MODELLING THE IMPACT OF COUNTRY-SPECIFIC WARMING ON AGRICULTURAL PRODUCTION: EVIDENCE FROM SOUTHEAST ASIAN ECONOMIES

ABSTRACT

This research investigates the link between climate change and Southeast Asian economies' agricultural production. Employing panel regression with fixed and random effects, the findings underscore the significant influence of climate change, particularly rising temperatures, on agricultural productivity in Southeast Asia. The results suggest that despite the inconclusive direction of the effects of temperature variability in agricultural productivity, it is observed that the countries of Cambodia, Lao PDR, Myanmar, and Vietnam are the most vulnerable to reduction in agricultural output due to increasing warming in the region.

I. INTRODUCTION

Southeast Asian economies ("region") agricultural production is among the most vulnerable to climate change. To this date, there are several studies conducted to study the impact of climate change on economic growth among Southeast Asian economies. However, there is limited understanding and comprehensive studies on how climate change impacts Southeast Asian agricultural production. Despite the region's rapid industrialization, agriculture continues to be an important sector of the economy. Given these facts, it is undeniable that climate change has a profound impact on Southeast Asian agricultural production. Thus, understanding the mechanism and channel of how shocks from both country-specific warming and global warming propagate and amplify the negative effects of climate change on Southeast Asian agricultural production is crucial to mitigate its negative externalities.

The effects of increasing warming in the region are more visible with different crops. Despite the reduction in crop yields due to temperature variation, varietal considerations all impact how crops adapt to temperature changes. This makes the impact of extreme temperatures highly localized. For example, Hatfield et al. (2011) in their study of the US soybean production, observed a 2.4% reduction in soybean yield due to temperature changes beyond normal in Southern states, while the Midwest region experienced a 1.7% increase in yield. Besides the local effect of temperature change, other studies, such as Welch et al. (2010), found that temperature variation significantly affects rice growth during the vegetative and ripening stages; higher minimum temperatures reduce yield while higher maximum temperatures raise it. Other studies on different crops show similar results. Ghosh et al.(2000) demonstrate that an increase in temperature reduces both the quality and quantity of dry matter like potatoes. Pressman et al. showed that continuous exposure of tomatoes to high temperatures decreases pollen grain numbers, thus impacting fruit viability. Meanwhile, Dufault et al. (2009) findings indicate that variation in mean daily temperature leads to reductions in lecture head numbers for specific crops

One area of literature focuses on the impact of climate change on agricultural production in developing countries. Fankhauser & Tol (1997), Mendelsohn et al. (2006), and Rosenzweig & Parry (1994) have contributed to this field. The reliance of developing economies on agriculture, coupled with limited climate adaptation and technology, makes these countries more susceptible to the effects of climate change. Raj et al.(2022) emphasized that policies for climate adaptation should prioritize food production and accessibility in areas where small subsistence farmers are from the majority of rural populations. Increasing agricultural productivity is essential for reducing income inequality between urban and rural areas as well as ensuring food security. Conversely, Webber et. al (2020) suggest that despite clear evidence linking extreme weather events to crop failures, there is a little indication regarding localized crop failure drivers. Large unexplained variations in local yields are likely driven by non-weather-related factors such as pests, weeds, nutrient management, or possible interactions between weather conditions and different agronomic practices leading to local yield failures.

The paper is also related to the literature that focuses on the impact of climate change on the ASEAN region's agriculture. The rapid population growth and economic expansion in the region are placing pressure on agricultural production to meet the increasing demand for food products. According to Venkatappa et al.(2021), approximately 19.9 million ha of croplands in the ASEAN region experienced severe drought conditions, while 3.6 million ha faced potential flood damage due to heavier-than-usual precipitation. Effective climate policies that address adaptation, mitigation, and carbon emissions must be developed within regional frameworks and through cooperation among nations. Despite a declining share of agriculture in each ASEAN country, it is expected that the impact of climate change will remain significant due to an increased reliance on agricultural imports over the coming decades as highlighted by Zhai and Zhuang (2009). This dependence could lead these economies to suffer from welfare losses stemming from deteriorating terms of trade with negative effects predicted for countries like the Philippines, Indonesia, Thailand, and Vietnam but less so for Singapore and Malaysia. Therefore, it is crucial to consider climate change and its impact on temperature variation and precipitation when analyzing agricultural production in ASEAN countries.

