Global climate change impacts and the supply of agricultural commodities to Europe

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The EEA has addressed the consequences of climate change in numerous reports, including Climate change, impacts and vulnerability in Europe 2016, the 2019 report Climate change adaptation in the agriculture sector in Europe and the European environment — state and outlook 2020 report. This briefing analyses the implications for Europe of the impact of global climate change on agricultural trade.

Key messages

Climate change is projected to affect the agricultural sector, altering regional crop growing conditions and pest incidence. Although global aggregate agricultural production is not projected to decline before 2050, suitable production zones will shift, annual yields will become more variable, and price volatility of agricultural commodities will increase. This will affect cultivation patterns, international trade and regional markets.

While Europe is, by and large, self-sufficient in terms of cereals and vegetables, the supply of imported tropical products and commodities for animal feed and processing is vulnerable, either because production is concentrated in relatively few countries, or because of vulnerability to climate change, or a combination of both.

Trade diversification, through either trading with more countries or diversifying the import portfolio, could reduce the risk of supply disruptions. This, however, is not applicable to all commodities and relies on private action rather than public policy.

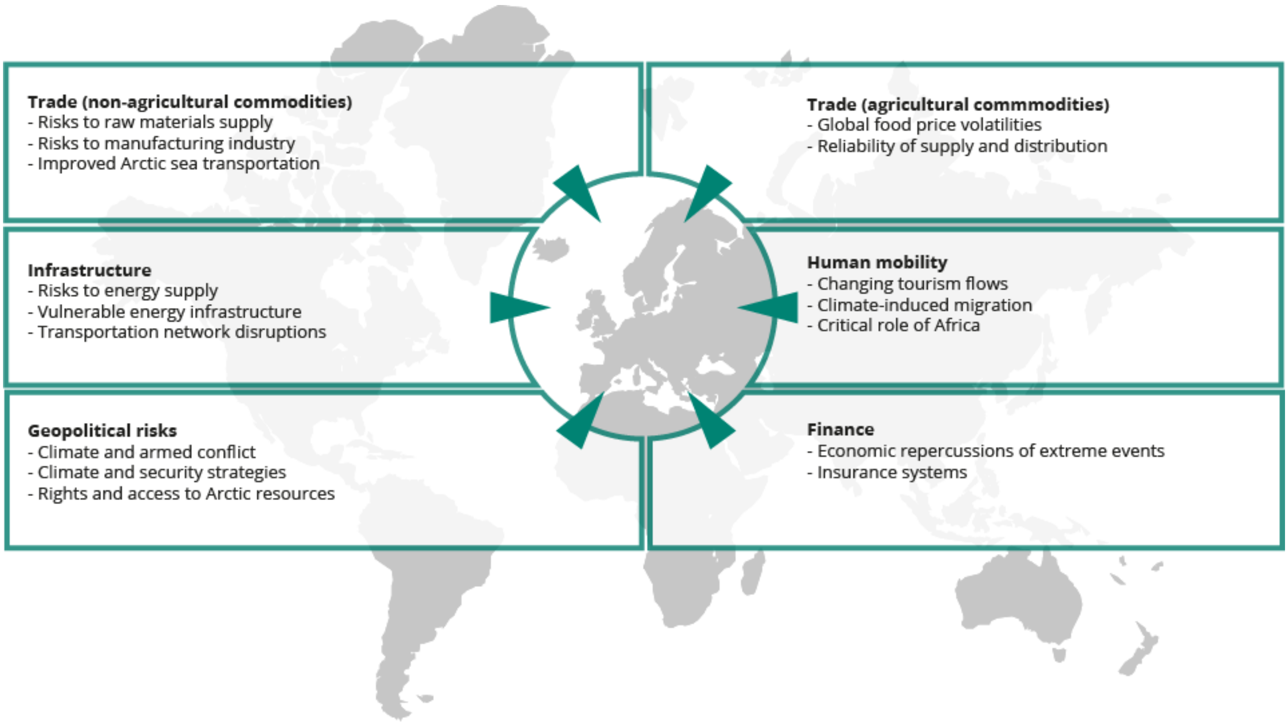
Public policy can help to avoid supply risks by reducing demand for vulnerable produce altogether, which is opportune for products associated with high environmental pressures.

