Exposure of the EU-28 food imports to extreme weather disasters in exporting countries

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Abstract

EU-28 relies on a diversified foreign market, even for crops for which it has a high self-sufficiency. This study contributes to the discussion on the vulnerability of agri-food supply to the impacts of extreme weather disasters (EWD). We focus on the largest import commodities of the EU-28 and we aim to (1) map external dependencies of EU-28 agri-food sector, (2) estimate the impact of EWD on crop production in countries from which the EU-28 receives their imports, and (3) assess the exposure of EU-28 agri-food imports to such impacts. Crop and trade data are acquired through EUROSTAT and FAOSTAT, EWD records from EM-DAT, all between 1961 and 2016. A superposed epoch analysis is used to estimate the impact of EWD on the average national production, yield and harvested area of selected crops in exporting countries.

The EU-28 imports between 35-100% of its consumption of soybeans, banana, tropical fruits, coffee and cocoa. Our study reveals a substantial impact of EWD, especially due to droughts and heat waves, on the production of soybeans, tropical fruits, and cocoa, with import weighted impacts of 3, 8, and 7%, respectively. Floods cause weighted impacts of 7% (soybeans) and 8% (tropical fruits). Coffee production shows gains during cold waves, but the inter-annual variability offsets these effects.

This study provides conclusions that may support EU-28 on the development of adaptation schemes in external supplier countries to secure EU-28 food supply. Such schemes may prioritize provisions contributing for the stability of crop production and incomes in those countries, while dealing with future adverse EWD impacts.

Keywords: extreme weather disasters, crop production, yield, harvested area, EU-28 exporting countries, EU-28 import share-weighted impacts

1. Introduction

Extreme weather events can cause damage to crops and food production systems, and associated price spikes have the potential to destabilize food systems and threaten local to global food security (Lesk et al., 2016; Nelson et al., 2014; Rosenzweig et al., 2014). The severity of an extreme weather event and the vulnerability and exposure of the human and natural systems to it will determine whether it results in a disaster (IPCC, 2012).

In the last four decades, droughts and heat waves have caused between 1200 and 1800 million tons of losses in national maize, rice, and wheat production, respectively (Lesk et al., 2016). Jägermeyr & Frieler (2018) confirm these findings with global crop modeling and show that heat waves and droughts predominantly affect rainfed rather than irrigated yields.

This first line of evidence suggests that damages are about 10% stronger in developed countries (Europe, North America and Australasia) compared to the developing world (Asia and Africa), where the crop and management diversification across many small fields allows for drought resistance (Lesk et al., 2016). In addition, the authors also stress that smallholders tend to minimize the risk of crop loss, whereas in higher-income countries the priority is to maximize yield, and mostly in large-scale monocultures, which compromise the resistance to droughts.

The EWD impacts on specific crops in tropical export-oriented countries and associated implications through trade dependencies have, however, not been explored in that study.

Our study is focused on the exposure of 28-Member States of the European Union (EU-28) agri-food supply to extreme weather disasters (EWD). The EU-28 is one of the world's largest suppliers and producers of food (EU, 2018). Previously published impacts of EWD on agricultural production within the EU-28 are summarized in Table A1 (in the appendix). As a central example, during the 2003 heat wave >10% declines in crop yields were reported in Italy, Germany, Austria, Spain, France, and Portugal (Jägermeyr et al., 2018). Wheat and maize were the most damaged crops, with reductions of 11% (10 Mt) and 21% (9 Mt), respectively (COPA-COGECA, 2003). Impacts were amplified regionally, across the Iberian Peninsula, cereals production fell on average by 40% during the 2004-2005 drought (EEA, 2010).

