

Main Crops' Yield Risks of the Belt and Road Terrestrial Countries Under 1.5°C and 2°C Global Warming Scenarios

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Abstract

According to the Fifth IPCC Assessment Report, climate change poses severe risks to the Belt and Road region. To promote regional food security, this study examined yield risks in four staple crops (rice, wheat, maize, and soybeans) under 1.5°C and 2°C global warming scenarios. Yield data was derived from simulations of multiple climate-crop model ensembles from the Inter-Sectoral Impact Model Intercomparison Project. A threshold was defined as the 10th percentile of the reference period distribution (1986–2005) of crop yields. Then, adverse consequences on yield were assumed to arise once future crop yields were lower than the threshold. To quantify the likelihood of crop yield loss, the agreement of model combinations at which the threshold was crossed was calculated for each crop on a grid scale. Conclusions about crop loss and its risks were as follows: (1) Impacts of warming on yields differ between crop types and regions. The likelihood of yield loss in low-latitude regions was higher than that in mid-latitude regions for maize, rice, and soybeans. (2) Under a higher warming scenario, the mean yield loss likelihood would increase 0.16%–3.06% at low-latitude subregions but dropped by no more than 2% for subregions with higher latitudes. (3) Under 1.5°C global warming, the “risk zone” accounted for 37%, 35%, 25%, and 13% of growing areas for maize, wheat, rice, and soybeans, respectively. (4) The higher the warming, the larger the “risk zone”. When warming increased from 1.5°C to 2°C, the four crops’ calculated “newly added risk zones” would increase by 1.8%–3.5%. This study revealed patterns of yield loss risks for major crops in the Belt and Road in different warming scenarios and subregions and could provide some references for regional responses or adaptations to climate change in the agricultural system.

1 Introduction

The "Belt and Road Initiative" is a new model of international regional economic cooperation proposed by the Chinese government that aims to promote the economic development of countries along the route (Liu 2015). The "Belt and Road Initiative" advocates a green, low-carbon, circular, and sustainable way of life and production, and the establishment of the "Belt and Road Initiative" International Alliance for Green Development can provide assistance to relevant countries in dealing with climate change (Xi 2017). According to the fifth assessment report of the Intergovernmental Panel on Climate change (IPCC), most Belt and Road countries would experience significant temperature and precipitation increases by the end of the 21st century (2081–2100), which would be higher than the global average. Since 1951, the warming rate in this area is about 0.22°C per decade, nearly twice the global average (IPCC 2014). According to the relevant World Bank statistics for 2018, the total population of the Belt and Road terrestrial countries reached 4.7 billion, accounting for about 62% of the global total population. At the same time, there are more than 40 Belt and Road countries with a per capita GDP less than US \$10,000 (current US dollars). Therefore, countries in the Belt and Road with large populations and developing economies face a higher level of climate risk than the global average.

According to the Food and Agriculture Organization (FAO) of the United Nations, agriculture provides more than 80% of the energy in the human diet and supports the income of more than 2.6 billion people (FAO 2008). The goal set by the United Nations Framework Convention on Climate Change (UNFCCC)

emphasizes that the concentration of greenhouse gases in the atmosphere should be stabilized at a level that protects the climate system from dangerous man-made interference and guarantees ecosystem production and food yields. To ensure future food production security in the Belt and Road terrestrial countries, it is necessary to assess the risk to agricultural food production so as to provide a scientific basis for the formulation of international and regional agricultural adaptation policies to prevent and mitigate the risks that climate change may bring to food production.

If the future global average temperature rises by 1°C–2°C than that for periods before industrialization, the impact on food production will increase significantly. The decrease in crop yield will be reduced if the warming is limited to 1.5°C instead of 2°C (Hoegh-Guldberg et al. 2018). In addition, the rate of sea level rise by 2100 under the 1.5°C warming scenario will be about 30% less than that under the 2°C scenario (Schleussner et al. 2016). Compared with the 2°C warming scenario, the average increased temperature in Asia under the 1.5°C scenario will be reduced by 0.5°C–1.0°C and the precipitation increase in most areas will be reduced by 5–20% (Xu et al. 2017). To reduce the adverse effects of warming, the Paris Agreement set a target to limit global mean temperature to “well below 2°C” above pre-industrial levels and to pursue efforts to limit it to 1.5°C by the end of this century, recognizing that this would significantly reduce the risks of climate change. However, at present, there is a lack of research on the risk to crop yields under different warming scenarios in the Belt and Road terrestrial countries.

Grain production is mainly affected by environmental conditions (including climate, weather, soil, diseases, and insect pests) and management methods (including sowing date, irrigation, and fertilization). Future crop yields can be predicted based on model simulations. Previous studies have shown that there were regional differences in the impact of climate change on crop yield. At low latitudes, the temperature is very close to the high temperature threshold suitable for grain growth. If the temperature increases by 1°C–2°C, it will adversely affect the per unit grain yield (Gornall et al. 2010; Hatfield et al. 2011; Pranuthi and Tripathi 2018). In contrast, at high latitudes or altitudes, especially among grains and seed crops grown in the cold season, the per unit yield will increase and the reduction of frost will extend the range suitable for crops northward (Olesen et al. 2007; Di Paola et al. 2018). However, owing to differences among scenarios, climate models, and crop models, there is great uncertainty in the simulation results. For example, the CLMcrop model was used to simulate the per unit yield of C3 crops (such as wheat, soybean, and rice) and C4 crops (such as maize and sugarcane) under RCP4.5 and RCP8.5 scenarios. It was found that the change in crop yield under the RCP8.5 scenario was twice as much as that under the RCP4.5 scenario (Levis et al. 2018). In the RCP8.5 scenario, based on three climate models (GFDLESM2M, GISS-E2-H, and HadGEM2-ES) and the LINTUL5 crop model, it was found that the change in maize yield in Ghana in West Africa differed under different climate models, which may be related to varying solar radiation settings in each climate model (Srivastava et al. 2018). The simulation results of different crop models also varied. The uncertainty in crop models mainly comes from the uncertainty of the input of the climate model results and the crop model itself, such as the crop model structures and parameters. Due to these factors, crop models usually have greater uncertainty than climate models (Rosenzweig et al. 2014; Yin et al. 2015; zhang et al. 2019b) .