More EU support for international adaptation to climate change is needed, particularly capacity building in producing countries, as announced in the blueprint for the new EU adaptation strategy. Sustainability paragraphs in EU trade agreements could drive necessary investments.

Assessing transboundary risks of climate change

The impacts of climate change in one region can spill over to another through a range of mechanisms, including trade, infrastructure and finance (see Figure 1). The associated systemic risks are being increasingly recognised and are subject to ongoing research [1]. National assessments of transboundary climate risks, however, are still scarce (AWB, 2020).

Figure 1. Transboundary risks resulting from global climate change impacts



Note: The impact pathways have been placed arbitrarily on the map; therefore, the arrows do not indicate any predominant geographic direction from which these impacts might affect Europe.
Source: EEA (2017).

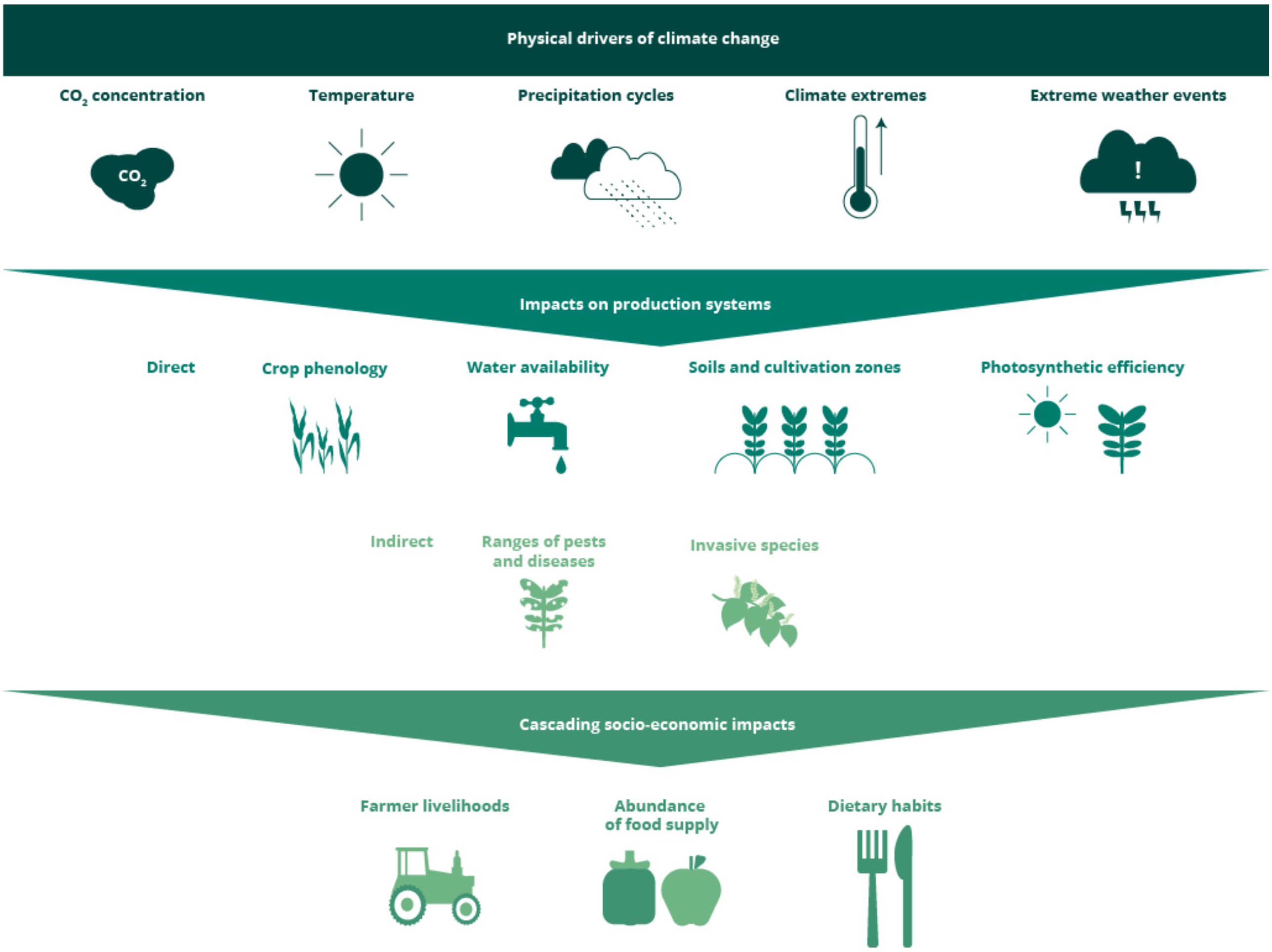
This briefing is based on a study commissioned by the EEA (Arvis et al., 2020), combining information on global climate change impacts on agricultural production with information on the EU's import profile and evidence on the vulnerability of the products' countries of origin to climate change. The most important commodities imported to the EU in terms of volume and value were identified using Eurostat data. The risk to their supply was judged based on both the distribution of suppliers (supplier or trade concentration) and the vulnerability of suppliers to climate change (climate vulnerability).