Extreme weather implications for the European food production system causes higher food import demands, but exporting countries can be affected as well (IPCC, 2014). Consequently, in view of potential future aggravations in global extreme weather event frequency and intensity due to climate change (Hanks et al., 2014; IPCC, 2012, 2014), there are growing concerns about Europe's food availability and access not just in terms of its own production, but especially cascading effects due to trade dependencies. In fact, Europe is the world's biggest importer of food, with about 70% of food imports from the developing world, regions considered highly vulnerable to climate change (EU, 2018; Hanks et al., 2014; IPCC, 2014). Trade dependencies propagate weather-related food production shocks throughout the global food system (Puma et al., 2015; Rosenzweig et al., 2001) and the reliance of the global food system on trade is expected to become even more substantial (Brooks et al., 2015).

This study sets out to (1) map the external dependency of the EU-28 agri-food sector, (2) estimate the impact of EWD on crop production, yield and harvested area in countries from which the EU-28 receives their imports (also referred as exporting countries or external supplier countries throughout the text), and (3) assess the exposure of the EU-28 agri-food imports to such weather-related shocks. This work does not consider any market or economic analysis, assumed as a limitation for a complete food security assessment.

2. Methods

2.1. Mapping external dependency and sufficiency of EU-28 agri-food supply

The EU-28 imported crop categories, between 2005 and 2014, are selected trough EUROSTAT (EUROSTAT, 2016) and FAOSTAT (FAO, 2017). Datasets used in this study are listed in Table 1. Processed food products are not considered for the analysis, as it is difficult to identify the exporting countries providing production statistics of such commodities. From the 48 crop categories imported by EU-28, we selected the following 12, representing 86% (in quantity) of the total imported: (1) soybeans, (2) maize, (3) wheat and meslin, (4) bananas, (5) rice, (6) cane or beet sugar, (7) coffee, (8) rape or colza seeds, (9) citrus fruit, (10) cocoa, (11) tropical fruits (dates, figs, pineapples, avocados, guavas, mangoes) and (12) apples, pears and quinces. For these crops, the import dependency and self-sufficiency are calculated, according to equations (1) and (2) respectively, by using data on imports, exports and production reported for EU-28 along ten years. The food import dependency means the reliance on imports for a country's food consumption needs, while food self-sufficiency refers to a country's ability to meet its own food requirements from domestic production without imports (Clapp, 2015). For simplification, and due to lack of data, crop reserves are not considered in the equations.

Eq. (1):

$$\mathrm{Id_{crop}} = (\sum_{i=1}^{10} \mathrm{I_{crop}})/(\sum_{i=1}^{10} \mathrm{P_{crop}} + \mathrm{I_{crop}} - \mathrm{E_{crop}}) * 100$$

Eq. (2):

$$\mathrm{Ss}_{\mathrm{crop}} = \left(\sum_{i=1}^{10} \mathrm{P}_{\mathrm{crop}} \right) / \left(\sum_{i=1}^{10} \mathrm{P}_{\mathrm{crop}} + \mathrm{I}_{\mathrm{crop}} - \mathrm{E}_{\mathrm{crop}} \right) * 100$$

Where,

Id_{crop} = Crop import dependency (%)

SS_{crop} = Crop self-sufficiency (%)

I_{crop} = Crop imports (tonnes)

P_{crop} = Crop production (tonnes)

E_{crop} = Crop exports (tonnes)

crop = each of the twelve crops

i = number of years, from 2005 to 2014

By selecting the world exporting countries supplying at least 95% of each crop (in quantity) to EU-28, we can map the main exporting countries per crop and the geographic distribution of EU-28 import dependency (Figure 1). Figure 2a shows that the EU-28 exhibits a self-sufficiency above 70% for rice, citrus, maize, rape and colza seeds, apples, pears, quinces, wheat, and sugar beet, even though these crops are among the 12 most imported in quantity. In fact, wheat, apples, pears, and quinces, show an EU-28 self-sufficiency above 100%, meaning that the region produces more than what it consumes, and the remainder is exported.

For soybeans, bananas, tropical fruits, coffee, and cocoa, the EU-28 self-sufficiency is below 9%, and 35 to 100% is being imported (between 2005 and 2014). The EU-28 import dependency of coffee is even higher than 100% as there are coffee exports, but no production. Soybeans shows a similar picture; demand exceeds by far the internal production mostly due to the livestock sector (Ercin et al., 2016).

