BUCHAREST UNIVERSITY OF ECONOMIC STUDIES
FACULTY OF AGRIFOOD AND ENVIRONMENTAL ECONOMICS

THE LINKAGES BETWEEN AGRICULTURAL TRADE, FOOD SECURITY AND CLIMATE CHANGE

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14 November 2019

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Climate change definition

- Climate change refers to "**a change in the state of the climate that can be identified (e.g. using statistical tests) by changes in the mean and/or the variability of its properties, and that persists for an extended period, typically decades or longer. It refers to any change in climate over time, whether due to natural variability or as a result of human activity"** (Intergorvernmental Panel on Climate Change).

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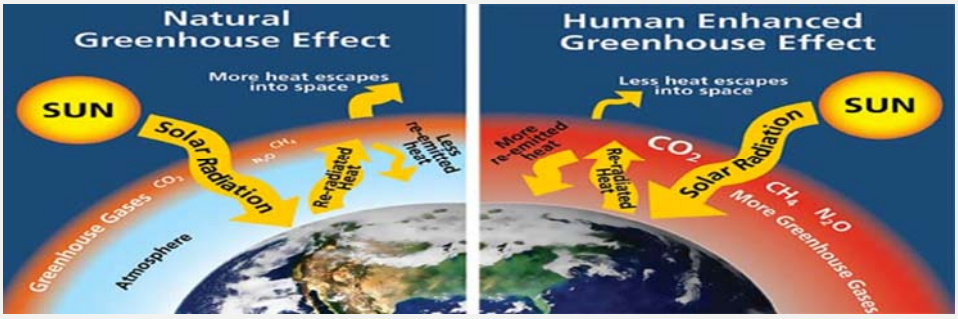
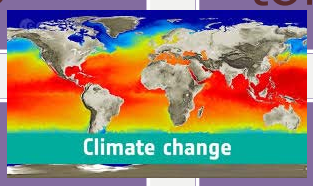
- Climate change is defined as "**a change of climate that is attributed directly or indirectly to human activity that alters the composition of the global atmosphere and that is in addition to natural climate variability observed over comparable time periods**" (United Nations Framework Convention on Climate Change).

CLIMATE CHANGE IS THE DIRECT RESULT OF GLOBAL HEATING OR TEMPERATURE INCREASE DUE TO THE "ARTIFICIAL" GREENHOUSE EFFECT.