Climate change and agricultural production

Agriculture is one of the socio-economic sectors most sensitive to climate change, dependent as it is on soil characteristics, weather patterns and biodiversity (EEA, 2019, 2020). Climate change affects precipitation, water flows, humidity and temperature. The frequency and magnitude of extreme weather and climate events will increase, and the distribution and abundance of pest species and pollinators may change (Bocci and Smanis, 2019; see also Figure 2). These changes will influence crop growth, phenology and yields, ultimately leading to shifts in zones suitable for cultivation and land use changes (Ceglar et al., 2019).

Assessing the regional impacts of climate change on agricultural yields is not straightforward. They vary with crop type, latitude and altitude, and need to be disentangled from other productivity factors, such as technological progress, agricultural practices and regular inter-annual variation. In addition, the role of higher atmospheric CO_2 concentrations in increasing photosynthetic activity, countering negative climate change impacts, is still being debated (Sultan and Gaetani, 2016). The findings of Lobell et al. (2011) point to a relative suppression of maize and wheat production since 1980, compared with a theoretical scenario without climate change. Climate change appears to have negatively affected productivity for major food crops in Europe and sub-Saharan Africa in recent decades, while effects seem to have been positive in Latin America and variable in North America and Asia (Ray et al., 2019). This mixed picture is projected to continue until mid-century, with a loss in global aggregate production of cereal crops expected only after 2050 (Challinor et al., 2014).

Figure 2. Impacts of climate change on agriculture



Source: Arvis et al. (2020).

Findings from the Joint Research Centre's PESETA IV project (Feyen et al., 2020) suggest that, up to 2050 [2], grain maize yields will decline by between 1 % and 22 % in the EU, and wheat yields in southern Europe by up to 49 %. In northern Europe, yields are projected to increase by between 5 % and 16 % (Hristov et al., 2020). Annual climate variability accounts for up to half of yield variance, depending on the crop and the region (Vogel et al., 2019). Considering that the frequency and severity of extremes will be aggravated by climate change (IPCC, 2014), increased volatility is to be expected.

International agricultural trade and market mechanisms

Nearly a quarter of food for human consumption is traded on international markets (D'Odorico et al., 2014). This proportion varies widely by commodity, however. For rice, butter and pork, it is below 10 %. For soybean, vegetable oils, fish and sugar, it exceeds 30 %. Maize, beef and wheat are intermediate, with 12 %, 15 % and 24 %, respectively. These proportions are expected to remain steady for the next decade (FAO and OECD, 2018) but to slightly increase by mid-century because of climate change (Cui et al., 2018).