Figure 2b presents the 41 countries that collectively provide more than 35% of the EU-28 imports for soybeans, banana, tropical fruits, coffee and cocoa. Soybeans is mostly provided by North American and South American countries, banana from Central and South American countries, tropical fruits mostly from Central America, coffee from South America and Asia, and cocoa from the African countries. Those are the five crops and the exporting countries that are considered for further assessment of the impact of EWD on crop production, yield, and harvested (section 2.2).

2.2. Impact of EWD on crop production in exporting countries supplying the EU-28

We use a Superposed Epoch Analysis (SEA), a time series statistical method used in data analysis, to isolate the average response signal of EWD on national crop production, while reducing noise due to extraneous variables, such as human decision making and agronomic management. This methodology is based in Lesk et al., 2016 who estimated national cereal production losses across the globe resulting from reported EWD, and in Jägermeyr et al., 2018 who represented spatially explicit information of growing seasons and surface water constraints in global gridded crop model simulations to quantify, through a SEA, the associated gains in model performance regarding annual fluctuations in national maize and wheat yields. The SEA analysis, also known as compositing, was mainly introduced by Mass et al., 1989.

The SEA is applied to national production, yield and harvested area from each of the five crops supplied by each exporting country. Crop data are obtained from FAOSTAT, between 1961 and 2016. The cases of banana from Suriname, tropical fruits from Panama and Ghana, coffee from Ethiopia, and cocoa from Togo and Guinea were excluded from the analysis since there is missing data on production, yield and/or harvested area. Therefore, this analysis consideres 37 out of the 41 external supplier countries.

Data on EWD is gathered for the same period through The International Disaster Database (EM-DAT, 2018). According to EM-DAT, for a disaster to be entered into the database at least one of the following criteria must be fulfilled: ten or more people reported killed, one hundred or more people reported affected, declaration of a state of emergency or call for international assistance. For this study we consider floods, droughts, heat waves and cold waves.

Due to an increasing trend in crop production, yield and harvested area, observational data are detrended before conducting the SEA. The trend is removed by subtracting the linear best-fit function from each time series. The result is a time series with normalized fluctuations from year to year.

As in Lesk et al., 2016, from each time series of crop production (i.e. one time series per crop and per exporting country) we extract shorter time series using a 7-year window centered on the year of occurrence of an EWD type, with 3 years of data preceding and following the event. For example, if in the period of analysis, ten years of droughts are reported (in non-consecutive years), then we would have ten time series of a 7-years window centered in each drought (which we call "Drought TS"). For production time series, this procedure is implemented four times, one per EWD type. Each 7-year window time series is normalized (year-wise) to the average of the 3 years preceding and following the EWD. We stress that the average of those six adjacent years is calculated only for the years with no EWD of the same type (i.e. non-disaster years). Therefore, whenever there is an EWD in one of the 3 years preceding and following the event, that year is excluded from calculating the mean. Also, for the same reason, the EWD occurring between 1961 and 1963, and 2014 and 2016 are not considered. Whenever an EWD of the same type occurs in multi-years, we average crop production across all EWD years to produce a single disaster year datum, which is then centered in the 3 years preceding and following the event. This procedure results in a reduction in the total number of events since the average of sequential EWD years (of same type) is considered as one event. By centering the time series in EWD years we are strengthening the signal (positive or negative) at the year of the event while also cancelling the noise in the non-disaster years. After implementing those procedures, we obtain a composite which is the mean of all the time series for an EWD type (in the above given example the composite would be the column average of the “Drought TS”). A list of the EWD that took place in the exporting countries supplying the EU-28 with each crop is provided on Tables A2-A4. These are the EWD considered in this study.