1. The greenhouses gases

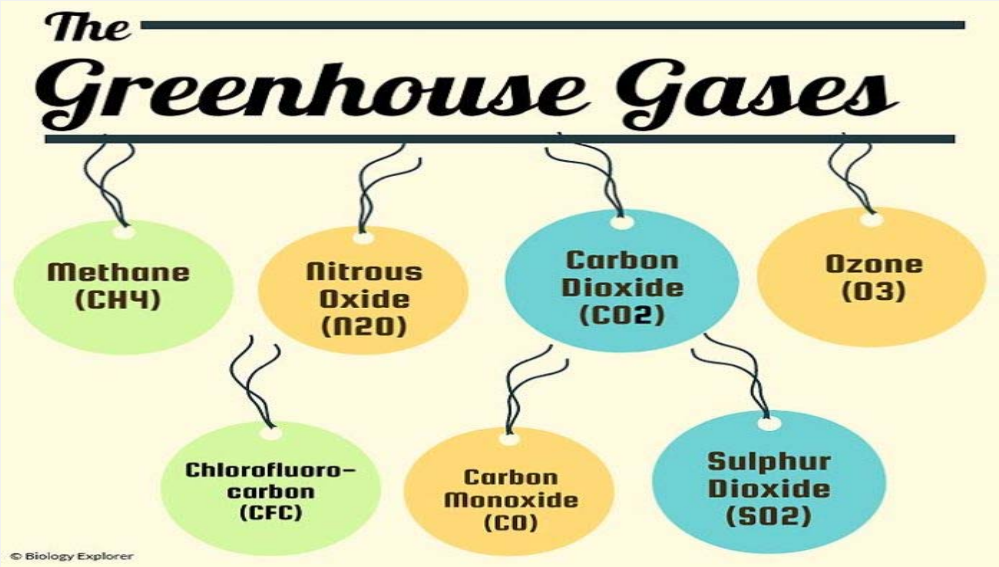
2. The global average temperature

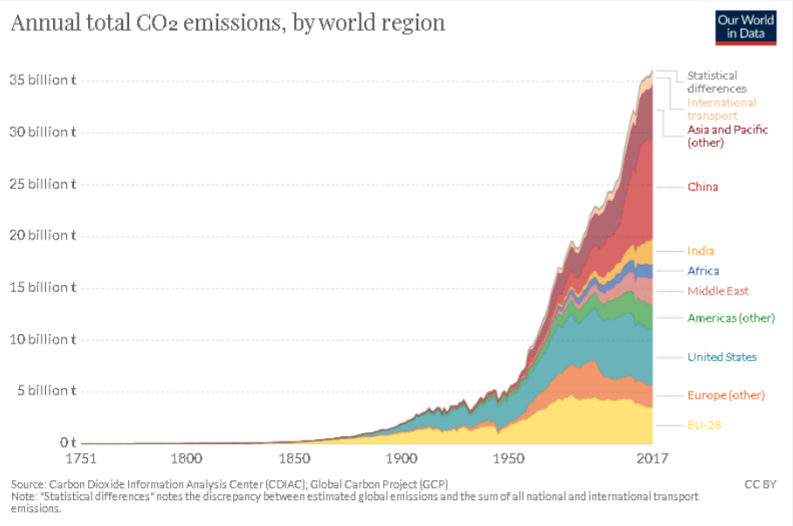


3. The sea level

4. Desertification vulnerability

1. The greenhouses gases

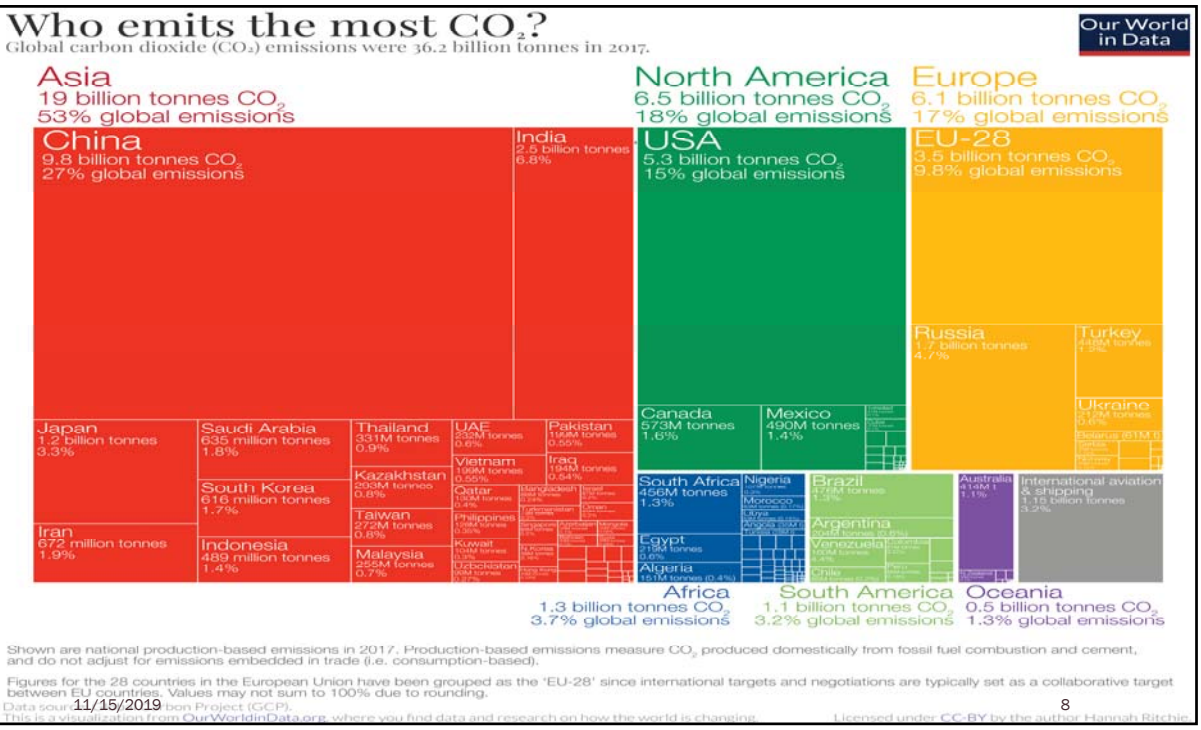




Global emissions increased from 2 billion tonnes of carbon dioxide in 1900 to over 36 billion tonnes 115 years later.

Whilst data from 2014 to 2017 suggested global annual emissions of CO2 had approximately stabilized, the most recent (preliminary) data from the Global Carbon Project reported a **2.7 percent increase in 2018**.