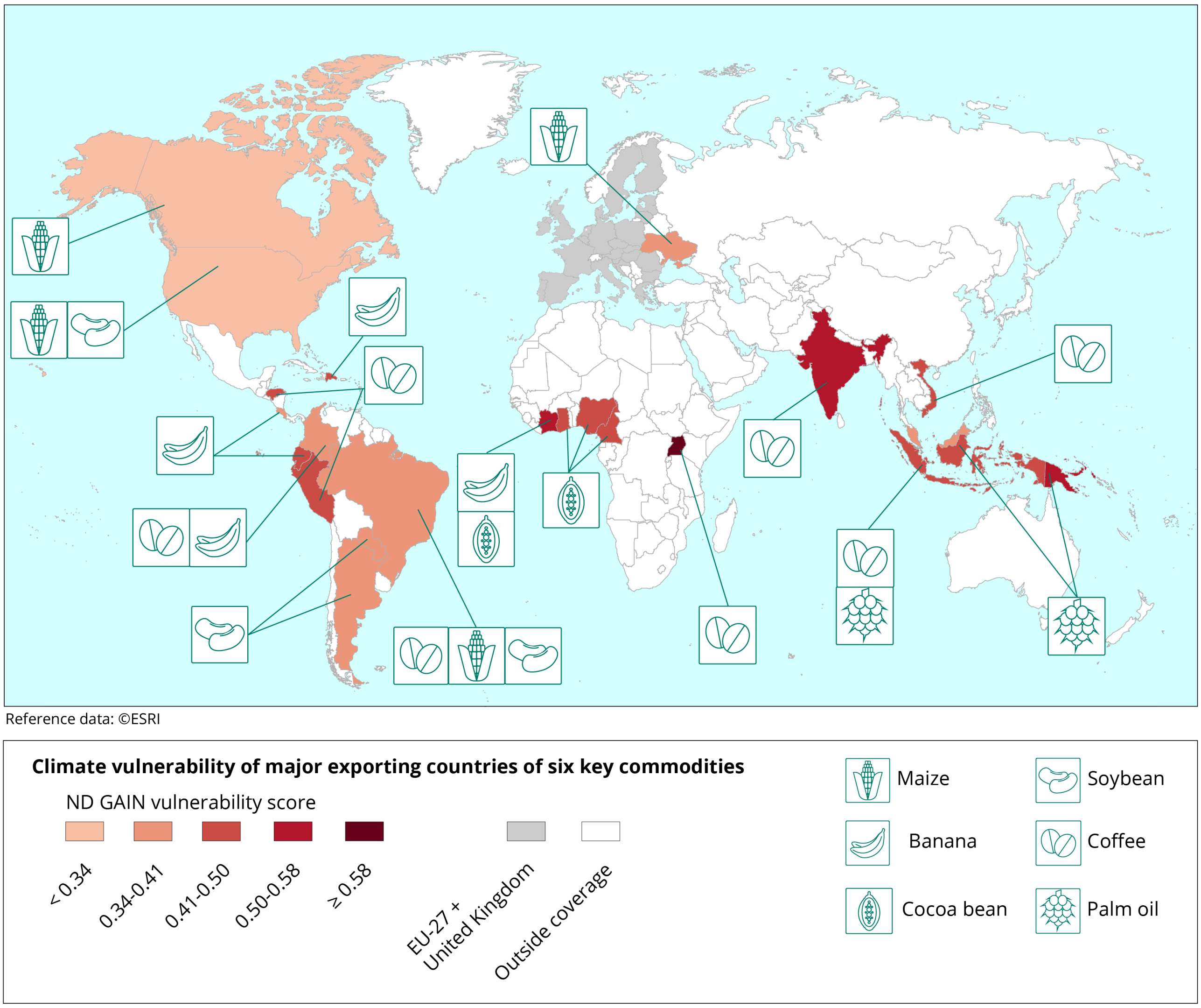
The demand for and supply of agricultural commodities vary little, or at least slowly, in response to changes in price. This means that shortages or oversupplies can lead to price swings. Trade can in theory dampen price volatility by buffering demand and supply across regions (Liapis, 2012). This applies particularly for grains that can be stored from one year to the next. Seasonality and buffer stocks (roughly 12 % of annual production, excluding China) play an important role in price formation (Wright, 2011).

Since 1970, global food supply has largely kept pace with growing demand resulting from population growth and rising incomes (Liapis, 2012). In the coming decade, this is expected to remain the case because of technological progress (FAO and OECD, 2018). In the longer term, however, the impacts of climate change are likely to kick in and affect productivity, with prices expected to rise significantly (Headey, 2011). Climate change can also affect trade by disrupting transport and distribution chains (Tamiotti et al., 2009).