The composites are calculated by the following approaches: 1st) by aggregating all time series per EWD type, regardless the crop, and 2nd) by aggregating the time series of the exporting countries supplying the EU-28 with each crop. This is done to enlarge our samples of EWD and to detect whether there is a signal in production data corresponding to when the disasters occurred.

We combine droughts and heat waves in the same composite and then perform the analysis by aggregated and by individual crops. Since the effect of those events on crop production may be offset, or even enhanced, if the crop is irrigated and/or if grown in a tropical wet climate (characterized by high surface temperatures with plentiful precipitation), we also analyze the effect of droughts and heat waves by considering only the exporting countries supplying the EU-28 with crops grown in rainfed and non-tropical systems (Table A5). For that case, only the countries with a percentage of irrigated harvested area higher than 40% are removed from the analysis. The percentage of irrigated area per crop, in each exporting country, is calculated through the ratio of the irrigated harvested area (provided by AQUASTAT (FAO, 2016)) with the total harvested area (provided by FAOSTAT (FAO, 2017)). This is calculated only for the most recent year with information available in AQUASTAT. According to the Koppen-Geiger classification (Kottek et al., 2006), exporting countries having ‘Tropical rainforest climate’ (Af) and ‘Tropical monsoon climate’ (Am) as a dominant climate classification are removed from the analysis.

For simplification an equal weight is attributed to all EWD regardless the EWD type, location, duration and impact. The above-mentioned procedure is applied to production, yield and harvested area time series, in total 12 time series per crop (i.e. a time series for production, yield, and harvested area considering the impact of floods, the combined droughts and heat waves, and cold waves).

With the SEA we estimate the associated loss or gain in production, yield and harvested area of each crop. The assessment of the statistical significance of the averaged normalized mean at the EWD years is performed from bootstrap replicate data sets, which are obtained by resampling (with replacement) the time series with absolute values of crop production, yield and harvested area. Bootstrapping resamples a dataset with replacement thousands of times to create simulated datasets. Specifically, per each crop and EWD type, each one of the 7-years’ time series is resampled (column-base), while applying the SEA, to create 1000 different composites. The normality of the normalized 1000 means at the EWD years is assessed with the histogram. For all crops we observe a normal distribution, therefore, for simplification, and as an example, histograms showing a normal distribution of the data are presented only for the resampled normalized means of aggregated crop production (Figure A1). The normalized mean at the EWD year of the 1000 resamples is considered to be statistically significant for the confidence intervals (CI) of 95%, 90%, 85%, 80%, and not significant for CI below 80%. This technique is well adopted in statistical models linking climate and crop yields (Leng et al., 2017). The MATLAB code to create a bootstrap to replicate a data set can be found at: https://www.mathworks.com/help/stats/datasample.html.

2.3. Exposure of EU-28 agri-food imports

The averaged impact estimated for each crop and EWD type (section 2.2), results from the arithmetic average of the impacts estimated from all the EWD that occurred in external supplier countries. This means that, among all the exporting countries supplying the EU-28, only the ones with reported EWD are considered for the estimation of the averaged impact in that crop. To elaborate on the exposure of the EU-28 agri-food imports due to the occurrence of EWD in the crop exporting countries, we estimate the import share-weighted impact of those events on crop production by considering the import share per exporting country. For each crop, the import share-weighted impact of each EWD type is done by: i) calculating the normalized composite of the estimated impact for each exporting country, ii) multiplying the normalized composite by the corresponding import weight to EU-28. The weighting scheme allows us to draw direct conclusions of the overall exposure of EU-28 agri-food imports to specific EWD types across exporting countries. This analysis is performed only for the statistically significant impacts of EWD on crop production.

3. Results

3.1. Assessing the impact of EWD in crop production in the exporting countries supplying the EU-28

The Superposed Epoch Analysis (SEA) is applied to the 37 countries (Figure 2b) supplying the five crops for which EU-28 had an import dependency above 35% (soybeans, banana, tropical fruits, coffee and cocoa). This provides a good sample size of EWD (310 floods, 190 droughts and heat waves and 56 cold waves) to estimate its impacts on crop production, yield, and harvested area, with importance for the EU-28 food supply regarding exporting countries.

