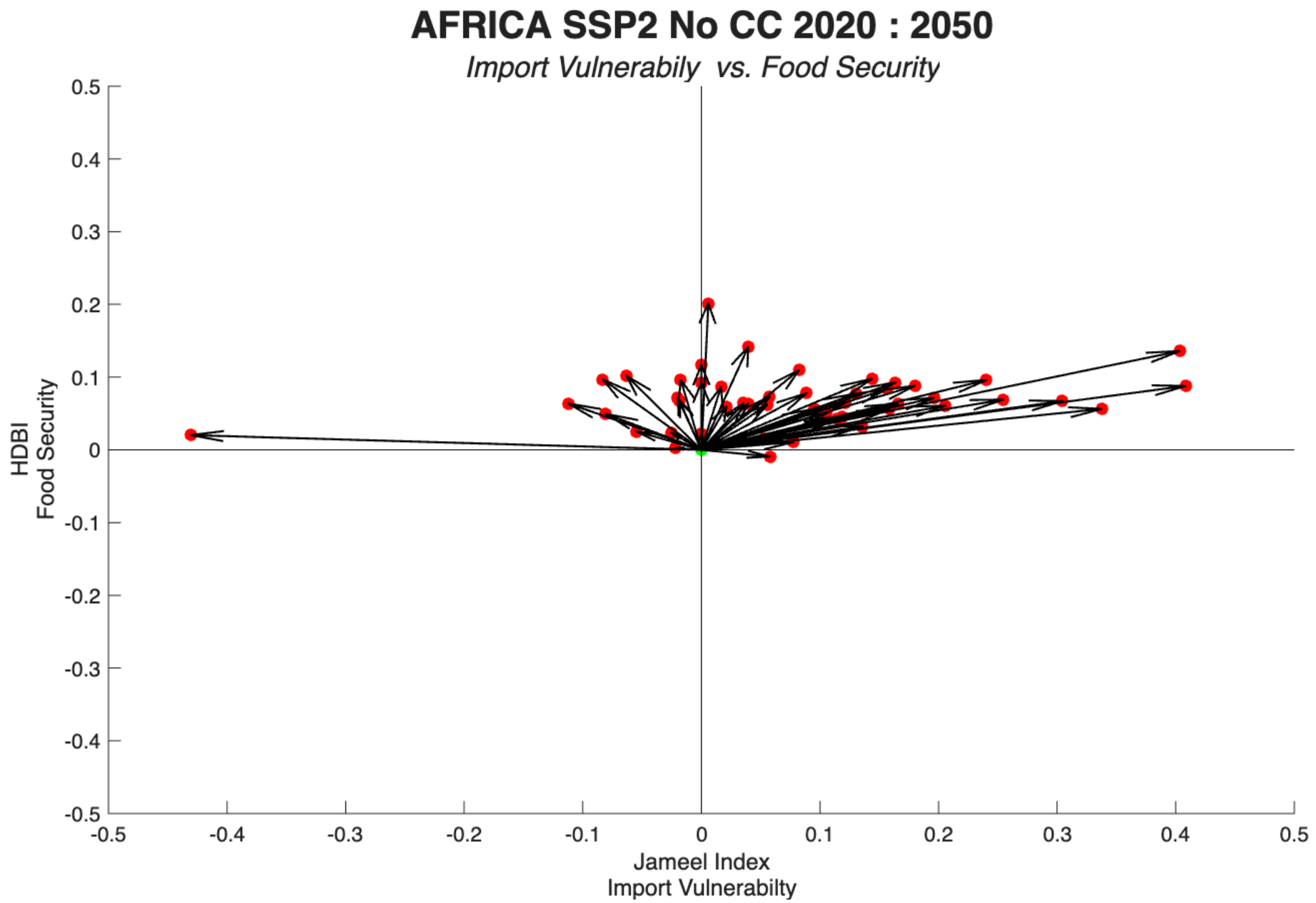




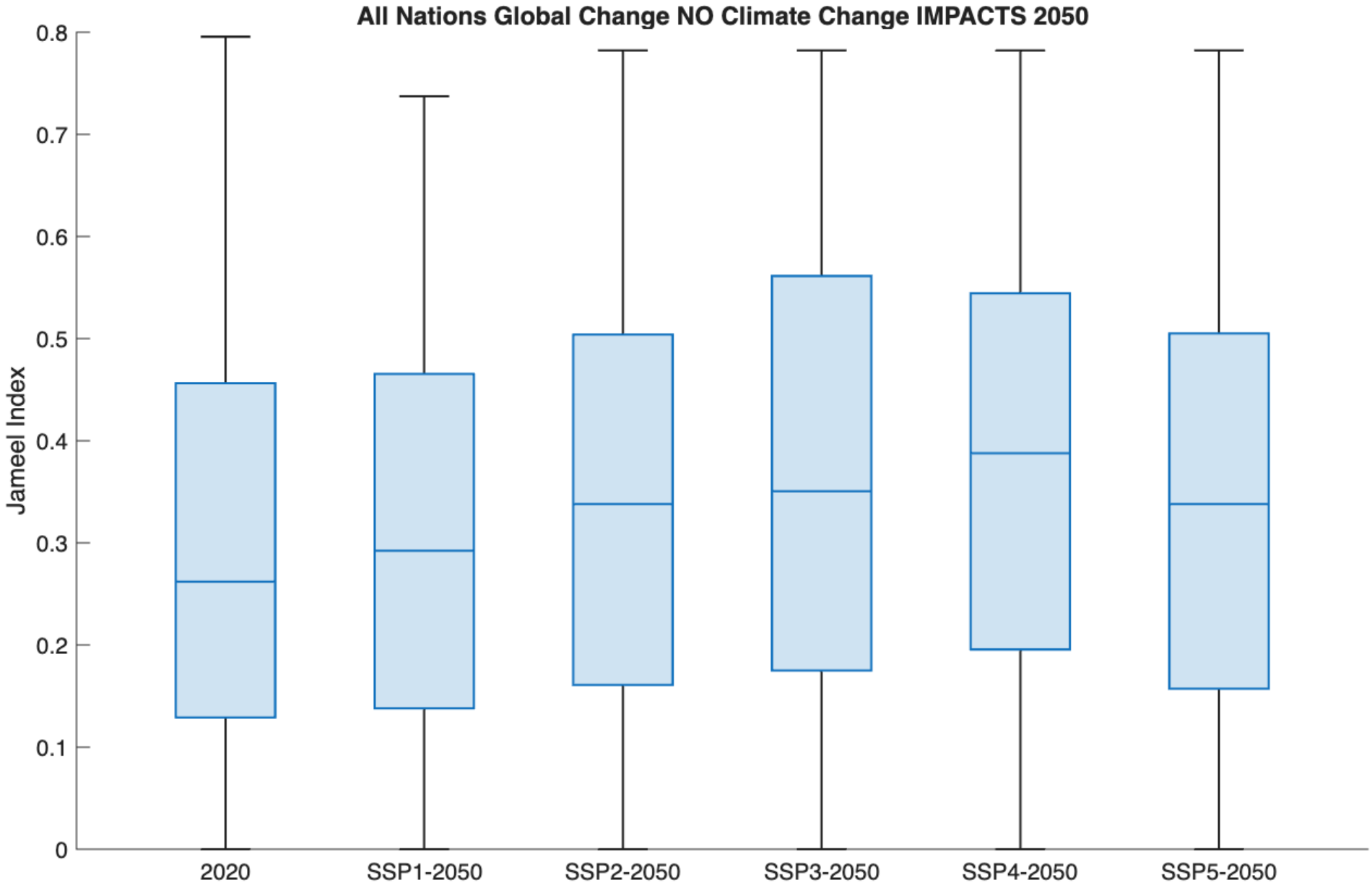




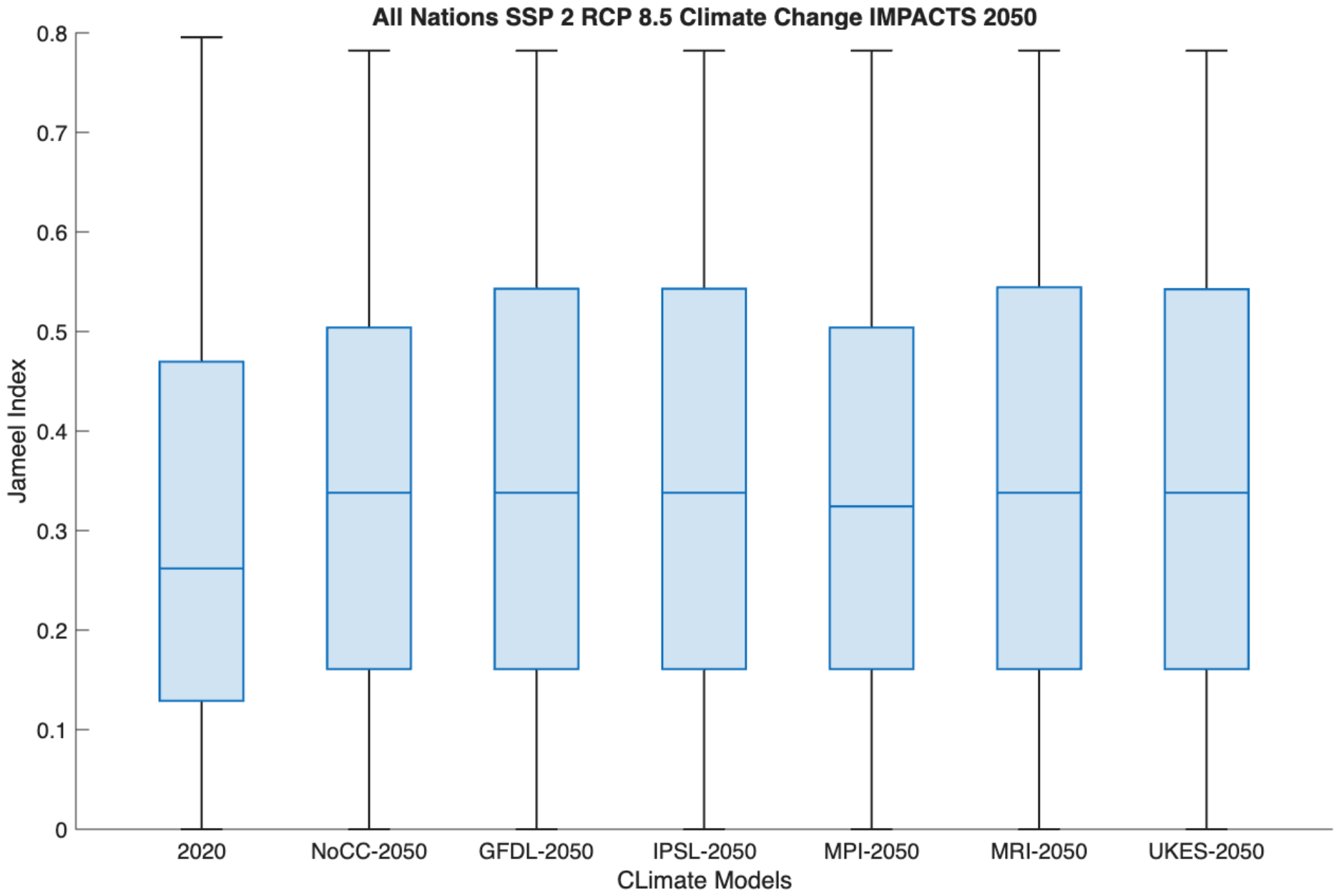
AFRICA


AFRICA SSP2 No CC 2020 : 2050
Import Vulnerabily vs. Food Security
HDBI
Food Security
Jameel Index
Import Vulnerabilty
0.5
0.4
0.3
0.2
0.1
0
-0.1
-0.2
-0.3
-0.4
-0.5
-0.5
-0.4
-0.3
-0.2
-0.1
0
0.1
0.2
0.3
0.4
0.5