(Source: https://ourworldindata.org/co2-and-other-greenhouse-gas-emissions)



Countries emissions over time

Rank	Country	$MtCO_2$
1	China	9839
2	United States of America	5270
3	India	2467
4	Russian Federation	1693
5	Japan	1205
6	Germany	799
7	Iran	672
8	Saudi Arabia	635
9	South Korea	616
10	Canada	573
11	Mexico	490
12	Indonesia	487
13	Brazil	476
14	South Africa	456
15	Turkey	448
16	Australia	413
17	United Kingdom	385
18	France	356
19	Italy	356
20	Thailand	331
21	Poland	327
22	Kazakhstan	293
23	Spain	281

(http://www.globalcarbonatlas.org/en/CO2-emissions)

Rank	Country	$MtCO_2$
24	Taiwan	272
25	Malaysia	255
26	United Arab Emirates	232
27	Egypt	219
28	Ukraine	212
29	Argentina	204
30	Vietnam	199
31	Pakistan	199
32	Iraq	195
33	Netherlands	164
34	Venezuela	160
35	Algeria	151
36	Qatar	130
37	Philippines	128
38	Czech Republic	108
39	Nigeria	107
40	Kuwait	104
41	Belgium	100
42	Uzbekistan	99
43	Bangladesh	88
44	Chile	85
45	Colombia	81
46	Romania	80

(http://www.globalcarbonatlas.org/en/CO2-emissions)

Rank	Country	$MtCO_2$
190	Solomon Islands	0.2
191	Samoa	0.2
192	Saint Vincent and the Grenadines	0.2
193	Turks and Caicos Islands	0.2
194	British Virgin Islands	0.2
195	Comoros	0.2
196	Vanuatu	0.2
197	Micronesia (Federated States of)	0.2
198	Liechtenstein	0.2
199	Anguilla	0.2
200	Dominica	0.1
201	Tonga	0.1
202	Marshall Islands	0.1
203	Sao Tome and Principe	0.1
204	Cook Islands	0.1
205	Saint Pierre and Miquelon	0.1
206	Kiribati	0.1
207	Nauru	0.1
208	Montserrat	0.1
209	Wallis and Futuna Islands	0.0
210	Niue	0.0
211	Tuvalu	0.0
212	Saint Helena	0.0

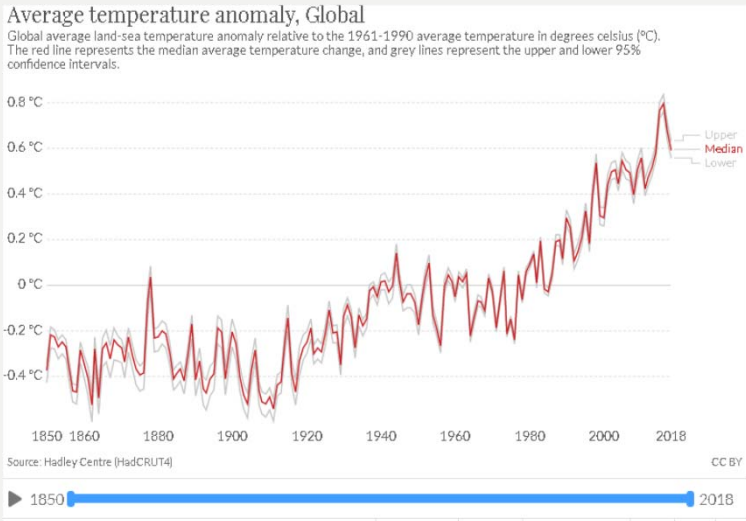
(http://www.globalcarbonatlas.org/en/CO2-emissions)

2. The global average temperature

Over the last few decades, global temperatures have risen sharply — to approximately 0.8 degrees celsius higher than our **1961-1990 baseline**.

When extended back to 1850, we see that temperatures then were a further 0.4 degrees colder than they were in our 1961-1990 baseline.

Overall, if we look at the total temperature increase since pre-industrial times, this amounts to approximately 1.2 degrees celsius.



The red line represents the average annual temperature trend through time, with upper and lower confidence intervals shown in light grey.

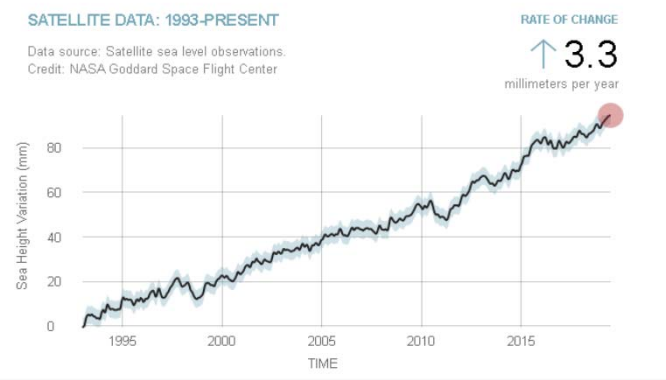
(https://ourworldindata.org/co2-and-other-greenhouse-gas-emissions)

3. The sea level

The physical signs and socio-economic impacts of climate change are accelerating as record greenhouse gas concentrations drive global temperatures towards increasingly dangerous levels, according to a new report from the World Meteorological Organization.