Previous studies mainly considered absolute or relative changes of future crop yields compared with the present or historical period, but there is still a lack of quantitative research on the risk possibility or likelihood of crop yield. The CERES model was applied to predict grain production under the future climate change scenario, and the agricultural grain production risk of Belt and Road countries was analyzed by comparing grain production between the benchmark period and a future period (Wu et al. 2018). However, the results of risk assessment may be affected by the uncertainty of a single crop model, besides, the risk pattern of agricultural grain production under different warming scenarios was not considered. In summary, under the warming scenarios of 1.5°C and 2°C, this study used the simulation results of ISI-MIP multimodel ensembles to evaluate the yield risks of main crops in the 65 terrestrial countries of Belt and Road, which may reduce the uncertainty of a single crop model and can contribute to risk adaptation and mitigation for this region.

2 Study Area

The "Belt and Road Initiative" is essentially an open, inclusive network of international and regional economic cooperation with no absolute boundary (Liu 2015). However, the scale and spatial scope are necessary for researches on geography. So, this article considered 65 terrestrial Belt and Road countries, including China and other 64 countries that signed cooperation documents with China at the early stage of the "Belt and Road Initiative". The geographic scope of the study area was 12°5'E–10°21'W, 81°51'N–10°59'S, covering most Eurasian countries and some regions in northern Africa (see S1). And the study area was divided into 7 subregions, referring to the website of the Belt and Road Portal of China (<https://www.yidaiyilu.gov.cn/>) : China (CH), Central Asia (CA), Northeast Asia (NEA), Southeast Asia (SEA), South Asia (SA), Central and Eastern Europe (CEE), and West Asia and North Africa (WAN). The corresponding countries in each subregion are listed in Table 1.

Table 1
Subregions of the Belt and Road countries

Subregions	Abbreviation	Detailed list
China	CH	Mainland China, Hong Kong, Macao, Taiwan
Central Asia	CA	Kazakhstan, Uzbekistan, Turkmenistan, Kyrgyzstan, Tajikistan
Northeast Asia	NEA	Mongolia, Russia
Southeast Asia	SEA	Vietnam, Laos, Cambodia, Thailand, Malaysia, Singapore, Indonesia, Brunei, Philippines, Myanmar, Timor-Leste
South Asia	SA	India, Pakistan, Bangladesh, Nepal, Bhutan, Sri Lanka, Maldives
Central and Eastern Europe	CEE	Poland, Czech Republic, Slovakia, Hungary, Slovenia, Croatia, Romania, Bulgaria, Serbia, Montenegro, Macedonia, Bosnia and Herzegovina, Albania, Estonia, Lithuania, Latvia, Ukraine, Belarus, Moldova
West Asia and North Africa	WAN	Turkey, Iran, Syria, Iraq, Afghanistan, United Arab Emirates, Saudi Arabia, Qatar, Bahrain, Kuwait, Lebanon, Oman, Yemen, Jordan, Israel, Palestine, Armenia, Georgia, Azerbaijan, Egypt

3 Data And Methods

3.1 Data source

The yield of four major crops (maize, rice, soybeans, and wheat) was derived from the simulation results of the first simulation round ISIMIP Fast Track of the Inter-Sectoral Impact Model Intercomparison Project (ISI-MIP, www.isimip.org). The resolution was $0.5^\circ \times 0.5^\circ$ and the unit for yield was t/ha. Based on five bias-corrected (Hempel et al. 2013) global climate models (GCM) (GFDL-ESM2M, HaDGem2-ES, IPSL-CM5A-LR, MIROC-ESM-CHEM, and NorESM1-M), ISI-MIP drives seven global gridded crop models (GGCM) (EPIC, GEPIC, GAEZ-IMAGE, LPJGUESS, LPJml, PEGASUS, and pDSSAT) combined with different parameter settings (with or without CO₂, with or without irrigation) to simulate the crop yield under different RCP scenarios. Finally, the number of future yield models of maize, rice, soybeans, and wheat under the RCP8.5 scenario provided by ISIMIP Fast Track were 116, 96, 116, and 116 (see S2–S3), respectively.

The time scale of this study included three 20-year time slices including the reference period (1986–2005) and the period in which the global average temperature will be 1.5°C or 2°C higher than that before industrialization under the RCP8.5 scenario (Table 2). The RCP8.5 emission scenario was used to reveal the distribution of crop yield risk under the highest greenhouse gas emission scenario. For the spatial scale, based on 65 Belt and Road countries, the planting ranges of four kinds of crops in the reference period (1986–2005) were extracted using MIRCA2000 data (Portmann et al. 2010). The corresponding

simulated yield of each crop provided by ISIMIP Fast Track were then masked by its covering range, respectively.

Table 2

The respective 20-year time slices for 1.5°C and 2°C global warming calculated by the ISI-MIP model ensembles under RCP8.5 scenario (Schleussner et al. 2016)

Name	Time slices for a 1.5°C global warming	Time slices for a 2°C global warming
GFDL-ESM2M	2028–2047	2044–2063
HaDGem2-ES	2010–2029	2022–2041
IPSL-CM5A-LR	2016–2035	2029–2048
MIROC-ESM-CHEM	2010–2029	2022–2041
NorESM1-M	2022–2041	2038–2057

3.2 Methodology

IPCC defines risk as the potential, when the outcome is uncertain, for adverse consequences on lives, livelihoods, health, ecosystems and species, economic, social and cultural assets, services (including ecosystem services), and infrastructure (IPCC 2014). And risk usually results from the interaction of vulnerability (of the affected system), its exposure over time (to the hazard), and the (climate-related) hazard and the likelihood of its occurrence (Hoegh-Guldberg et al. 2018) .