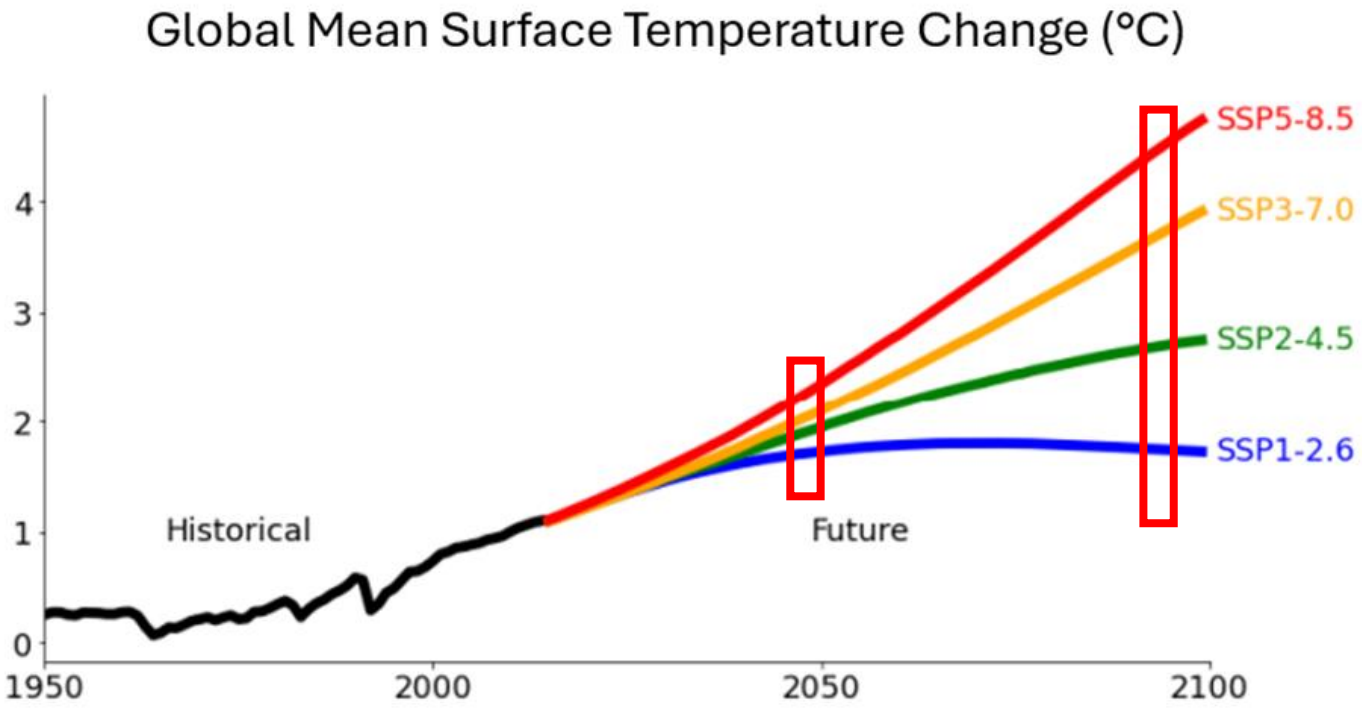
2050 GLOBAL CHANGE IMPACT



SSP2 2050 CLIMATE CHANGE IMPACT



An Overview of the Global & Climate Change Analysis

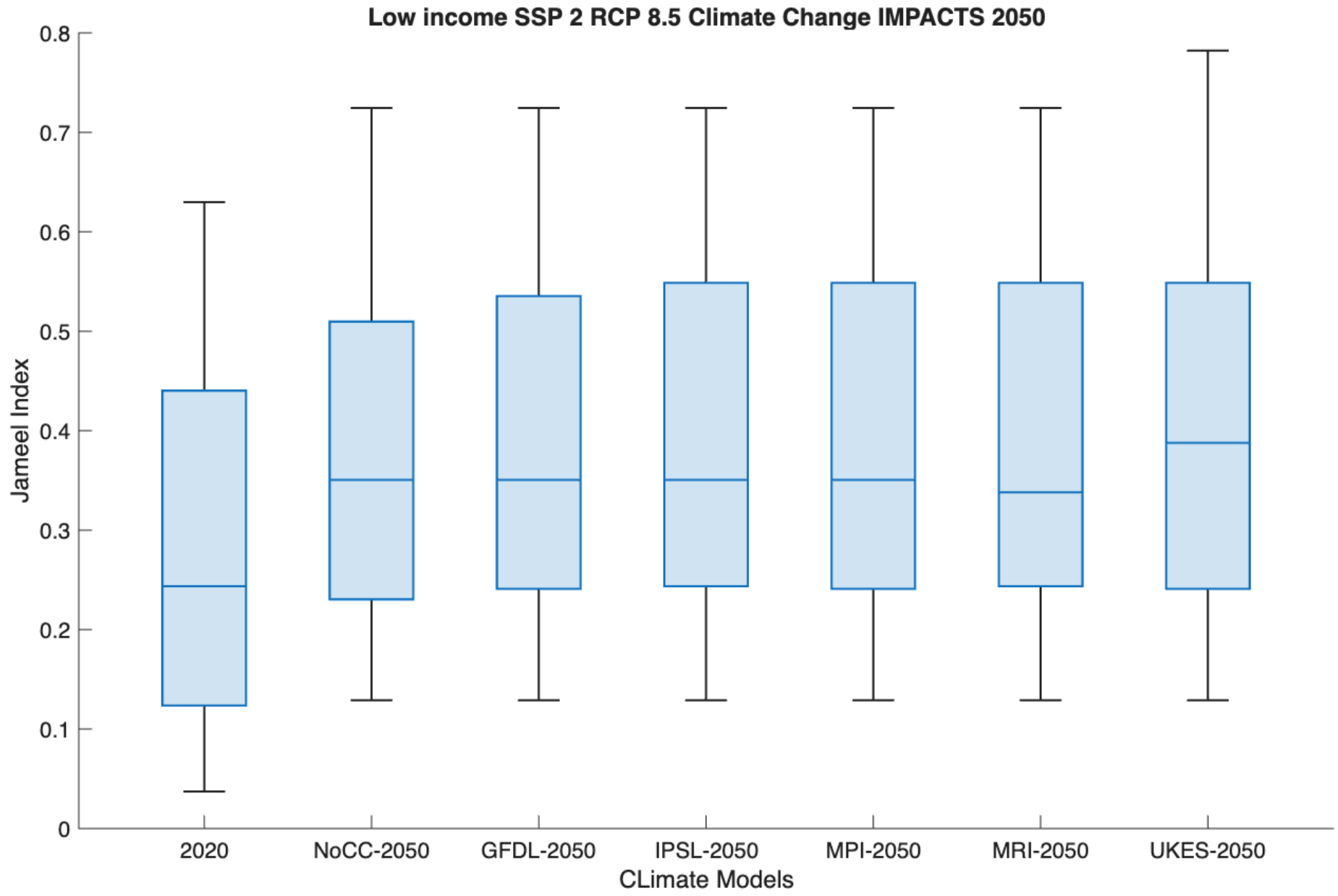