The WMO Statement on the State of the Global Climate in 2018, its 25th anniversary edition, highlights record sea level rise, as well as exceptionally high land and ocean temperatures over the past four years. This warming trend has lasted since the start of this century and is expected to continue.

(https://public.wmo.int/en/media/press-release/state-of-climate-2018-shows-accelerating-climate-change-impacts)



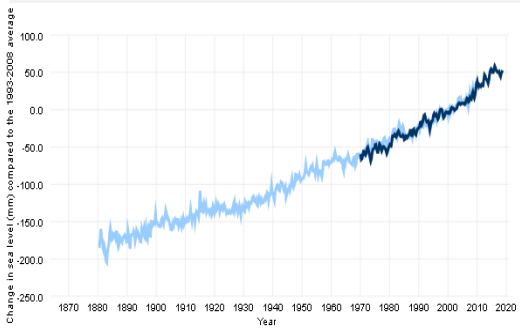
(https://climate.nasa.gov/vital-signs/sea-level/)

Sea level rise is caused primarily by two factors related to global warming:

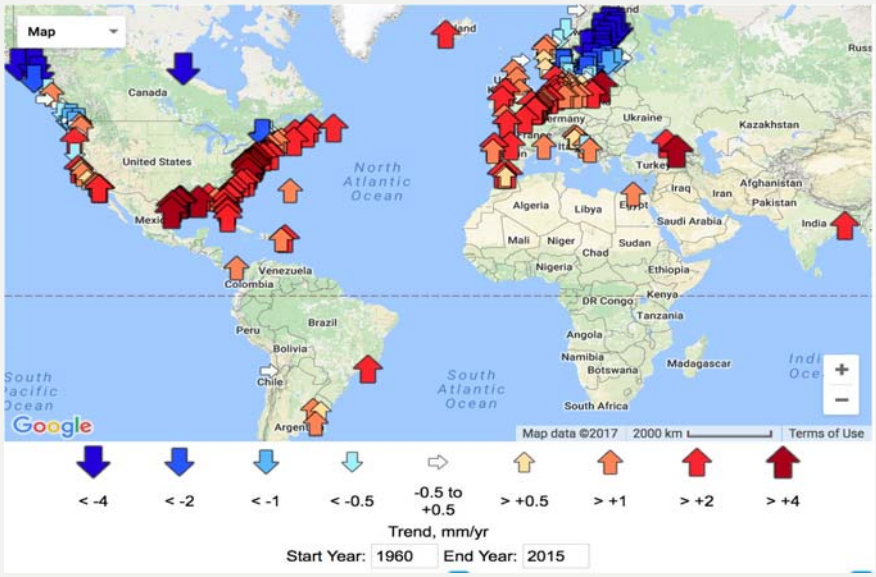
- the added water from melting ice sheets and glaciers and
- the expansion of seawater as it warms.

This graph tracks the change in sea level since 1993 as observed by satellites.

Global sea level since 1880



(https://www.climate.gov/news-features/understanding-climate/climate-change-global-sea-level)

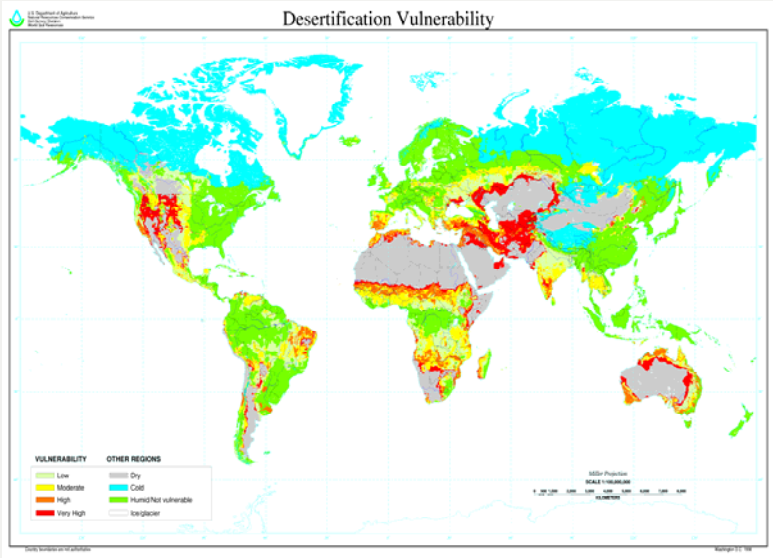


Sea level rise (SLR) is anything but spatially uniform.