Based on the simulated crop yields provided by ISIMIP Fast Track, this article evaluated yield risks for major crops in 65 terrestrial countries of the Belt and Road (Fig. 1). First, the yields of four crops were taken as an index to recognize the adverse effects of yield loss. Referring to Piontek et al. (2014), the 10th percentage point of yield distribution in the reference period (1986–2005) was taken as the threshold. Then, the average yields of different crops under 1.5°C or 2°C warming scenarios (that is, the global average temperature rising 1.5°C or 2°C, respectively under the RCP8.5 scenario) were calculated and compared with the threshold of the reference period (1986–2005). Once the future average yield is lower than the threshold, yield reduction will take place under the warming scenario. The yield loss likelihood could be approximately represented by the consistency of multimodel results, namely, the model agreements. Owing to the differences among models, projected crop yields may decrease or increase in different models. The model agreement of each raster grid can indicate how large the likelihood is by dividing the number of models with yield loss by the total number of models. If the model agreement on a grid was larger than 50%, it meant that at least half of the models showed yield loss, so it was considered that there was a risk of yield loss; if the consistency of the model was between 10% and 50%, it was considered that the crops on the grid still have a potential risk of yield loss. Therefore, the area with 10–50% model consistency was regarded as the "potential risk zone". The area with model consistency greater than 50% was defined as the "risk zone". The expanded "risk zone" under the 2°C warming scenario than the 1.5°C warming scenario was the "newly added risk zone".

4 Results

4.1 Crop cultivation structure in different subregions during the reference period

Based on the MIRCA2000 data, the maximum monthly planted area of four crops in seven subregions of the Belt and Road during the reference period (1986–2005) was calculated (Fig. 2). In terms of planted area: According to the order of the total planted area of the four crops, CH had the greatest total planted area for $9.42 \times 10^5 \text{ km}^2$, followed by $8.85 \times 10^5 \text{ km}^2$ in SA. CA had the smallest total planted area for only about $1.33 \times 10^5 \text{ km}^2$, less than 15% of CH's. There were significant differences in the proportion of the four crops in different subregions. The proportion of planted areas for wheat, rice, and maize in CH was 33%, 31%, and 26% respectively, but the planted area of soybeans was relatively small, being less than 10% of the total planted area. In SA, rice and wheat were the main crops with corresponding planting areas for about 51% and 33%, respectively. As for SEA, rice was the main crop, accounting for more than 75% of the total planted area of the four crops. Wheat and maize were the two main crops in CEE, with a combined proportion of 98%. It's clear that wheat was the main crop in WAN, NEA, and CA, with a planting proportion for more than 80% in all three subregions.

4.2 The spatial distribution of likelihood for crop yield loss

The likelihood distribution of yield loss for the four crops for a 1.5°C global warming is shown in Fig. 3 (the distribution for 2.0°C global warming is shown in S4). Under the RCP8.5 scenario, if the global average temperature rises by 1.5°C in the future, the maximum yield loss likelihood for maize, rice, soybean, and wheat would reach 90%, 85%, 90%, and 78%, respectively. At low latitudes, especially in SA and SEA, the yield loss likelihood of maize and soybeans was higher than that in other subregions. For rice, the regions with high yield loss likelihood included Laos and Cambodia of SEA and Pakistan of SA. While for wheat, the regions with high likelihood of yield loss were mainly located in SA, CEE, and the western part of NEA.

The median likelihood of crop yield loss at the same latitude under different warming scenarios is shown in Fig. 4. Under the 1.5°C and 2°C warming scenarios, the distribution of yield loss likelihood of the four crops was consistent. In the northern hemisphere, the yield reduction likelihood of maize and soybean decreased with the increase in latitude, and was relatively high at low latitudes (20°N–10°S), for about 60% and 50%, respectively. As for rice, the yield loss likelihood was high in the area between 35°N and 10°S, fluctuating between 30% and 55%, but decreased rapidly from 40°N to 50°N. For wheat, the yield reduction likelihood had two obvious peaks at about 20°N and 60°N, reaching 58% and 63%, respectively. The yield loss likelihood of maize, rice, and soybeans at low latitudes (30°N–10°S) was higher than that at middle latitudes (30°N–60°N). Some related studies also shown that tropical regions at lower latitudes experienced a greater magnitude of impact and likelihood of reduced crop yields than temperate regions (Challinor et al. 2014; Asseng et al. 2015). In contrast, in CEE and the European regions of Russia, the

yield loss likelihood of wheat was higher at higher latitudes, mainly due to the increase of extreme high temperature and drought in this region under the warming scenario and the shortening of the crop growth period (Moore and Lobell 2015; (Pavlova et al. 2019). Therefore, the yield loss likelihood of wheat in those regions was higher.

4.3 Likelihood characteristics of crop yield loss in different subregions

The maximum, minimum, and average values of yield loss likelihood of different crops in 7 subregions of the Belt and Road under different warming scenarios are shown in Fig. 5. There was a large deviation in the crop yield loss likelihood in different subregions. In China, the yield loss likelihood of soybeans was from zero to 90%, indicating that there were great differences in crop yield loss likelihood within subregions as well as between subregions. Crop yield loss likelihood also varied in different warming scenarios and subregions. In low latitudes in SEA, SA, and WAN, the average yield loss likelihood of maize, rice and wheat under the 2°C warming scenario increased by 0.16–3.06% compared with that under the 1.5°C warming scenario. However, in the higher latitudes of CEE and NEA, the average yield loss likelihood of maize and rice decreased slightly by no more than 2% under the higher warming scenario. This showed that the scenario with higher temperature will aggravate yield loss of crops at low latitudes, while the likelihood will decrease at some higher latitude areas, which is in line with previous studies including those conducted by Rosenzweig (Rosenzweig et al. 2014) and Belyaeva (Belyaeva and Bokusheva 2018). In CA, the average likelihood of yield loss for soybeans under the 2°C warming scenario was about 1% higher than that in the 1.5°C warming scenario, but the changes of average loss likelihood of other crops were not obvious, which may due to the small crop acreage in CA. In China, the average yield loss likelihood of rice and wheat was similar under different scenarios, while the average yield loss likelihood of maize and soybeans under higher warming scenarios reduced by 1.03–1.96%, which may be related to regional differences of warming effects on crop yields. That's to say, warming would prolong the crop growth period, at the same time, chilling injuries caused by extreme low temperature would decrease or disappear in the alpine areas of China, which would contribute to the increase of crop yield at high-altitude places and in northeast parts of China. However, at the middle-low latitudes, warming would shorten the crop growth period, reduce soil moisture, and increase drought, resulting in an increase in crop yield loss (Liu and Lin 2007; Guo 2015; Zhang et al. 2019a).