This paper wishes to fill the gap and contribute to the literature in many dimensions. First, although, there is growing evidence and studies related to the impact of climate change, there is still limited understanding of the mechanisms of how this could impact agricultural production at the regional or local level. The diverse characteristics of the region's agriculture could produce a vague understanding of the severity of climate impact on the region's agricultural production. In this study, I account for this by introducing both country-specific and regional climate variables in the empirical model. Secondly, using a panel of selected ASEAN economies, this paper contributes to the literature by providing evidence on the impact of climate change on agricultural production in the region. Finally, the literature survey relies on the assumption that climate and weather conditions are identical shocks that drive changes in agricultural production. I fill this gap by defining weather and climate variables as distinct exogenous shocks in the empirical model. This modeling choice accounts for the unique individual effects of local temperature changes versus global temperature changes in the agricultural production of each ASEAN country.

Against this backdrop, this study aims to investigate the impact of climate change on Southeast Asian economies. To the best of my knowledge, this study is the first to investigate the impact of climate change on Southeast Asian agriculture that focuses on comparing country-specific warming against global warming. In investigating the impact of climate change, I use country-specific OLS regression and panel data regression of Southeast Asian economies. The choice of climate variables and control variables is based on the survey literature. I use temperature change, precipitation, and carbon emission for climate variables and land, and labor for control variables.

III. DATA COLLECTION AND EMPIRICAL MODEL

To examine the effects of warming and precipitation on Southeast Asian economies, I estimated a country-specific OLS regression and panel model using annual time series from 1991 to 2021. The baseline regression model is as follows:

Country Specific OLS

$$y_t = \kappa z_t + \beta x_t + \varepsilon_t \tag{1}$$

ASEAN Panel Model

$$y_{j,t} = \kappa z_{j,t} + \beta x_{j,t} + \delta_j + \varepsilon_{j,t} \tag{2}$$

Where y_j is the region's or country's agricultural production; z_t represents the climate variables; x_t denotes the control variables that are relevant to agricultural production; δ_j are the country's fixed effects and ε_j is the error term.

C. Data Collection and Description

I collected annual time series from 1991 to 2020 from the World Bank Development Indicator, Word Bank Climate Knowledge Portal, and Food and Agricultural Office. Table 6 in the Appendix details the data sources and definitions.

IV. RESULTS AND DISCUSSION

A. Benchmark Panel Model and Country OLS Regression

The benchmark model assumes a contemporaneous impact on Southeast Asian agricultural production. Table 1 in the Appendix displays the results of both panel and country-specific OLS regressions. The findings align with the earlier literature, indicating that most Southeast Asian countries could experience a negative impact from rising temperatures, except for Brunei Darussalam and Lao PDR. This is statistically significant for Malaysia, Myanmar, and the Philippines. Furthermore, the panel results demonstrate that ASEAN agricultural production is negatively affected by rising temperatures; Singapore has the highest negative coefficient.

The control variables align largely with expectations - an increase in arable land positively contributes to Southeast Asian agricultural production but not to Myanmar. This effect is statistically significant for Brunei Darussalam, Indonesia, Lao PDR, Malaysia, Myanmar, Philippines, and Vietnam including ASEAN. However, labor share in agriculture yields intriguing results warranting further discussion; an increase in labor share negatively impacts outcomes of Southeast Asian agricultural production which holds statistical significance for several countries such as Brunei Darussalam Cambodia Indonesia Laos Malaysia Philippines Thailand, and Vietnam These findings highlight the complex relationship between temperature, arable land, labor share, and agricultural production in ASEAN countries.

The impact of precipitation and CO2 emissions on agricultural production varies among the 10 Southeast Asian economies. The relationship between agricultural production and precipitation is positive for Brunei Darussalam, Cambodia, Indonesia, Lao PDR, Myanmar, Philippines, and Vietnam; however, it is negative for Malaysia, Singapore, and Thailand. Additionally, as a group, ASEAN has a statistically significant negative relationship with precipitation. Similarly, the effect of CO2 emissions on Southeast Asian agricultural production is mixed. In Indonesia, Lao PDR, the Philippines, and Singapore an increase in emissions leads to a reduction in agricultural output. However, in Brunei Darussalam, Cambodia, Malaysia, Myanmar, Thailand, and Vietnam an increase in CO2 emission improves agricultural output. The results are statistically significant for Brunei Darussalam, Malaysia, and the Philippines. Surprisingly, ASEAN as a group exhibits the least coefficient.