The results on the impact of each type of EWD, including its statistical significance, for aggregated and individual crops, are shown in Figure 3. By aggregating the five crops (Figure 2, 1st row) the results are the following ones: during years of floods an average loss of -2% and -1% (CI 95%) is observed for crop production and yield, respectively. During years of droughts and heat waves, an average impact on the aggregated crop production of -1% (CI 80%) is observed, although for yield and harvested area no significant impact is detected (since the CI is below 80%, i.e. not statistically significant (n.s.)). We did not find statistically significant impacts from droughts and heat waves in rainfed or in non-tropical systems (Figure A2).

Overall, considering the different EWD, the aggregation across crops results in smaller average impacts as specific crops can have opposing responses under the same EWD type. We therefore present results individually for each crop hereinafter: (a) Soybeans - both production and yields were negatively affected by floods (-7% and -5%, respectively, CI 95%) and droughts and heat waves (-4% and -3%, respectively, CI 95%). The average impact of these events in production is estimated in a loss of 555 Mt; (b) Banana - production and yield declined by 6% (CI 95%) and 10% (CI 95%), respectively during cold waves, while harvested area was found to increase by 5% (CI 95%). Yields were also negatively impacted by floods, by -5% (CI 95%), while the harvested area increased by 3% (CI 75%). Droughts and heat waves did not have significant impacts on production, yield, or harvested area; (c) Tropical fruits – production was negatively affected by floods (-4%, CI 95%) and droughts and heat waves (-3%, CI 95%). The overall impact in years of these events represent a loss of nearly 40 Mt. The low relative negative impact in yield is statistically significant for floods (-1%, CI 80%) and for droughts and heat waves (-2%, CI 90%); (d) Coffee – a positive response to the EWD types analysed here is detected. Both production and yield increase during droughts and heat waves by 2% (CI 80% and 90%), respectively, as well as, during cold waves by 4% and 3%, respectively (CI 95%). However, we find a substantial decrease in production and yield in the year after the extreme event (by about 7%, respectively). The effect of flood is not statistically significant for production and harvested area, but yield increased by 1% (CI 80%); (e) Cocoa – we detect significant losses during years of droughts and heat waves by -6% (CI 75%, equivalent to 6 Mt), -2%, and -3% (CI 90%) for production, yield, and harvested area, respectively.

3.2. Assessing the exposure of EU-28 agri-food imports

Soybeans, tropical fruits, and cocoa show the largest impact during EWD years, which can have potential implications for the EU-28 agri-food supply. We therefore weight country-level EWD impacts by EU-28 import shares, which highlights the EU-28 exposure (Figure 4). The combined impact from floods, and from droughts and heat waves in soybeans production was -11% (-7% from floods and -4.3% from droughts and heat waves). However, the import share-weighted impact was -9%, meaning that the negative impact is higher in exporting countries from which EU-28 has a lower import dependency. For tropical fruits the picture is different, the arithmetic mean production impact of about -7%, caused by both floods and droughts and heat waves together, more than doubles to about -16% when weighted by import shares. This indicates that most of the crop loss occurs in exporting countries from which EU-28 has a higher import share. The import share-weighted impact of droughts and heat waves in cocoa production (-7%) is slightly higher comparing with the average impact in exporting countries (-6%).

Banana and coffee are crops for which there is not a potential implication for the EU-28 agri-food supply. Cold waves negatively impacted banana production (-6%) but those events took place only in Brazil and Belize (Table A2), which together represent only 3% of the EU-28 import share of that crop and thus the weighted banana exposure is marginal. Coffee production increased, on average, during years with cold waves and droughts and heat waves with an overall gain of nearly 6%. This overall impact slightly decreases to 4% (mostly due to cold waves) when considering the share of EU-28 imports per external supplier countries. This could be explained with the fact that nearly 70% of the cold waves took place in a group of exporting countries representing a lower share of EU-28 coffee imports (8%). Therefore, the weighted coffee gain decreases comparing with the overall gain.