4.4 Crop yield risk patterns for 65 countries of the Belt and Road

In the 1.5°C and 2°C warming scenarios, areas showing yield risks of maize, rice, and wheat (the model consistency is more than 10%, that is, gray, pink, and red areas in Fig. 6) accounted for at least 90% of their respective planted areas. The proportion of areas where soybeans faced risk also reached 78%. Under the 1.5°C warming scenario, the "risk zones" of maize and wheat were widely distributed, accounting for about 37% and 35% of their planted areas in the reference periods (1986–2005),

respectively, and the proportions of the "risk zones" for rice and soybeans were about 25% and 13%, respectively. Under the 2°C warming scenario, the "risk zone" of four crops' yields was further expanded, and wheat was the most sensitive crop to an additional 0.5°C warming (from 1.5°C to 2°C). The "newly added risk zone" accounted for about 3.5% of the wheat's cultivated area in the reference period (1986–2005), followed by rice and maize, whose proportion of "newly added risk zone" was about 3%, then soybean with "newly added risk zone" no more than 2% of its planted area. Generally speaking, maize and wheat were at severe risk of yield loss under both the 1.5°C and 2°C warming scenarios in the study area.

Analysis of the risk characteristics of crop yield in different subregions could contribute to the formulation of high-risk crop adaptation measures in different subregions. Each subregion's "risk zone" for four crops under the 1.5°C warming scenario is shown in Fig. 7a. The yield risk of maize in SEA and wheat in NA was prominent, and the corresponding grid number of the "risk zone" reached about 900. For SA, yield risks mainly comes from maize and wheat with the total grid number of the "risk zones" of the two crops being more than 1600. For other subregions, the crop yield risks were smaller, and the maximum grid number of the "risk zone" in each subregion was no more than 400. Considering the "newly added risk zones" in each subregion (Fig. 7b), the "newly added risk" in SA were mainly for maize, rice, and wheat. In SEA, "newly added risk zone" for wheat was the smallest one, and for the other three crops, the grid number of the "newly added risk zone" was about 30. In NEA, wheat had the largest "newly added risk zone", which is about 4 times of that for maize. For the rest subregions, wheat also shows the largest "newly added risk zones".

5 Discussion

This risk assessment was based on a set of multimode ensembles with reduced the potential errors and model uncertainty of a single model. While it thoroughly described the crop yield risk in 65 countries of the Belt and Road under different warming scenarios in the future, it still had some deficiencies. For example, this study used the planted areas of four major crops in the reference period (1986–2005) as a mask, ignoring the transfer or expansion of crop cultivated areas in the future. Although climate change may have both positive and negative effects on crop yield, but this study focused on the risk of crop yield loss in the 65 countries of the Belt and Road, so the benefits of planted area expansion were not considered.

Studies have proved that drought and extreme high temperature events also had significant impacts on crop yield (Lesk et al. 2016). However, the ISI-MIP multimodel simulated results used in this study have been deviated, and there may be deficiencies and differences in the representation of extreme events by different crop models, which makes the risk assessment results of this article fail to take into account the impact of extreme weather events on crop yield. The extreme thermal events in many regions are projected to be more frequent and intense considering the fact of global warming, as a result, crop yield risks in 65 countries of the Belt and Road may be more severe as our assessment results are considered to be conservative.

This article did not consider agricultural adaptations and responses to the risks of climate change, such as improving crop species (with high climate resistance), effective fertilization and improved irrigation. However, this article reveals the risk pattern under the warming scenario of 1.5°C and 2°C, which is helpful to promote the climate change adaptation to the high-risk areas in the 65 countries of the Belt and Road. In the future, we can conduct further works from the perspective of quantitative adaptations considering the socio-economic situation and adaptive ability.

6 Conclusions

Using the multimodel simulated results of crop yield provided by ISI-MIP, this article explored the crop yield loss likelihood through the consistency of multimodel ensembles. Combined with yield reduction and its likelihood, this article reveals the risk pattern of four main crops in 65 countries of the Belt and Road. The main conclusions are as follows:

- (1) Under the RCP8.5 scenario, if the global average temperature rises 1.5°C, the yield loss likelihood of the four crops could reach 90%. For maize, rice, and soybeans, the yield loss likelihood at low latitudes was higher than that at middle latitudes. For wheat, the yield loss likelihood showed two peaks at regions around 20°N and 60°N.
- (2) If the global average temperature increase by 2°C rather than 1.5°C, the average likelihood of crop yield loss in subregions at lower latitudes would increase by 0.16–3.06%, while that in subregions at higher latitudes such as CEE and NEA would decrease slightly by no more than 2%.
- (3) Under the 1.5°C warming scenario, the yield risk of maize and wheat in 65 countries of the Belt and Road was prominent, the "risk zone" accounted for more than 35% of their respective planted area. For rice and soybean, their proportions of the "risk zones" were about 25% and 13%, respectively.
- (4) If warming reaches 2°C instead of 1.5°C, the proportion of the "newly added risk zone" of the four crops will be between 1.8% and 3.5% with wheat showing the largest "newly added risk zone" yet soybean the smallest.
- (5) According to the characteristics of crop "risk zone" and "newly added risk zone" in different subregions, for maize in Southeast Asia, wheat in Northeast Asia, and maize, wheat, and rice in SA, their yield loss risks were prominent and severe, so there is an urgent need to take targeted measures to adapt to climate change risk for these crops.