B. Effects Country-specific Warming Panel Model with Fixed and Random Effect

In terms of other climate variables, precipitation is statistically significant for all groups, indicating that an increase in precipitation leads to a reduction in agricultural output except for Developing Southeast Asia. CO2 emissions also show a statistically significant and positive relationship for all groups except for Developing Southeast Asia with FE.

In comparing the results, it is evident that Developing Southeast Asia as a group is the most vulnerable to increasing warming. Countries such as Cambodia, Myanmar, Lao PDR, and Vietnam are among the most productive rice producers in the region. Moreover, when considering arable land use for agricultural production Comparing the results, Developing Southeast Asia has the largest coefficient. The significant potential of Developing Southeast Asia to contribute to the region's food security cannot be overlooked.

To further validate our findings, I conducted similar regression models for rice and maize production. Tables 4 and 5 in the Appendix present the results of regression for the two most important crops in the region. The results indicate that Developing Southeast Asian rice and maize production is the most vulnerable to rising warming in the region compared to ASEAN 5 and Brunei. This vulnerability is particularly evident in Cambodia, Myanmar, Lao PDR, and Vietnam, which are major rice and maize producers in the region. The results of the regression highlight the asymmetry of the impact of climate change in the region.

C. Effects of Global Warming

Table 3 in the Appendix presents the regression performed using alternative measures of global warming, as in Table 2. The benchmark model exposes each country in the panel to country-specific shocks in temperature variability. The difference in regression presented in Table 3 indicates a common shock in temperature variability within the region. Despite the modification in the benchmark empirical model to account for the common warming shock, the results reported in Table 3 are consistent with the observed results in Table 2 in which country-specific warming is the treatment variable. The results in Table 3 show the statistically significant effects of global warming on agricultural production in ASEAN as a group and Developing Southeast Asia.

Conclusion

The findings of this study highlight the substantial influence of climate change, especially rising temperatures, on agricultural output in Southeast Asia. Although the results are inconclusive in the impact of temperature variation on agricultural production in the region, it is evident that increasing temperatures alone do not necessarily lead to negative impacts on agricultural productivity. Elevated levels of CO2 emissions and warmer temperatures have been observed to enhance growth and yields, particularly for temperate and perennial crops such as rice and maize. However, it is important to note that the beneficial effects of warming temperatures are contingent upon various factors, including access to irrigation, varietal improvement, farm practices, and the availability of other agricultural technologies. Therefore, while warming temperatures may have some positive outcomes for agricultural production, the paper shows that there is a lot of complexity in the interaction of temperature and agricultural production.

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Appendix

Table 1

Panel Regression with Fixed Effect and Country OLS Results
Region and Country's Agricultural Production

	ASEAN	BRN	CAM	IND	LAO	MYS	MYN	PHL	SGP	THA	VTM
Labor Share of	-0.015***	-1.0560 ***	-0.0211 *	-0.0135 ***	-0.0594 ***	-0.0143	-11.4470	-0.0257 ***	-0.5664	9.767 ***	0.0042
Agriculture	(0.002)	(-3.756)	(-2.421)	(-3.918)	(-4.310)	(-1.758)	(-0.951)	(-6.826)	(-1.133)	(0.255)	(0.734)
Arable Land	0.036***	5.2241 ***	1.5713	1.5111 ***	0.93677 *	1.1460 ***	-0.0511 ***	1.5125 ***	0.8309	5.873	0.8819 **
	(0.006)	(4.335)	(1.686)	(6.540)	(2.340)	(7.347)	(-4.560)	(4.408)	(1.189)	(5.660)	(3.482)
Precipitation	-0.556***	0.2058	0.1256	0.0737	0.17578	-0.0167	1.5779	0.0510	-1.1288	-4.305	0.1374
	(0.103)	(0.426)	(0.611)	(0.614)	(1.079)	(-0.178)	(1.990)	(0.777)	(-1.810)	(-0.387)	(0.861)
C02 Emission	-0.017	1.0216 *	0.1445	-0.0810	-0.0876	0.5478 ***	0.23463	-0.2525 **	-1.1464	2.433	0.3541
	(0.027)	(2.345)	(1.227)	(-0.557)	(-0.963)	(5.170)	(0.796)	(-3.364)	(-0.721)	(1.939)	(2.738)
Country	-0.509	2.0236	-3.0600	-1.0200	1.0073	-5.1903 **	-0.2242 **	-3.7843 **	-23.0475	-6.213	-1.4076
Temperature	(0.433)	(0.569)	(-1.424)	(-0.460)	(0.785)	(-3.631)	(-3.318)	(-3.009)	(-1.715)	(-0.691)	(-1.813)
Constant	–	-18.7036	1.2048	- 8.7432	-3.4286	10.4990 *	0.52320	3.0659 ***	93.1098	-5.235 ***	-0.6392
		(-1.528)	(0.107)	(-1.124)	(-0.618)	(2.078)	(0.214)	(0.539)	(1.937)	(-5.103)	(-0.178)
Observations	270	24	24	24	24	24	24	24	24	24	24
R-squared	0.374	0.7927	0.968	0.9765	0.9848	0.9801	0.933	0.9691	0.2563	0.9533	0.9876
No. of Country	10	1	1	1	1	1	1	1	1	1	1

