THE POTENTIAL IMPACTS OF CLIMATE CHANGE ON ECONOMIC DEVELOPMENT IN THE ASEAN REGION

VANNASINH SOUVANNASOUK

MASTER OF ECONOMICS IN APPLIED ECONOMICS

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A THESIS SUBMITTED IN PARTIAL FULFILLMENT
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ชื่อเรื่อง ผลกระทบจากการเปลี่ยนแปลงสภาพภูมิอากาศ ต่อการพัฒนาเศรษฐกิจในภูมิภาคอาเซียน
ชื่อผู้เขียน Mr. Vannasinh Souvannasouk
ชื่อปริญญา เศรษฐศาสตรมหาบัณฑิต สาขาวิชาเศรษฐศาสตร์ประยุกต์
อาจารย์ที่ปรึกษาหลัก ผู้ช่วยศาสตราจารย์ ดร.นิโรจน์ สินณรงค์

บทคัดย่อ

การศึกษานี้ประมาณการผลกระทบที่อาจเกิดขึ้นจากการเปลี่ยนแปลงสภาพภูมิอากาศที่มีต่อผลิตภัณฑ์มวลรวมภายในประเทศในภูมิภาคอาเซียนจากข้อมูลในอดีต ตั้งแต่ ปี ค.ศ. 1995 ถึง ปี ค.ศ 2018 แบบจำลองแผงเศรษฐมิติเพื่อตรวจสอบผลกระทบของตัวแปรการเปลี่ยนแปลงสภาพภูมิอากาศและไม่เปลี่ยนแปลงสภาพภูมิอากาศที่มีต่อผลิตภัณฑ์มวลรวมในประเทศในภูมิภาคอาเซียน ได้แก่ ปริมาณน้ำฝน การตกตะกอน ความแปรปรวนของอุณหภูมิ อุณหภูมิแปรปรวน กำลังแรงงาน ดุลบัญชีเดินสะพัด อัตราเงินเฟ้อ และการลงทุนทั้งหมด เป็นตัวแปรที่ใช้สำหรับการประมาณแบบจำลองสถานการณ์จำลองคงที่ ซึ่งผลลัพธ์แสดงให้เห็นว่าบางส่วนที่มีนัยสำคัญและไม่มีนัยสำคัญ จากผลการประมาณการหากผู้กำหนดนโยบายมีความกังวลเกี่ยวกับการกระทำที่เปลี่ยนแปลงของสภาพภูมิอากาศจะช่วยให้การตัดสินใจเกี่ยวกับความเสี่ยงที่ครอบคลุมมากขึ้น และการดำเนินนโยบายควรมุ่งเน้นไปที่การเปลี่ยนแปลงสภาพภูมิอากาศต่อผลิตภัณฑ์มวลรวมภายในประเทศทั้งหมดในภูมิภาคอาเซียน

สถานการณ์จำลอง B2 จะมุ่งเน้นไปที่การแก้ไขปัญหาในท้องถิ่นเศรษฐกิจทางสังคมและสิ่งแวดล้อมอย่างยั่งยืน เนื่องจากประชากรยังคงเพิ่มขึ้นอย่างต่อเนื่อง (แต่เพิ่มขึ้นน้อยกว่าสถานการณ์จำลอง A2) การคุ้มครองสิ่งแวดล้อมในระดับภูมิภาคจึงมีการพัฒนาทางเศรษฐกิจในระดับปานกลาง เทคโนโลยีมีการเปลี่ยนแปลงในหลาย ๆ ด้าน ด้วยการปกป้องสิ่งแวดล้อมและความเท่าเทียมกัน สังคมควรให้ความสำคัญกับการคาดการณ์การเปลี่ยนแปลงสภาพอากาศในอนาคตของภูมิภาคอาเซียน ค่าเฉลี่ยในแต่ละภูมิภาคอาเซียนจากการวิจัยผลกระทบของอนาคต ผลกระทบภายใต้สถานการณ์การปล่อยก๊าซของสถานการณ์จำลอง A2 พบใน ปี ค.ศ. 2039 2059 2079 และใน ปี ค.ศ. 2099 ผลิตภัณฑ์มวลรวมภายในประเทศในภูมิภาคอาเซียนได้รับผลกระทบ สปป. ลาวจะได้รับผลกระทบจากการเปลี่ยนแปลงสภาพภูมิอากาศมากที่สุดใน ปี ค.ศ. 2039 และ ปี ค.ศ. 2059 โดยมีร้อยละ 0.431 และ 0.991 ตามลำดับ ยิ่งไปกว่านั้นใน ปี ค.ศ. 2079 ประเทศเวียดนามจะได้รับผลกระทบจากการเปลี่ยนแปลงสภาพภูมิอากาศมากที่สุดที่ร้อยละ 1.269 นอกจากนี้ในปี ค.ศ. 2099

สปป. ลาวจะได้รับผลกระทบมากที่สุดจากการเปลี่ยนแปลงสภาพภูมิอากาศที่ ร้อยละ 1.276 ผลกระทบภายใต้สถานการณ์การปล่อยก๊าซจากสถานการณ์จำลอง B2 พบในปี ค.ศ. 2039 2059 2079 และในปี ค.ศ. 2099 ผลิตภัณฑ์มวลรวมภายในประเทศในภูมิภาคอาเซียนได้รับผลกระทบ การเปลี่ยนแปลงสภาพภูมิอากาศ ในอนาคตภายใน ปี ค.ศ. 2039, 2059 และ ค.ศ. 2079 ซึ่งสาธารณะรัฐประชาธิปไตยประชาชนลาวจะได้รับผลกระทบจากการเปลี่ยนแปลงสภาพภูมิอากาศมากที่สุดที่ ร้อยละ 0.353 0.554 และร้อยละ 0.573 ตามลำดับ นอกจากนี้ในปี ค.ศ. 2099 ประเทศเวียดนามจะได้รับผลกระทบจากการเปลี่ยนแปลงสภาพภูมิอากาศมากที่สุดที่ร้อยละ 0.612