Declarations

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Availability of data and material The data that support the findings of this study are available under reasonable request to the author.

Code availability Not applicable.

Authors' contributions All authors contributed to the study conception and design. Material preparation, data collection and analysis were performed by Miao Tong. The first draft of the manuscript was written by Miao Tong and all authors commented on previous versions of the manuscript. All authors read and approved the final manuscript.

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Figures

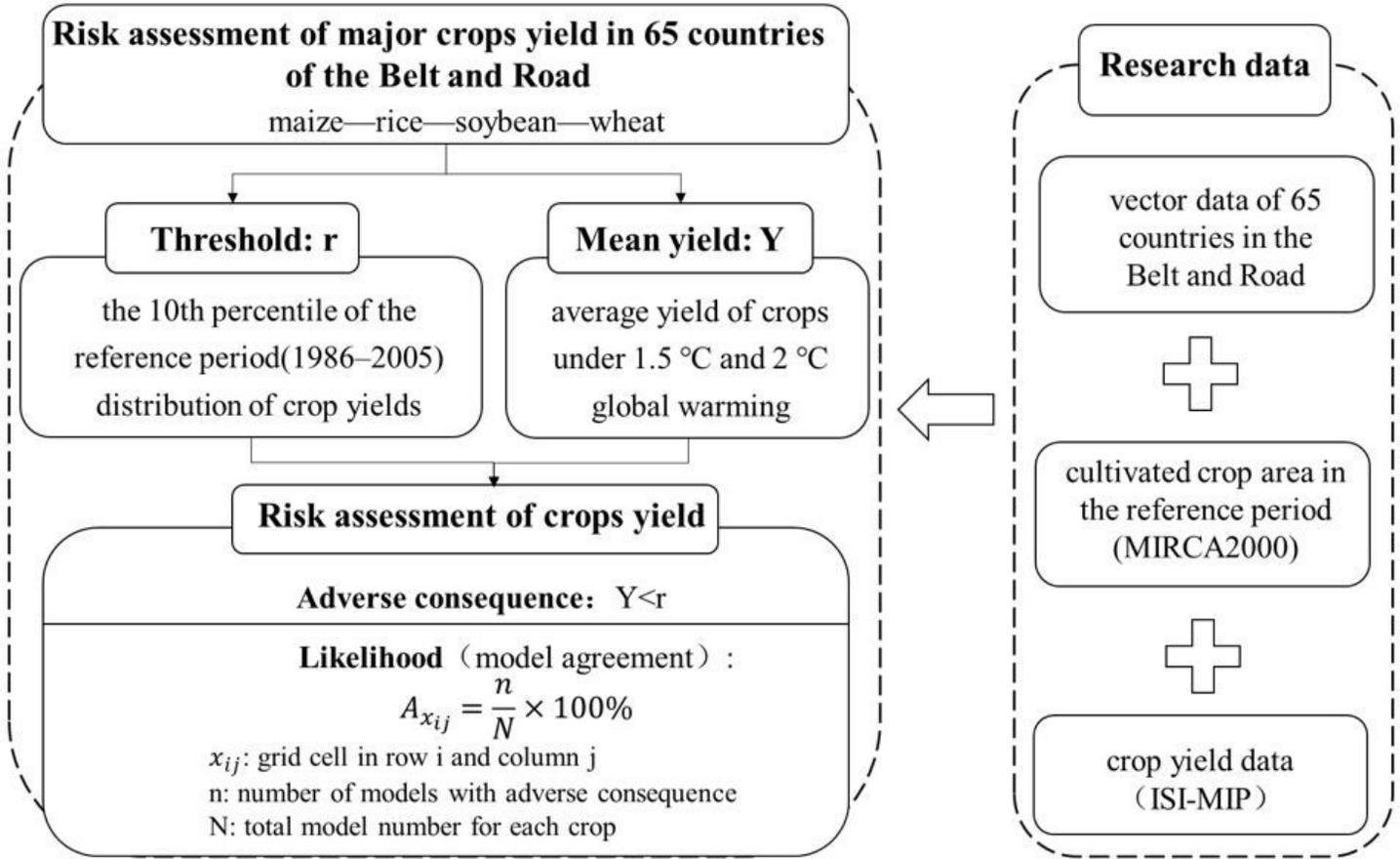


Figure 1

The workflow of our methods

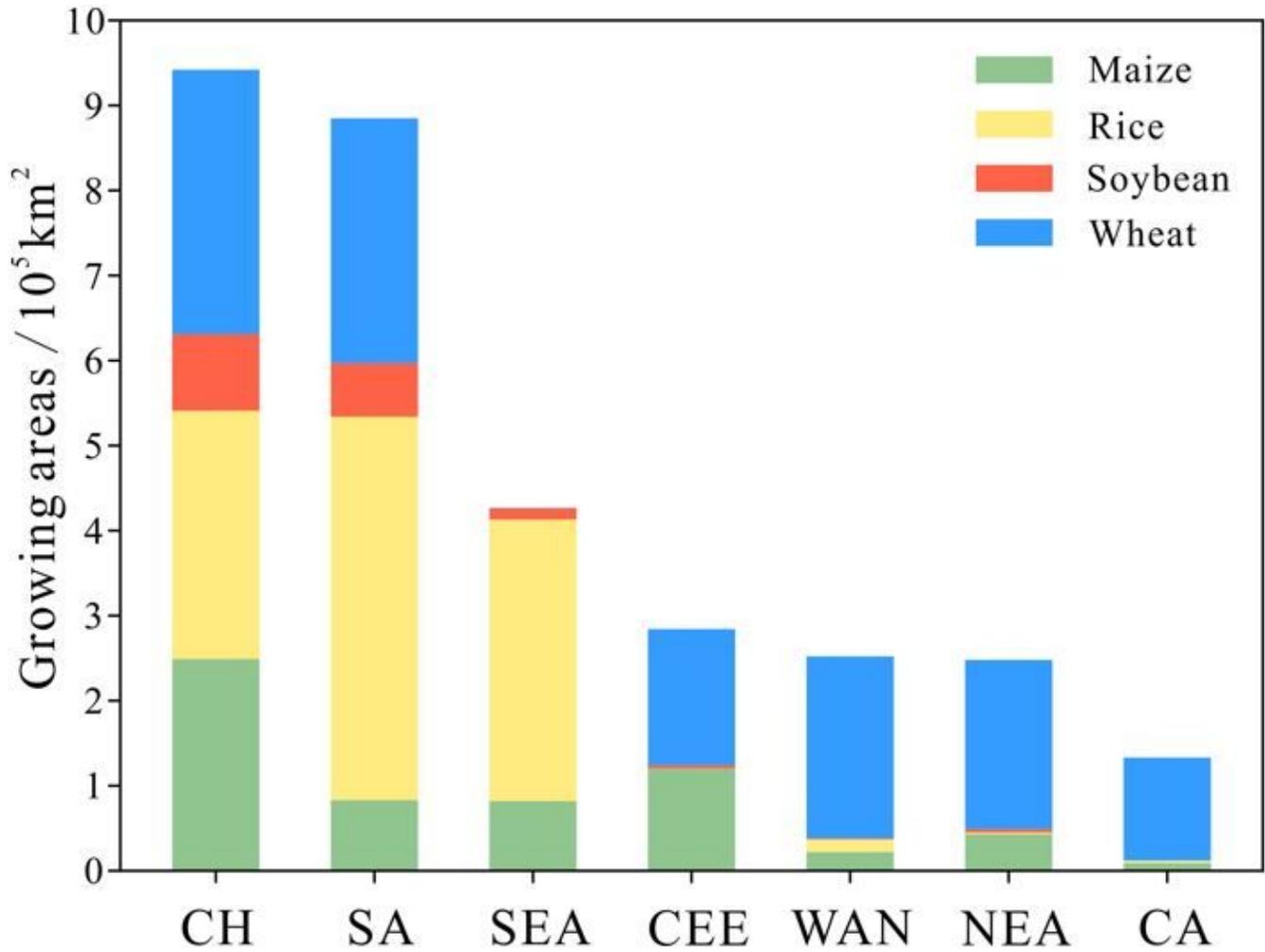


Figure 2