The satellite derived SLR rates that you present are a good example of the complexity of the spatial response.

(https://earthscience.stackexchange.com/questions/10876/how-will-sea-level-rise-be-distributed-across-the-globe)

4. Desertification vulnerability

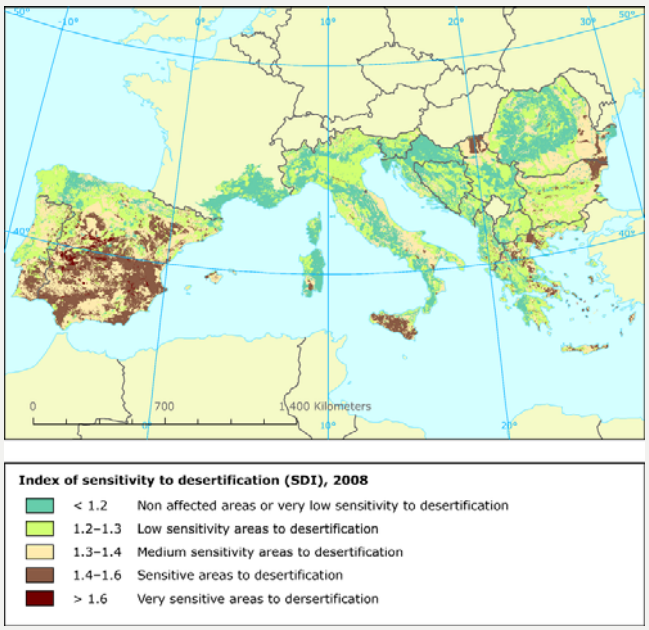


Desertification is an advanced stage of land degradation where the soil has lost part of its capability to support human communities and ecosystems.

Desertification is defined by the United Nation Convention to Combat Desertification (UNCCD) as "**land degradation in arid, semiarid and sub-humid areas resulting from various factors, including climatic variations and human activities**" (UNCCD,1997).

https://data.europa.eu/euodp/it/data/dataset/data_sensitivity-to-desertification-and-drought-in-europe/resource/354d30d0-e4ee-41e5-bec5-ed817a83b12e

(https://www.nrcs.usda.gov/wps/portal/nrcs/detail/soils/use/worldsoils/?cid=nrcs142p2_054003)

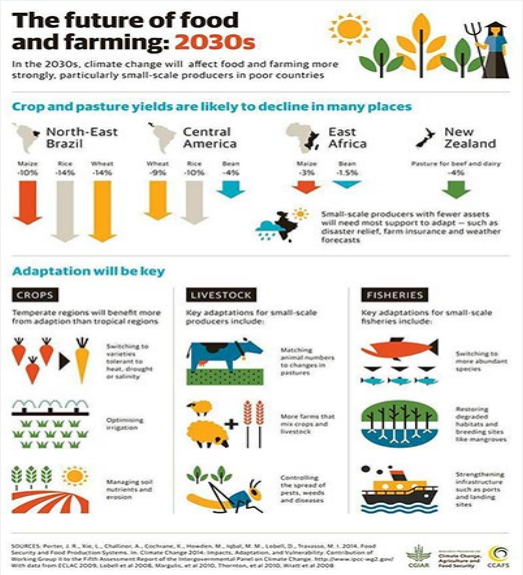


The sensitivity to desertification and drought is defined by the sensitivity to desertification index (SDI) based on **soil quality, climate and vegetation parameters.**

https://www.eea.europa.eu/data-and-maps/figures/sensitivity-to-desertification-index-map

CLIMATE CHANGE IMPACTS IN EUROPE

https://www.youtube.com/watch?v=jS0ZIUtsQHg



Global climate change influences all aspects of our daily lives, and it will for many years to come.

The challenge for each individual, institute, company and government is to not only identify the risks but also adapt and mitigate the effects to ensure a future for all on planet Earth.

Although not all effects of climate change may turn out negative, most sectors will need to find ways to deal with the effects.

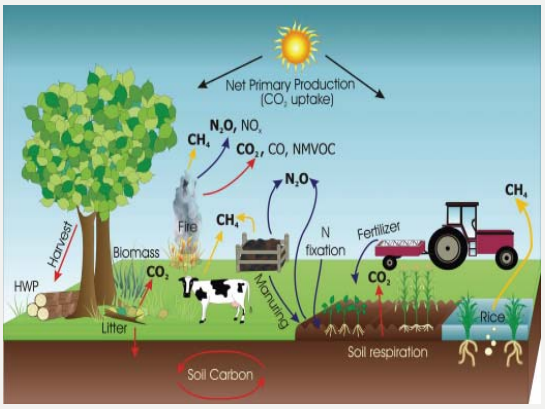
Areas at high risk are agriculture and food security.