4. Discussion

The 12 crops most imported by EU-28 are provided by a diversified foreign market since, for most external suppliers, the dependency on imports is below 10%. Seven of those crops are largely grown in the EU-28, with a self-sufficiency above 70%. For the other five crops (i.e. soybeans, banana, tropical fruits, coffee and cocoa) more than 35% of what is consumed in EU-28 is produced in 41 exporting countries.

The SEA revealed significant negative impacts from EWD on soybeans, banana, tropical fruits and cocoa in exporting countries. Despite a diversified external market, the impacts from EWD in soybeans, tropical fruits and cocoa, have the potential to negatively affect the EU-28 imports of these crops. For banana the EU-28 import share-weighted impact is negligible. Coffee production shows gains during cold waves but consistent loss in the following year with large inter-annual variability, in general, offsets these effects (see discussion below).

The estimated loss in soybeans production represents an EU-28 import share-weighted impact of -9%, and this negative impact is higher in exporting countries from where EU-28 has a lower import dependency. Nevertheless, such impact may imply a potential decrease on the crop availability in the EU-28 market. Since soybeans is a common substitute of wheat and maize, any fluctuation on its production, and consequently on its prices, may influence the demand and supply chain of the other commodities as well (Ercin et al., 2016).

The impact of floods in soybeans crops have been reported for many areas of the United States of America and the world (Sullivan et al., 2001), and vary according to the crop growth stage during the flood, the duration of the flooding or if in presence, or not, of a flood-tolerant soybean variety (Wu et al., 2017). Such factors were not, however, considered during this first national-level analysis and would be useful for further risk assessments. Flooding can cause physical injuries and anaerobic stress to soybean crops, which in turn can result in a poor vegetative growth and in a low photosynthetic activity, leading to yield loss (Tewari et al., 2016). Our estimation on the impact of droughts and heat waves in soybeans production is in line with Siebers et al. (2015) who, by using infrared heating technology in an open-air field experiment, as a way to impose heat waves on soybeans, showed that short high-temperature stress events resulted in losses in crop production in the Midwest, in the USA.

We found that cold waves and floods lead to increased banana harvested area, indicating that these events might not have been harmful for the entire area, or that the impact was offset as a result of farmer decision when faced by beneficial economic influences such as governmental subsidies (Iizumi et al., 2015). During years of droughts and heat waves, no significant impact is observed in banana production, yield or harvested area. Most of the exporting countries that are banana growers are under the influence of a wet tropical climate or use irrigation, which are factors that can offset the impact during those events. As demonstrated by Jägermeyr et al., 2018, at the global scale, heat wave and drought events predominantly affect rainfed over irrigated yields and in case water demand is fulfilled (through irrigation, or as a result of a humid climate), the additional available radiation during those years can offset losses, or even be beneficial for crop growth. This might also contribute to the observed gains in coffee production during droughts and heat waves.

For tropical fruits, there is a high exposure of EU-28 imports to the impact of EWD. The adverse effect of floods is significant for crop production, yield and (in a less extend) harvested area. This indicates a potential trend for complete crop failure during years with floods. Nonetheless, one year after floods, there are no changes on average production and harvested area, meaning that the crop potentially recovers from the impact.

Cocoa production is substantially affected by droughts and heat waves, with import share-weighted impact of nearly -7%. This comes with a lagged effect and even higher observed losses in the first year after the event. Such multi-year impact of droughts and heat waves might affect the recovery of perennial crops and soil moisture, but also changes in planting habits (see discussions in Lesk et al. (2016) on cereals). Since the EU-28 completely relies on cocoa imports to satisfy its consumption, a weighted loss of 7% in cocoa production may have consequences to market speculations and may result in economic volatility.