Growing areas for maize, rice, soybeans, and wheat of subregions in the Belt and Road during the reference period (1986–2005). CH (China), SA (South Asia), SEA (Southeast Asia), CEE (Central and Eastern Europe), WAN (West Asia and North Africa), NEA (Northeast Asia), CA (Central Asia)

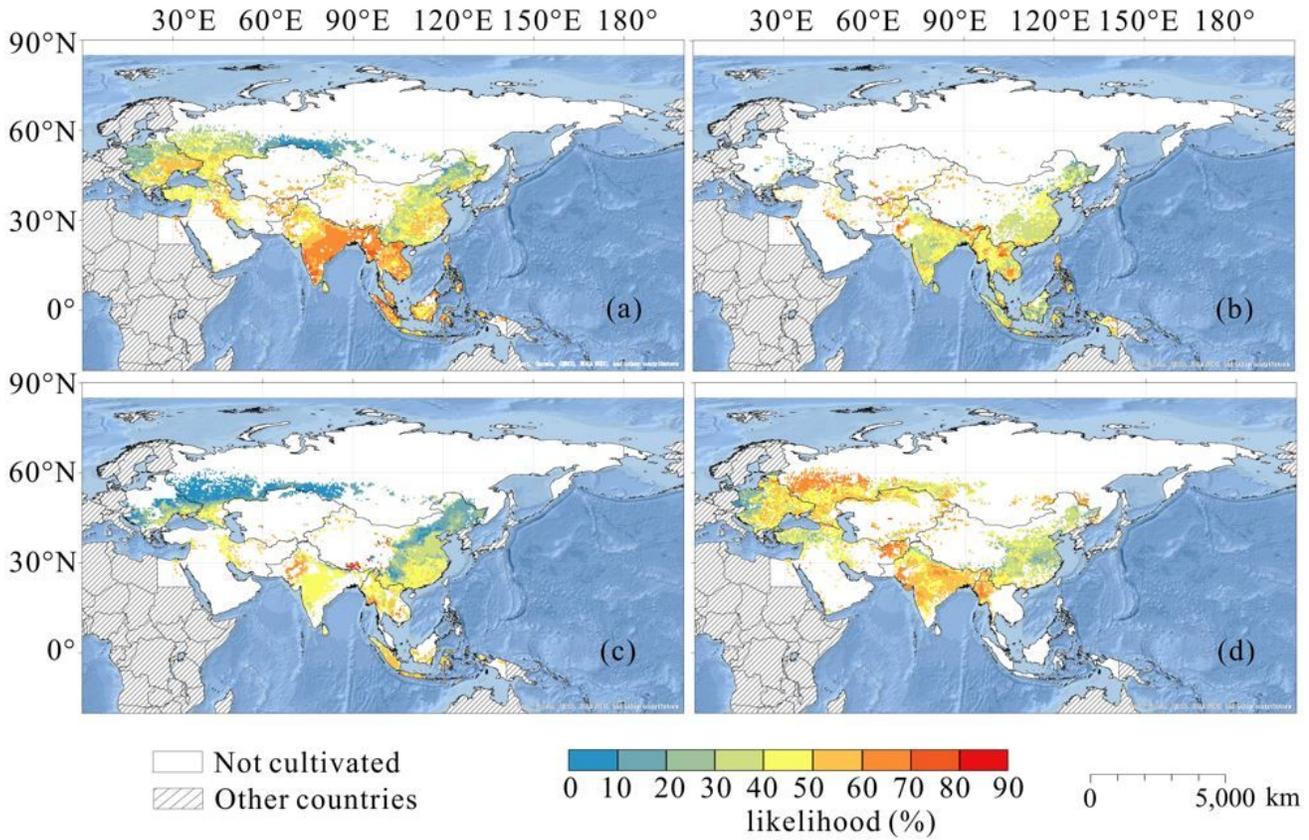


Figure 3

The spatial distribution of yield loss likelihood for maize(a), rice(b), soybeans(c), and wheat(d) yield loss of the Belt and Road for 1.5°C global warming under the RCP8.5 scenario. Note: The designations employed and the presentation of the material on this map do not imply the expression of any opinion whatsoever on the part of Research Square concerning the legal status of any country, territory, city or area or of its authorities, or concerning the delimitation of its frontiers or boundaries. This map has been provided by the authors.