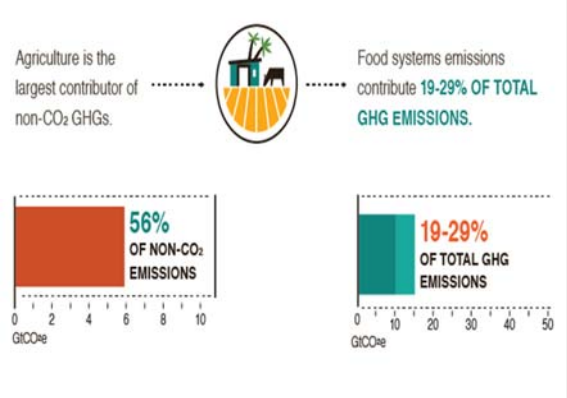
(https://www.elsevier.com/connect/how-will-climate-change-affect-food-security)

- *Climate change will affect world regions unevenly.* It is already affecting vulnerable countries and will pose a major threat to their food security.
- *Climate change will alter conditions for agriculture.* This could lead to changes in comparative advantage across regions and consequently to changes in agricultural trade.
- *Agricultural trade can help in adapting to climate change and in ensuring food security.* It can support adaptation efforts by stabilizing markets and reallocating food from surplus to deficit regions.

- *Climate is an essential input in agricultural production.* Shifts in the average levels of temperature and precipitation inevitably have an impact on agricultural productivity, farm incomes and prices.
- *Agriculture also contributes to climate change directly by emitting methane, nitrous oxide and carbon dioxide*, and indirectly by affecting net carbon emissions through its impact on soil, forests and other land uses.
- *The impacts of a warming planet are already becoming detectable* in many parts of the world and are expected to accelerate in the coming decades.
- *Understanding the changes in the climate and their potential impact on agriculture and vice versa, has become an active area of research* bringing together various natural science and socio-economic disciplines.

- Agriculture is an important source of greenhouse gas emissions in the EU, while also being heavily affected by climate change.
- Mitigation and adaptation have to be prioritised by both farmers and policy makers in order to coordinate efforts to reduce emissions from the sector and meet demands for food.
- Balancing these sometimes competing interests presents a significant policy challenge.





(https://climatepolicyinfohub.eu/agriculture-and-climate-change-eu-overview)

- **Climate affects agriculture through various channels.**
  - *Higher temperatures can have significant impacts on crop growth.*
    - They result in faster crop development, a shortened grain-filling stage and reduced yields.
    - High temperatures can also damage plant cells, and extreme heat during the flowering stage increases sterility rates.
  - *Increases in temperatures also affect livestock.*
    - While there is limited evidence of these effects on a broad scale, experiments and observational data suggest that a warming planet will have negative effects on feed intake, the rate at which animals grow and gain weight and dairy production.
    - Disease and parasites, as well as mortality rates, are expected to increase.
    - By altering the growth rate of pastures, climate change can also have an indirect effect on ruminant and dairy productivity.
  - **There are several avenues through which climate change can affect agriculture, with the adverse impacts becoming more dominant as temperatures rise.**

- Climate change is expected to slow down the decline in the number of undernourished, partly offsetting the positive effect of economic growth on food security.
- Most modelling studies suggest that the likely impact of climate change on food security, globally, may be relatively small compared to that of other drivers such as population and GDP growth.
- However, due to its uneven effects, climate change can be a critical factor for food security in some regions.
- Climate change can also affect nutrition. The effects that climate change might have on the four dimensions of food security – **availability, access, utilization and stability**.

CLIMATE CHANGE AND FOOD SECURITY

Dimension of food security	Climate change effects on food security	Time horizon
Availability	▸ Global mean crop yields of rice, maize and wheat projected to decrease 3–10 percent per degree of warming ▸ Impacts on livestock through reduced feed quantity/quality, pest and disease prevalence, physical stress; meat, egg and milk yield and quality decrease ▸ 5–10 percent decrease in potential fish catch in tropical marine ecosystems	Slow onset, long term
Access	▸ Increasing food prices ▸ Relocation of production with impacts on prices, trade flows and food access	Slow onset, long term
Utilization	▸ Reduced food safety due to higher rates of microbial growth at increased temperatures ▸ Reduced nutritional quality of crops due to decreases in leaf and grain nitrogen, protein and macro- and micronutrient concentrations associated with increased carbon dioxide concentrations and more variable and warmer climate	Slow onset, long term
Stability	▸ Damage to crops and livelihoods from extreme events (heatwaves, droughts, floods, storms, etc.) ▸ Short-term disruptions of trade through effects on transport systems	Extreme events, short term

SOURCE: Based on FAO (2016); Campbell *et al.* (2016); and Schmidhuber and Tubiello (2007).