Note: The result is based on the benchmark model $y_{i,t} = labor_{i,t} + land_{i,t} + prec_{i,t} + CO2_{i,t} + ctry\_temp_{i,t}$ $*** \; p > 0.001$ $** \; p > 0.01$ $* \; p > 0.05$. All variables are in the log except the labor share of agriculture. The one in () is the t-statistic. Where $y_{i,t}$ is the country's FAO agricultural production index. Country and panel OLS regression is from 1991-2020. BRN = Brunei Darussalam, CAM = Cambodia, IND = Indonesia, LAO = Lao PDR, MYS = Malaysia, MYN = Myanmar, PHL = Philippines, SGP = Singapore, THA = Thailand and VTM = Viet Nam.

Table 2

Country-Specific Warming Panel Regression with Fixed Effect and Random Effects
The Region, ASEAN 5 + BRN and Developing ASEAN Agricultural Production

	ASEAN		ASEAN 5 + BRN		Developing Southeast Asia	
Variables	**FE**	**RE**	**FE**	**RE**	**FE**	**RE**
Labor Share of Agriculture	-0.012***	-0.015***	-0.030***	-0.022***	-0.006	-0.033***
	(0.001)	(0.001)	(0.003)	(0.002)	(0.009)	(0.003)
Arable Land	-0.003	0.006	0.078***	0.015	-0.001	0.021
	(0.005)	(0.006)	(0.020)	(0.013)	(0.037)	(0.031)
Precipitation	-0.309***	-0.354***	-0.788***	-0.390**	0.060	0.401**
	(0.075)	(0.082)	(0.253)	(0.161)	(0.328)	(0.193)
C02 Emission	0.040**	0.097***	0.441***	0.253***	-0.010	0.128***
	(0.017)	(0.019)	(0.067)	(0.046)	(0.093)	(0.040)
Country Temperature	0.707*	0.440	13.143***	3.765*	-1.791	2.162***
	(0.372)	(0.446)	(3.693)	(2.223)	(1.283)	(0.510)
Constant	_	6.098***	_	-4.704	_	-3.845*
		(1.707)		(8.055)		(2.243)
Observations	270	270	150	150	90	90
R-squared	0.551	0.581	0.480	0.501	0.666	0.869
No. of Country	10	10	6	6	4	4

Note: The result is based on the lag model $y_{i,t} = labor_{i,t} + land_{i,t-1} + prec_{i,t-1} + CO2_{i,t-1} + ctry\_temp_{i,t-1}$ $*** \ p > 0.001$ $** \ p > 0.01$ $* \ p > 0.05$. All variables are in the log except the labor share of agriculture. The one in () is the t-statistic. Where $y_{i,t}$ is the region's FAO agricultural production index. Panel regression is from 1991-2020. FE = Fixed Effect and RE = Random Effect. ASEAN 5 is the 4 middle-income countries of IND = Indonesia, MYS = Malaysia, PHL = Philippines, THA = Thailand, and a developed economy of SGP = Singapore. BRN = Brunei. Developing Southeast Asia is defined as CAM = Cambodia, LAO = Lao PDR, MYN = Myanmar, and VTM = Viet Nam.