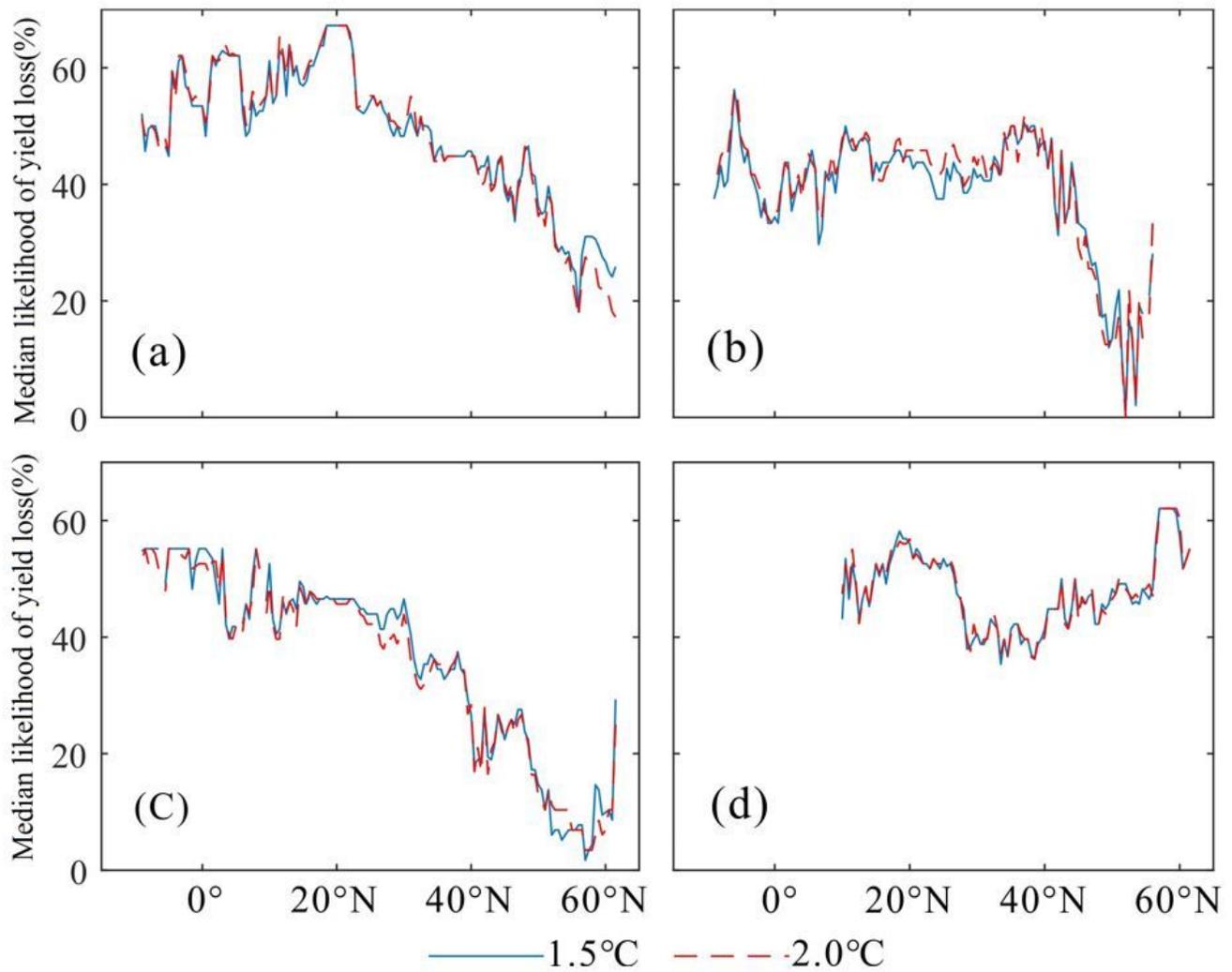


Figure 4

The latitudinal distribution of likelihood for maize(a), rice(b), soybeans(c), and wheat(d) yield loss of the Belt and Road for 1.5°C and 2°C global warming under the RCP8.5 scenario