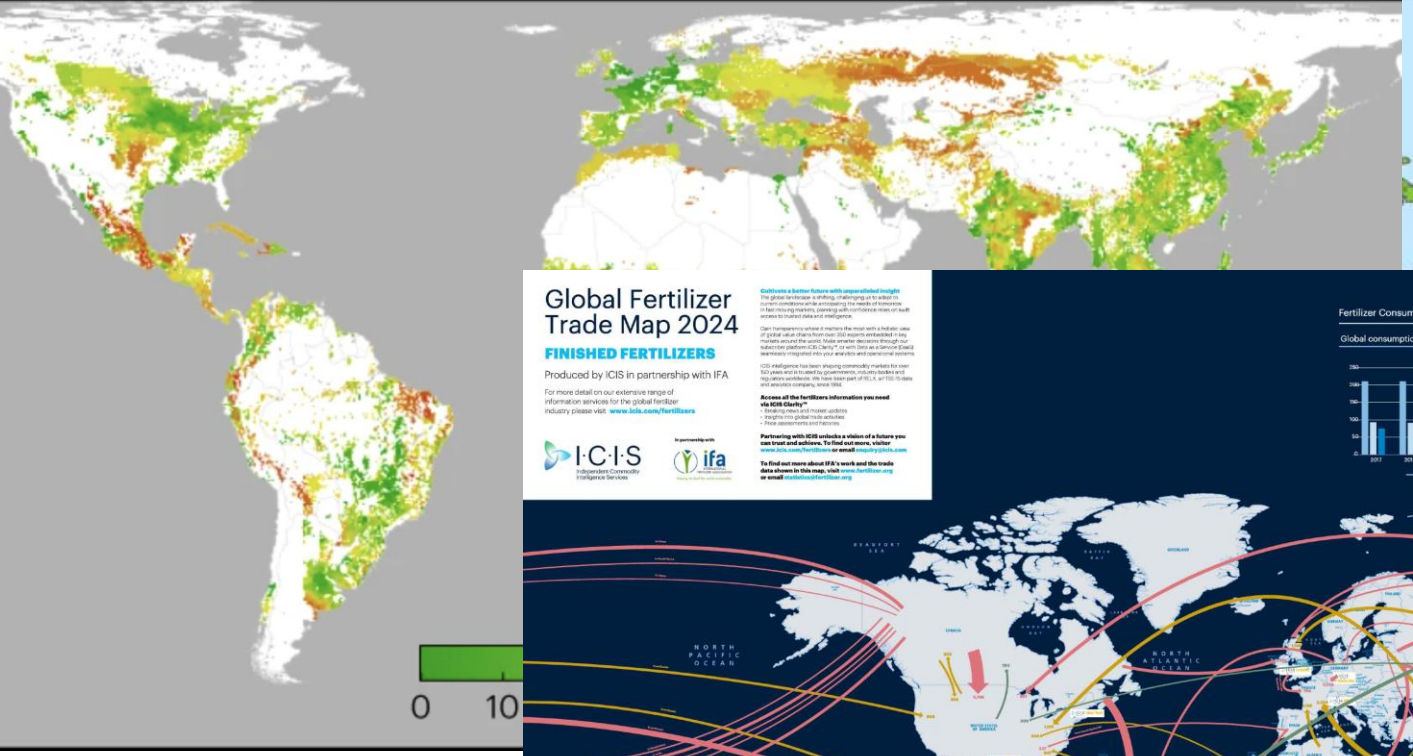
Baseline SSP scenarios

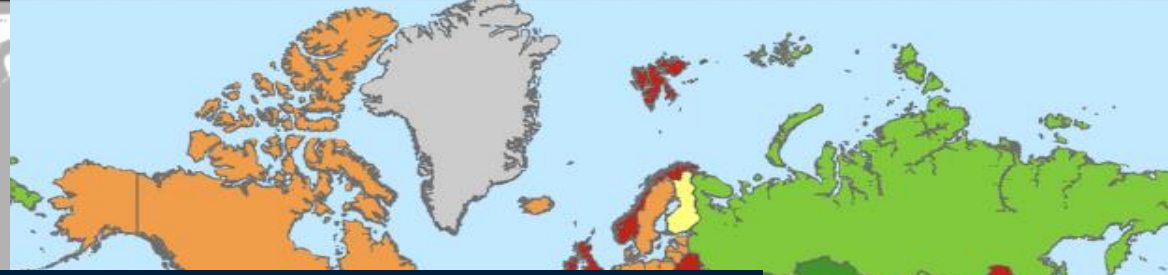
Class Changes	Percent of Countries Changing Jx Ranking 2020-2050 (SSP2)	
	Global Change	CC Only
-2	1%	0.1%
-1	6%	2.3%
0	64%	94.3%
1	22%	3.3%
2	5%	0.0%
3	2%	0.0%

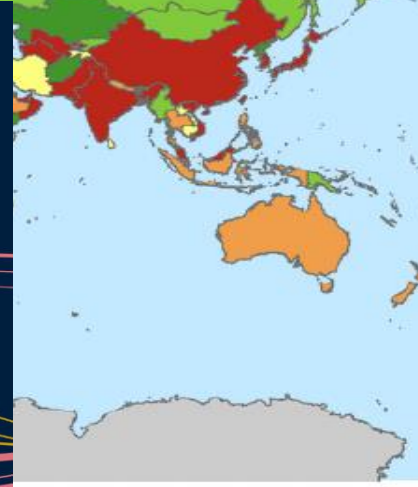
Change in Jx vulnerability class under broad global change and isolating for climate change only between 2020-2050 under SSP2