Table 3

Global Warming Panel Regression with Random Effects
The Region, ASEAN 5 + BRN and Developing ASEAN Agricultural Production

	ASEAN		**ASEAN 5 + BRN**		**Developing Southeast Asia**	
Variables	**NASA**	**NOAA**	**NASA**	**NOAA**	**NASA**	**NOAA**
Labor Share of Agriculture	-0.012***	-0.013***	-0.024***	-0.023***	-0.021***	-0.021***
	(0.001)	(0.001)	(0.003)	(0.003)	(0.002)	(0.002)
Arable Land	-0.002	-0.001	-0.002	-0.002	0.035	0.043
	(0.005)	(0.005)	(0.007)	(0.007)	(0.031)	(0.030)
Precipitation	-0.290***	-0.334***	-0.535***	-0.523***	0.185	0.106
	(0.071)	(0.071)	(0.145)	(0.142)	(0.190)	(0.191)
C02 Emission	0.063***	0.069***	0.298***	0.285***	0.124***	0.136***
	(0.015)	(0.014)	(0.055)	(0.051)	(0.041)	(0.039)
Global Temperature	0.383***	0.303***	-0.022	0.001	0.341***	0.257***
	(0.043)	(0.034)	(0.062)	(0.048)	(0.085)	(0.063)
Constant	7.223***	7.399***	8.892***	8.816***	4.030***	4.434***
	(0.552)	(0.551)	(1.105)	(1.085)	(1.398)	(1.403)
Observations	270	270	150	150	90	90
R-squared	0.678	0.678	0.491	0.491	0.867	0.868
No. of Country	10	10	6	6	4	4

Note: The result is based on the lag model $y_{i,t} = labor_{i,t} + land_{i,t-1} + prec_{i,t-1} + CO2_{i,t-1} + global\_temp_{i,t-1}$ $***\ p > 0.001$ $**\ p > 0.01$ $*\ p > 0.05$. All variables are in the log except the labor share of agriculture. The one in () is the t-statistic. Where $y_{i,t}$ is the region's FAO agricultural production index. Panel regression is from 1991-2020. FE = Fixed Effect and RE = Random Effect. ASEAN 5 is the 4 middle-income countries of IND = Indonesia, MYS = Malaysia = Philippines, THA = Thailand, and a developed economy of SGP = Singapore. BRN = Brunei. Developing Southeast Asia is defined as CAM = Cambodia, LAO = Lao PDR, MYN = Myanmar, and VTM = Viet Nam. Global temperature is primarily collected by NASA = National Aeronautics and Space Administration and NOAA = National Oceanic and Atmospheric Administration.

Table 4

Country-Specific Warming Panel Regression with Fixed Effect and Random Effects
The Region, ASEAN 5 + BRN and Developing ASEAN's Rice Production

	ASEAN		**ASEAN 5 + BRN**		**Developing Southeast Asia**	
	FE	**RE**	**FE**	**RE**	**FE**	**RE**
Labor Share of Agriculture	-0.005	-0.009***	0.063***	0.031***	-0.011**	-0.034***
	(0.003)	(0.003)	(0.006)	(0.005)	(0.005)	(0.002)
Arable Land	-0.058***	-0.046***	-0.174***	-0.046	0.108***	0.092***
	(0.016)	(0.016)	(0.036)	(0.034)	(0.027)	(0.031)
Precipitation	-2.956***	-2.434***	2.580***	3.075***	-0.601**	-0.340*
	(0.208)	(0.206)	(0.438)	(0.319)	(0.281)	(0.206)
Country Temperature	12.342***	12.141***	-14.492*	23.572***	-17.024***	-13.393***
	(1.065)	(1.080)	(8.009)	(5.438)	(0.748)	(0.419)
Constant	_	-3.700	_	-86.179***	_	63.438***
		(3.869)		(19.230)		(2.239)
Observations	240	240	120	120	90	90
R-squared	0.629	0.549	0.935	0.843	0.992	0.976
No. of Country	10	10	6	6	4	4

The result is based on the lag model $y_{i,t} = labor_{i,t} + land_{i,t-1} + prec_{i,t-1} + ctry\_temp_{i,t-1}$ $***\ p > 0.001$ $**\ p > 0.01$ $*\ p > 0.05$. All variables are in the log except the labor share of agriculture. The one in () is the t-statistic. Where $y_{i,t}$ is the region's FAO rice production data. Panel regression is from 1991-2020. FE = Fixed Effect and RE = Random Effect. ASEAN 5 is the 4 middle-income countries of IND = Indonesia, MYS = Malaysia, PHL = Philippines, THA = Thailand, and a developed economy of SGP = Singapore. BRN = Brunei. Developing Southeast Asia is defined as CAM = Cambodia, LAO = Lao PDR, MYN = Myanmar, and VTM = Viet Nam.