- **International trade can play an important role in facilitating adaptation to climate change** in the context of food security.
- In a country experiencing declines in production due to a weather-induced shortfall, trade can contribute towards food security in terms of both availability and access. It can help in addressing domestic price instability due to extreme weather events.
- Furthermore, trade can have a positive effect on utilization, as it allows for greater diversity in the food available, particularly in regions where climatic factors may not allow for the production of a large variety of different crops.

The role of agricultural trade policy in adaptation

- As climate change is expected to have an uneven effect across regions, **international trade can be an important tool in ensuring food security**.
- In well-functioning global markets, trade patterns will respond to changes in the comparative advantage across regions and countries.
- Global markets are important and a number of studies carried out on the intersection of trade and climate change have focused on **how trade policy can strengthen the adaptation role of trade by moderating the impacts of climate change on agricultural prices, welfare and food security**.
- One study finds, for instance, that **agricultural price increases due to climate change are greater and more widespread when trade is restricted across regions**, compared to when all tariffs and export subsidies on agricultural and food products are removed

CLIMATE CHANGE AND CHOKEPOINTS OF GLOBAL FOOD TRADE

- **Extreme weather events and slow-onset climate change also affect main transportation routes for agricultural trade**. According to a recent Chatham House report, most international agricultural trade depends on only a small number of 'chokepoints,' of which 14 have been identified as being critical to food security.
- Droughts, storms and floods may cause temporary closures of chokepoints, while weather-related wear and tear of infrastructure can reduce their efficiency and make them even more vulnerable to extreme events. Rising sea levels are likely to threaten the integrity of port operations and coastal storage infrastructure and will increase their vulnerability to storm surges.
- Climate change may also increase the risk of supply disruptions, as extreme weather events become more common and concurrent across different locations. The most important chokepoints are:
  - *Maritime (straits and canals): Panama Canal, Strait of Malacca (transit of over a quarter of global soybean exports), Turkish Straits (pass for one-fifth of global wheat exports, largely from the Black Sea 'breadbasket' region);*

- *Inland and coastal chokepoints (in major crop-exporting regions): United States of America, Brazil, Black Sea (together they account for 53 percent of global exports of wheat, rice, maize and soybean).*

- For example, the Chatham House report underlines the vulnerability of the Middle East and North Africa (MENA), a major food import dependent region in the world, to chokepoint disruptions. Over 30 percent of grain imports destined for this region are routed through at least one maritime chokepoint.

- Limiting the risks from chokepoint disruptions will require the integration of chokepoint analysis in mainstream risk management, infrastructure investments, enhancement of confidence and predictability of global trade, and the development of emergency supply-sharing arrangements. In light of this, the G20 have requested to expand the activities of the Agricultural Market Information System (AMIS) to include assessment of chokepoint disruption risk, and to monitor chokepoint performance by collating data on throughput, congestion and climate resilience.

- While **trade** can help moderate climate change impacts on food availability and access, it **can also have both positive and negative spillover effects**.

- In the long term, greater competition, combined with appropriate policies, may result in increases in sustainable productivity through improved technologies or investments that can support growth and employment.

- Nevertheless, increased international trade can result in increases in GHG emissions due to transport and deforestation from the expansion of agricultural land use in exporting countries.

- In general, **the benefits from agricultural trade for developing countries depend on their net trade position (net exporter or net importer) and on their own policy efforts**.
- Under deteriorating conditions for agricultural production from climate change, food imports by low-latitude (often developing) countries will have to come from high-latitude (often developed) countries.
- Although trade may alleviate climate change pressures on domestic markets, in the long term it may result in food import dependence for negatively-affected countries. It can also increase the risk of exposure to higher market and price volatility due to extreme events that could affect large players in the international market.

- Import dependence raises the question of whether countries will have the financial capability to buffer agricultural production losses due to climate change in the long run.
- **Trade can be an important component of ensuring food security in the context of climate change, but there is a need for a range of measures to build resilience**.
- **Policy options should focus on promoting the structural transformation of agriculture, but also on putting the broader economy on a sustainable path**. Climate pressures on agriculture – which in developing countries provides employment to a large part of the population – should be met by efforts to facilitate sustainable growth in both agriculture and other sectors of the economy.
- In agriculture, this requires sustainable agricultural productivity growth, including through the adoption of improved technologies and practices, especially by small-scale family farmers in the poorest countries that will be disproportionately affected by climate change.