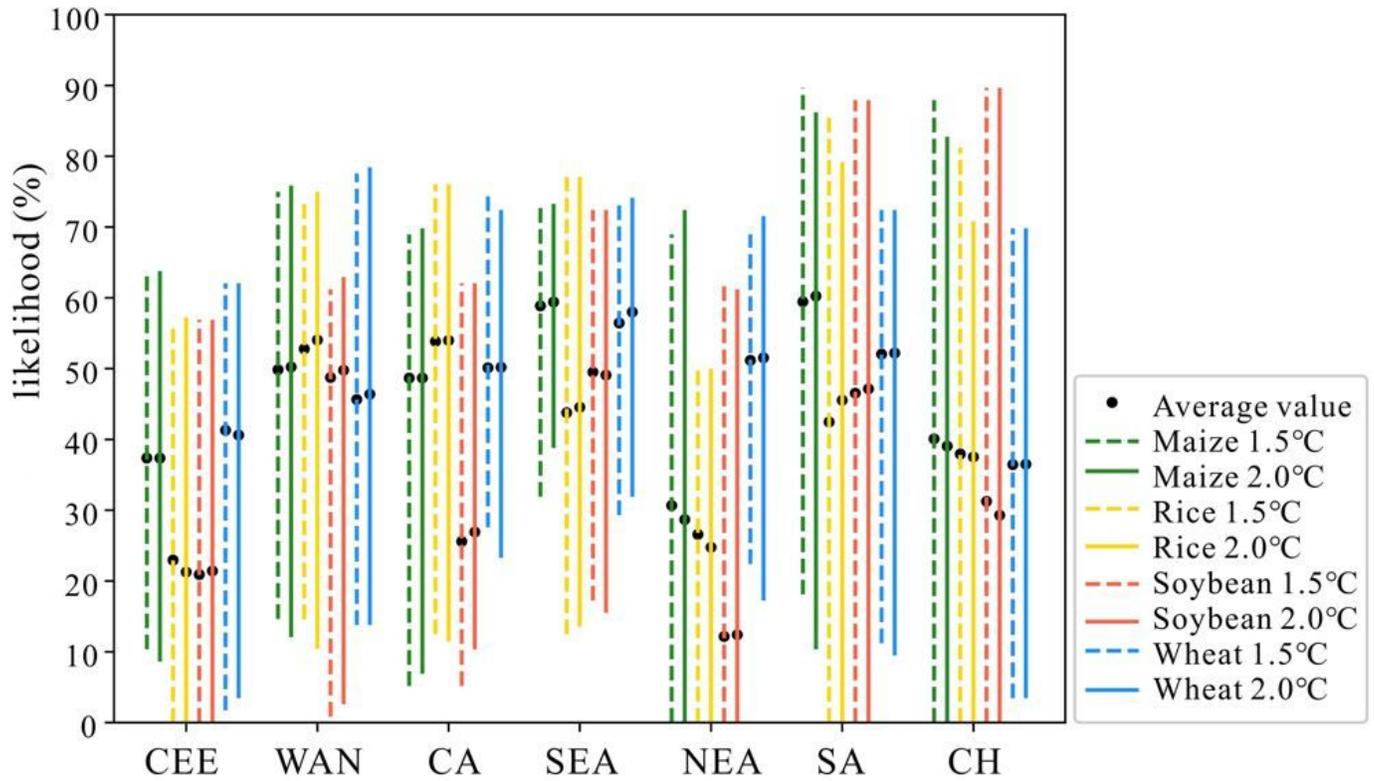


Figure 5

Minimum, maximum, and mean of likelihood for crop yield loss between subregions of the Belt and Road for 1.5°C and 2°C global warming under the RCP8.5 scenario; the bottom of the vertical line indicates the minimum while the top is the maximum. The dot within each vertical line shows the subregion's average value. CEE (Central and Eastern Europe), WAN (West Asia and North Africa), CA (Central Asia), SEA (Southeast Asia), NEA (Northeast Asia), SA (South Asia), and CH (China)

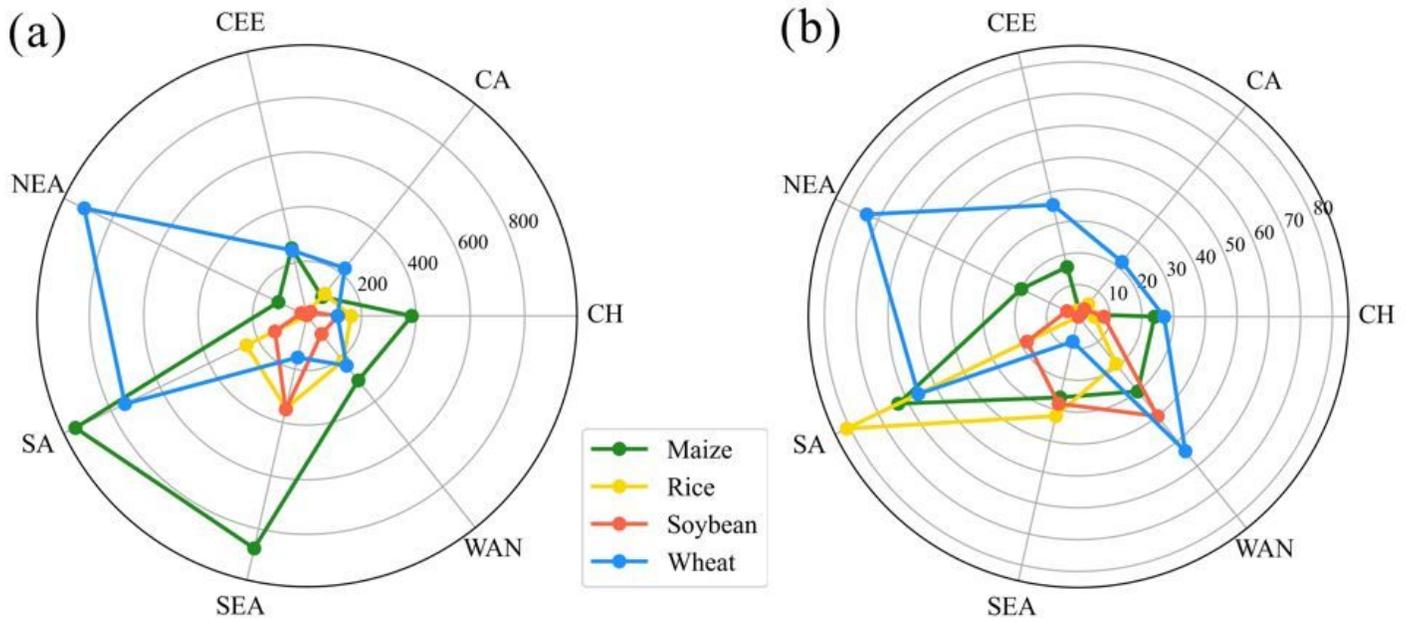


Figure 7

(a): The number of grids within crop's "risk zone" in 7 subregions of the Belt and Road for 1.5°C global warming under the RCP8.5 scenario; (b): the number of grids within a crop's "newly added risk zone" in subregions of the Belt and Road under the RCP8.5 scenario; CEE (Central and Eastern Europe), CA (Central Asia), CH (China), WAN (West Asia and North Africa), SEA (Southeast Asia), SA (South Asia), and NEA (Northeast Asia)

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