Table 5

Country-Specific Warming Panel Regression with Fixed Effect and Random Effects
The Region, ASEAN 5 + BRN and Developing ASEAN's Maize Production

	ASEAN		**ASEAN 5 + BRN**		**Developing Southeast Asia**	
	FE	**RE**	**FE**	**RE**	**FE**	**RE**
Labor Share of Agriculture	-0.019***	-0.026***	0.183***	0.110***	0.028**	-0.077***
	(0.005)	(0.004)	(0.014)	(0.011)	(0.014)	(0.005)
Arable Land	0.078***	0.092***	0.094	0.325***	0.731***	0.643***
	(0.026)	(0.026)	(0.076)	(0.072)	(0.074)	(0.081)
Precipitation	-1.847***	-1.253***	5.160***	6.578***	-1.274	0.302
	(0.346)	(0.327)	(0.929)	(0.670)	(0.787)	(0.534)
Country Temperature	28.589***	28.486***	10.358	85.260**	-16.327***	-1.058
	(1.769)	(1.718)	(17.002)	(11.422)	(2.093)	(1.096)
Constant	–	-68.708***	–	120	–	14.135**
		(6.154)		0.789		(5.819)
Observations	240	240	120	150	90	90
R-squared	0.586	0.563	0.910	0.501	0.904	0.859
No. of Country	10	10	6	6	4	4

Note: The result is based on the lag model $y_{i,t} = labor_{i,t} + land_{i,t-1} + prec_{i,t-1} + ctry\_temp_{i,t-1}$ $*** \ p > 0.001$ $** \ p > 0.01$ $* \ p > 0.05$. All variables are in the log except the labor share of agriculture. The one in () is the t-statistic. Where $y_{i,t}$ is the region's FAO maize production data. Panel regression is from 1991-2020. FE = Fixed Effect and RE = Random Effect. ASEAN 5 is the 4 middle-income countries of IND = Indonesia, MYS = Malaysia, PHL = Philippines, THA = Thailand, and a developed economy of SGP = Singapore. BRN = Brunei. Developing Southeast Asia is defined as CAM = Cambodia, LAO = Lao PDR, MYN = Myanmar, and VTM = Viet Nam.

Table 6
Description of Variables

Variable	Definition	Data Source
Agricultural production	The FAO indices of agricultural production show the relative level of the aggregate volume of agricultural production for each year in comparison with the base period 2014-2016. Indices for meat production are computed based on data for production from indigenous animals.	The data on the agricultural production index is downloaded from FAO metadata https://www.fao.org/faostat/en/#data/OEA/metadata
Labor Share of Agriculture	Employment in agriculture, forestry, and fishing by age: The indicator corresponds to the ILOSTAT indicator "Employment by sex, age, and economic activity (thousands) – Annual "for the agriculture, forestry, and fishing sector which is defined by the Section A of ISIC classification. Employment comprises all persons of working age who during a specified brief period, such as one week or one day, were in the following categories: a) paid employment (whether at work or with a job but not at work) or b) self-employment (whether at work or with an enterprise but not at work). Employment in agriculture, forestry, and fishing by status of employment	Labor share of agriculture is sourced from FAO metadata https://www.fao.org/faostat/en/#data/OEA/metadata
Arable Land	The FAOSTAT Land Use domain contains data on forty-four categories of land use, irrigation, and agricultural practices and five indicators relevant to monitoring agriculture, forestry, and fisheries activities at the national, regional, and global levels. Data are available by country and year, with global coverage and annual updates.	Land use is downloaded from FAO metadata https://www.fao.org/faostat/en/#data/RL/metadata
Precipitation	Average precipitation in depth (mm per year). Average precipitation is the long-term average in depth (over space and time) of annual precipitation in the country.	Data for the precipitation is downloaded from https://climateknowledgeportal.worldbank.org/

	Precipitation is defined as any kind of water that falls from clouds as a liquid or a solid.	
Country Temperature	The mean temperature is defined as the average between the max and min temperature in the day. the expected temperature in degrees, valid for the indicated hour. Global temperature is an average of air temperature recordings from weather stations on land and sea as well as some satellite measurements. Extreme temperature events (i.e., maximum, minimum) may have short-term durations of a few days with temperature increases of over 5°C above the normal temperatures.	Data for the temperature is source from download from https://climateknowledgeportal.worldbank.org/
CO_2 Emission	Carbon dioxide emissions are those stemming from the burning of fossil fuels and the manufacture of cement. They include carbon dioxide produced during consumption of solid, liquid, and gas fuels and gas flaring.	The series for the CO_2 emission is sourced from Word Bank Development Indicator https://databank.worldbank.org/source/world-development-indicators