Climate change-related vulnerability of supply to Europe

Europe is a major exporter of processed food and dairy products and, by and large, is self-sufficient in terms of the main staple foods such as grains (wheat, barley) and vegetables. This means that there are no immediate food security concerns in Europe related to climate change impacts elsewhere. However, Europe is heavily reliant on imports of products for animal feed (soybean and maize); products grown in tropical regions (e.g. cocoa, coffee, bananas); and commodities for secondary processing (e.g. palm oil, beet and cane sugar).

Figure 3. Climate vulnerability of major exporting countries of six key commodities

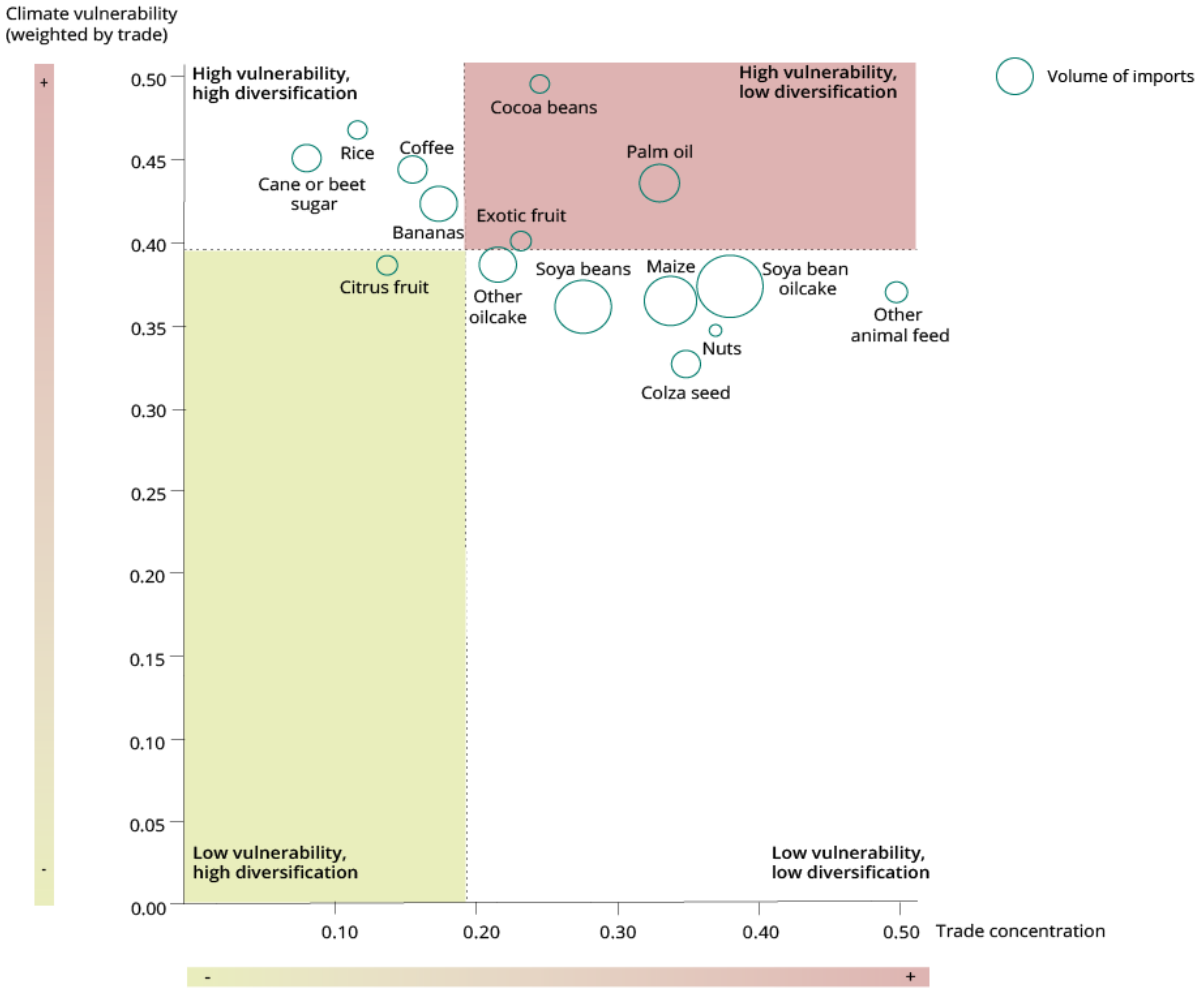


Note: Major exporting countries refers to those accounting for the top 80 % of European imports. Vulnerability score is according to the Notre Dame Global Adaptation Initiative (ND-GAIN)[3] , with higher values indicating higher vulnerability to climate change.
Source: Arvis et al., 2020.