- As open markets are likely to increase the competitive pressure on import-competing sectors, **the need for sustainable agricultural productivity growth becomes more pronounced in achieving a better balance between export and import performance.**

- **Trade and other policies should** contribute towards stable domestic prices that promote food security, while at the same time **provide appropriate incentives to farmers to adapt to climate change and increase productivity.**

- Efforts should also focus on improving markets for land, labour and credit, which are central to promoting technology adoption and investment and ensuring an efficient allocation of natural resources.

Food availability and climate change

- In many regions, **the adverse impacts of climate change on crop yields and agricultural production could partly be offset by farm-level responses and autonomous adaptation, such as intensifying management** (e.g. increasing use of fertilizers) and expanding the arable area.

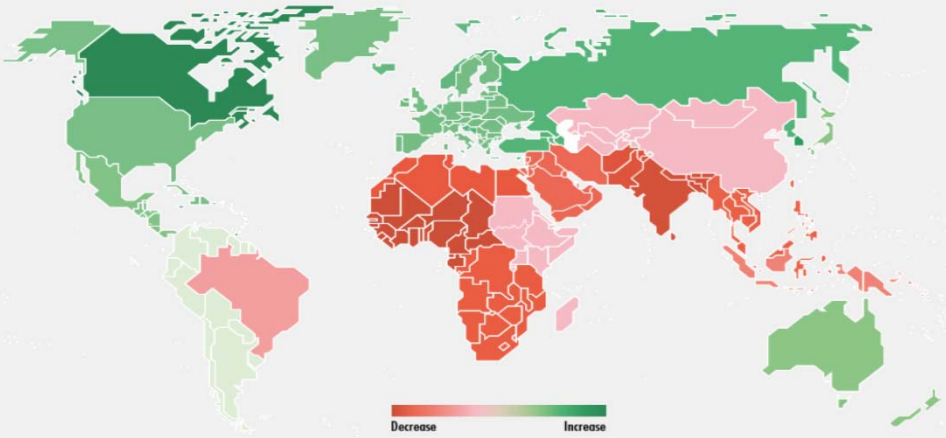
- Nonetheless, compared with the baseline, climate change is expected to result in declines in agricultural production in large parts of Africa, the Middle East and South and Southeast Asia.

- These declines are projected to be more pronounced in West Africa and India, where production could decrease by 2.9 and 2.6 percent respectively due to climate change impacts.

- In higher latitude regions, higher temperatures are projected to result in increases in agricultural production, as for example in Canada (2.5 percent) and the Russian Federation (0.9 percent).

- **South Asia and sub-Saharan Africa**, particularly West Africa**, are among the most vulnerable regions to climate change. In these regions, national economies depend on agriculture for a significant share of GDP and employment.**
- At the same time, small-scale family farmers have little access to innovative technologies and inputs, which limits their capacity to adapt to a changing climate. Differences in access to markets and technologies across countries and within countries are likely to exacerbate the effects of climate change.
- Indeed, uneven climate change effects in combination with differences in adaptation capacity may give rise to a growing divide between developed and developing countries.

FIGURE 2.1
CHANGES IN AGRICULTURAL PRODUCTION IN 2050: CLIMATE CHANGE RELATIVE TO THE BASELINE



NOTE: The final boundary between the Republic of the Sudan and the Republic of South Sudan has not yet been determined. Final status of the Abyei area has not yet been determined.
SOURCE: Based on data provided by Wageningen Economic Research. 2018. Climate Change and Global Market Integration: Implications for global economic activities, agricultural commodities and food security. SOCO 2018 Background Paper, Rome, FAO.

- **Regions that experience agricultural production declines due to climate change are expected to increase imports of agricultural products.** Temperate regions, where production is projected to increase, will export more.

- **By 2050, climate change will affect the net trade positions of countries and regions compared with the baseline. Net food importing countries in North and West Africa are projected to increase their net imports by 2.6 and 7.7 percent respectively. Net imports are also expected to » increase relative to the baseline in Rest of South Asia (3.6 percent) and India (20.4 percent).**

- Most of the countries in sub-Saharan Africa could deepen their net import position. By contrast, Canada – a traditional agricultural net exporting country – will expand its net exports by 21.9 percent relative to the baseline. The Russian Federation and the Caucasus, a net food importing region that will experience increases in production due to higher temperatures, will import less and export more, resulting in a 35.5 percent decline in its net imports.