This study assesses the impact from EWD in crops that were selected according to the EU-28 import-dependency ratio. Those are staple crops (such as soybeans, banana and some tropical fruits), which are considered important for caloric consumption in the EU-28, but are also cash crops (such as coffee and cocoa), which are not subsistence crops from the perspective of a healthy diet. A negative impact from EWD on the analyzed crops can potentially reduce the availability in the EU-28 but not directly impact the EU-28 food security. Import-induced market volatility, however, can lead to price spikes, which can have significant adverse effects on food access and, therefore, to the food security especially for the poor, while potentially exacerbating social unrest. A decrease in crop production among exporting countries can also potentially lead to market price speculations and, consequently, disturb the economic stability of the EU-28 food industries.

In order to guarantee the imports of cocoa, tropical fruits, and soybeans, the EU-28 could assist on adaptation schemes in exporting countries, for example by establishing partnerships for research and innovation in crop tolerance to extreme weathers, and by supporting the definition and implementation of disaster risk reduction and management actions, while also supporting the implementation of fair and ethical food policies. This would also be helpful to promote the stability on the production of such crops and, consequently, the stability of incomes in exporting countries, contributing for local food security.

The present study has research limitations that, if overcome, could substantially improve the obtained results. The presented impacts from EWD on crop production, yield, and harvested area are based on a first-order approach at national level with limited data availability. The effect of extreme weather disaster can be much stronger locally, especially in large countries where only part of the cultivated area is being affected. Not all the weather events with impact on agriculture are reported or classified as natural disasters recorded in EM-DAT. Information on the effects of local extreme events are tracked in local statistics only and not available at the international level (Kocur-Bera, 2018). We also did not attribute weights to the magnitude and duration of EWD as there is no such data available, meaning that we treated all events listed in the same way. Moreover, since we aggregated data for each crop from many external supplier countries, it could result in the attenuation of the impact of those events, i.e., losses in one country could be offset by gains among the others. The EWD were not selected based on the crop growth stage, and we did not consider the type of crops varieties in each country (i.e., if tolerant or not to a type of an EWD).

Future research could take advantage of data on EWD that occur in a medium to local scale. It could also be improved if benefited from a detailed georeferenced information on the agro-climatic zones from crop growing regions and on the major agricultural systems (i.e. if irrigated or not).

5. Conclusion

This study highlights the Extreme Weather Disasters (EWD) impacts on specific crops in export-oriented countries and presents the larger implications of such impacts through trade dependencies based on the import share per external supplier country. The focus is on the EU-28 agri-food sector, for which we mapped the external dependency and assessed its potential exposure to EWD. This was done by estimating the overall impact of EWD on production, yield, and harvested area in exporting countries. To the best of our knowledge this is the first study to perform it.

The EU-28 imports between 35-100% of its consumption of soybeans, banana, tropical fruits, coffee and cocoa, which are grown in 41 countries. Floods, droughts and heat waves significantly decreased the overall averaged production of soybeans (11%) and tropical fruits (7%), while cocoa production decreased (6%) during years with droughts and heat waves.

Despite a diversified external market, such losses represent a substantial negative exposure of EU-28 imports to EWD, namely from floods, that cause import share-weighted impacts of -7% (soybeans) and -8% (tropical fruits), while droughts and heat waves of -3% (soybeans), -8% (tropical fruits), and -7% (cocoa). Since the impacts from floods in tropical fruits, and from droughts and heat waves in cocoa, have a significant negative impact on the respective crop production, these events potentially imply negative consequence for EU-28 imports. This can potentially lead to market speculations and to higher volatility in commodity prices in the food industries.

In order to stabilize the EU-28 food imports, the European Union could support the implementation of adaptation schemes in external supplier countries. Improved crop production stability would be associated with important co-benefits regarding the stability of local incomes in exporting countries, and therefore contributing to local food security.

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Compliance with ethical standards

Conflict of interest

The authors declare that they have no conflict of interest with any organizations or individuals.

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