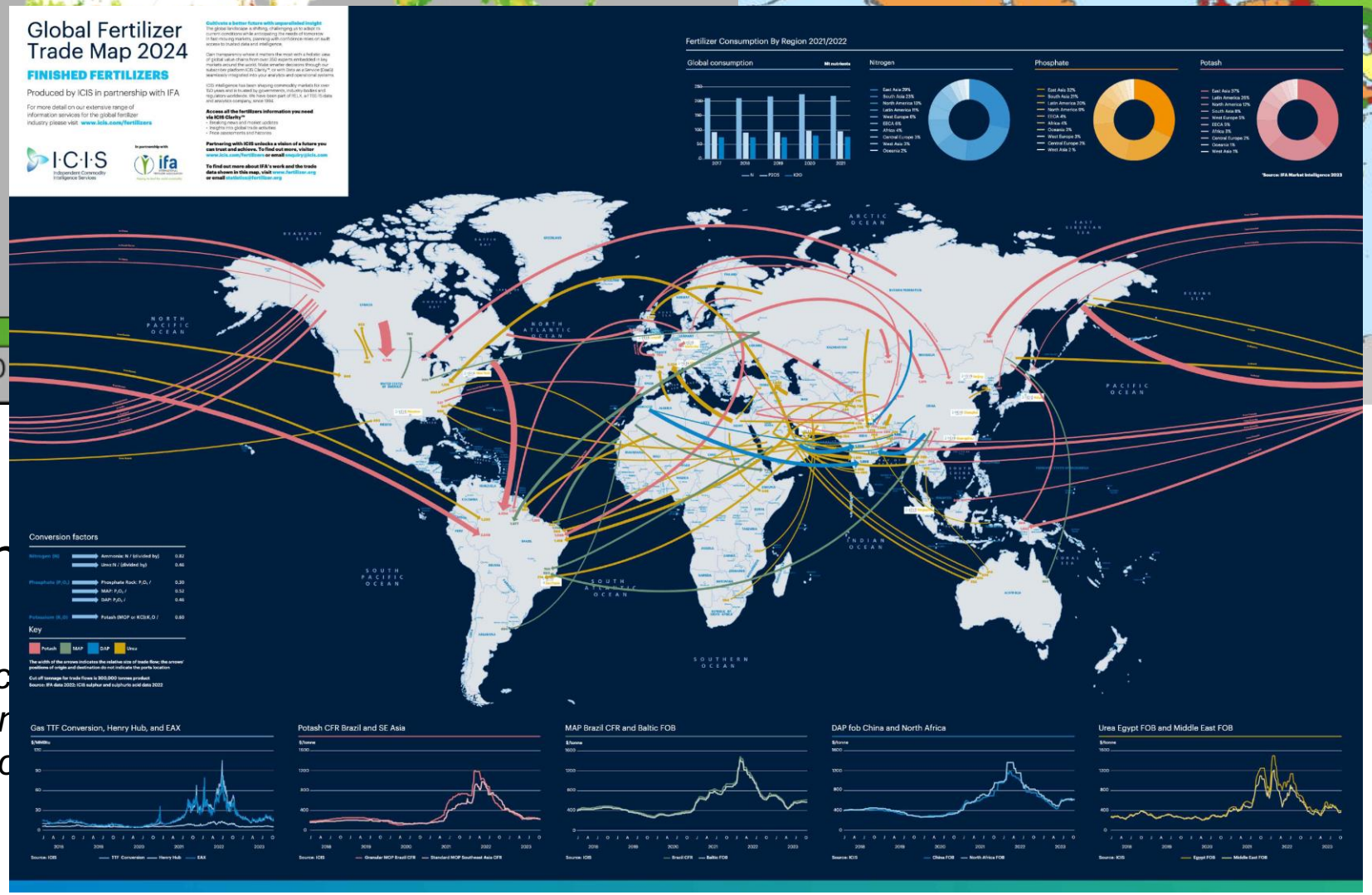
2050 Low Income CLIMATE CHANGE IMPACT SSP2











Yield Gap 10 r

Source: Gerber, et al 2024

Crops include barley, c
rice, sorghum, soybean
gap (shown as the perc
achieved)

- <Null>
- Extreme
- High
- Medium
- Low
- Very low
- <all other values>

FINDING 2 - GLOBAL CHANGE OVER CLIMATE CHANGE - GLOBALLY not LOCALLY

IMPACTS ON 2050 FOOD SECURITY & TRADE VULERNERALITY

- **DOMINATED BY POPULATION AND ECONOMIC GROWTH**
- **BY 2050 CLIMATE CHANGE IMPACTS ON CROP YIELD APPEARING, BUT**
- **TECHNOLOGICAL CHANGE INCREASING YIELDS PLUS AUTONOMOUS ECONOMIC ADAPTATION IS DAMPENING CC IMPACT ON SUPPLY**

FINDING - 3 TRADE A MAJOR COMPOMENT OF SECURITY IN 2050

1) **FOOD IMPORTS AND EXPORTS**
2) **AG INPUTS (FERTILIZER,TECH,..) IMPORTS AND EXPORTS**

HOW DO WE ADDRESS THE VULNERABLE NATIONS?

The need for investments for

1) **Food production**
2) **Export generation for foreign exchange**

THANK YOU

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