Figure 3 shows the major countries of origin of selected commodities imported into Europe, and their climate-related vulnerability score according to the Notre Dame Global Adaptation Initiative (ND-GAIN) (Chen, et al., 2015). Producer concentration is high; 78% of EU palm oil imports is from Malaysia and Indonesia;72 % of imported soybean is from Brazil and the United States; 87 % of imported soya oilcake comes from Brazil and Argentina; and 71 % of imported maize is from Brazil and Ukraine.

Figure 4 shows the concentration of suppliers and their vulnerability to climate-related factors for the main commodities imported into Europe, again using ND GAIN vulnerability scores. Supplies of cocoa beans, palm oil and exotic fruit are likely to be particularly vulnerable, as these commodities are highly vulnerable to climate-related factors and their suppliers are highly concentrated in certain countries. Other commodities stand out because of their highly concentrated trade (e.g. soybean, soybean oilcake, maize) or their high level of vulnerability to climate change (e.g. rice, coffee, bananas). The former are more susceptible to short-term shocks (i.e. seasonal variability and harvest failure) and the latter to incremental climate change and shifting production areas.

Figure 4. Vulnerability matrix for the main agricultural commodities imported into Europe



Note: Trade concentration was assessed using the Herfindahl-Hirschman Index by World Bank [4] with higher values indicating dependence on a smaller number of producing countries. Climate vulnerability was assessed using the average ND-GAIN vulnerability score of the exporting countries involved, weighted by trade volume, with higher values indicating higher vulnerability to climate change [5].
Source: Arvis et al. (2020).

Policy aspects

The growing knowledge and recognition of the indirect impacts of climate change calls for more integration of transboundary aspects into EU and national adaptation policies (AWB, 2020). The current EU adaptation strategy focuses on the direct impacts of climate change on the EU territory only (EC, 2018a). However, the blueprint for the new EU adaptation strategy includes reinforced global action for climate resilience as one of its key focus areas (EC, 2020).

At the national level, transboundary impacts are not yet widely addressed. In a questionnaire sent to EEA member countries in 2018, only 5 out of the 24 countries that responded stated that transboundary impacts were considered in their national climate change impact and vulnerability assessments; seven more viewed these impacts as a priority area of research (EEA, 2018a).

Trade diversification, through either establishing trade relations with more countries producing the same commodity or diversifying the import portfolio, can reduce the risk of supply disruptions to some extent. However, this is not generally applicable to all commodities and relies mainly on private action. Reducing demand through top-down policies and consumer-oriented approaches is an option for products associated with high environmental pressures, such as palm oil and soybean.

Another approach is to build capacity in producing countries, through knowledge sharing on good practices in the exporting regions most vulnerable to climate change. Trade agreements, particularly their sustainability paragraphs, could provide a concrete mechanism for fostering resilience at source and diminishing the risk of supply disruption.

As for knowledge development in support of adaptation policy, scenario-based approaches examining the impact of climate change on supply and demand mechanisms would be useful. Developing such a forward-looking perspective would be in line with the current European Commission’s increased focus on strategic foresight.

Notes

[1] see for example project “Cascading climate risks: towards adaptive and resilient European societies” https://www.cascades.eu/

[2] Under an intermediate emission scenario (representative concentration pathway (RCP) 4.5) and high-end emission scenario (RCP 8.5), with assumed average global temperature rises of 1.5 and 2.7 °C, respectively.

[3] Data: https://gain.nd.edu/our-work/country-index/rankings/

[4] Data: https://tcdata360.worldbank.org/indicators/hh.mkt

[5] ND-GAIN data:https://gain.nd.edu/our-work/country-index/rankings/, calculation details in Arvis et al. (2020)

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