คำสำคัญ : การเปลี่ยนแปลงสภาพภูมิอากาศ, ผลิตภัณฑ์มวลรวมภายในประเทศ, ภูมิภาคอาเซียน, แบบจำลองข้อมูลแผงเศรษฐมิติ

Title THE POTENTIAL IMPACTS OF CLIMATE CHANGE ON ECONOMIC DEVELOPMENT IN THE ASEAN REGION

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ABSTRACT

This study estimates the potential effects of climate change on the gross domestic product in the ASEAN region based on historical data from 1995-2018. An econometric panel model to examine the impact of the changing climatic and non-climate change variables on the gross domestic product in the ASEAN region, including precipitation, variance precipitation, temperature, variance temperature, labor-force, current account balance, inflation rate, and total investment. The variables used for a fixed-effect model estimation which the results show some significant and insignificant. Based on estimation results, if the policymaker is concerned about climate change actions, it will help more comprehensive risk decision-making and policy exertions should be concentrated toward climate change to the total gross domestic product in the ASEAN region.

Section B2's situation will focus on resolving local problems, economic, social, and environmental sustainability, as the population continues to grow. (But increases less than situation A2) emphasis on environmental protection at the local level, the region has moderate economic development. Technology has changed in many ways with environmental protection and equality. A society with an emphasis on local and regional levels with a projection of future weather changes of the ASEAN region is the average in each ASEAN region from the research of the impact of the future. Effects under the A2 emission scenario were found in 2039, 2059, 2079, and in 2099, the total gross domestic product in the ASEAN region has been affected. Lao PDR will be the most affected by climate change in the years 2039 and 2059,

with 0.431 percent and 0.991 percent, respectively. Moreover, in the year 2079, Vietnam will be the most affected by climate change at 1.269 percent. In addition, in the year 2099, the Lao PDR will also be the most impacted by climate change at 1.276 percent. Effects under the B2 emission scenario were found in 2039, 2059, 2079, and in 2099, the total gross domestic product in the ASEAN region has been affected. Future climate change by the years 2039, 2059, and 2079 which Lao PDR will be the most affected by climate change at 0.353 percent, 0.554 percent, and 0.573 percent, sequentially. In addition, in the year 2099, Vietnam will be the most affected by climate change at 0.612 percent.

Keywords : Climate change, GDP, ASEAN region, Econometrics panel data model

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UNIT 1

INTRODUCTION

1.1 The importance of the problem

Climate change is mainly attributed to the unabated increase in greenhouse gases, including fluorinated gases, carbon dioxide, methane, and nitrous oxide, which bring changes in rain pattern, temperature, and negative effects on water and land resources, floods and droughts. Climate change is considered to be a global phenomenon. However, its impacts are more widely felt in the developing countries, due to their greater vulnerabilities and lesser ability to mitigate the effect of climate change (Ali et al., 2017). The evidence indicates that climate change has already results in extreme weather events and sea level rises (Yeghicheyan et al., 2013). Climate change is the top of agenda of policymakers as they gather in Paris for the United Nations Climate Change Conference, COP21 (Rahim and Puay, 2017). Changes in weather such as increased temperature and reduced air quality of precipitation affect the numbers of society indirectly. Scientists forewarn that the failure to take timely action will be disastrous (Urama and Ozor, 2010). Temperature adversely affects the economic growth in poor countries. They concluded that 1 degree centigrade increase in annual average temperature corresponded to 1.39 percent drop in per-capita gross domestic product in countries studied (Dell et al., 2012). Over the past decade, a growing body of economic research has projected the impacts of climate change on important facets of well-being, such as agriculture, industry, human health, energy demand, and economic growth (Dell et al., 2014). Climate scientists have spent billions of dollars and eons of supercomputer time studying how increased concentrations of greenhouse gases and changes in the reflectivity of the earth's surface affects dimensions of the climate system relevant to human society: surface temperature, precipitation, humidity, and sea revels. The current consensus estimates from what may be the most heavily peer-reviewed scientific publication in human history, the 5th Assessment Report of the Inter-governmental Panel on Climate Change, are that the average global surface

temperature has increased by 0.85° Celsius (1.5° F) since the industrial revolution. Estimates of future warming by the end of the current century range from 0.9 to 5.4℃ (1.6 - 9.7°F) (Pearce et al., 2014).

The development of socio-economic projection scenarios plays a central role in the assessment of climate change impacts, as well as in the design of policy response. Scenario building facilitates the interdisciplinary research efforts that appear necessary for understanding the feedback mechanisms between climate impacts and socio-economic conditions. Recent proposals for climate research projection scenarios build on defining matrix structures where the interplay of climate signals and socio-economic developments is explicitly emphasized (Van Vuuren et al., 2012). However, the majority of this study focuses on temperature and precipitation, largely ignoring other climatic variables such as humidity, wind speed, sunshine duration, and evaporation (hereinafter referred to as additional climate variables) (Ahmed and Hassan, 2011). Natural systems, human health, and agricultural production have been badly affected by devastating environmental change (Arunanondchai et al., 2018). With the rapid increase in the world's population, there is corresponding increase in food demand owning to concerns about the stability of the global environment. Water availability, air pollution, and soil fertility have large impact on agriculture productivity (Noya et al., 2018). Emission of dangerous gases, especially CO_2 are the main factors for the greenhouse effect and warmer average global temperature (Vaughan et al., 2018). The effects of climate change and environmental variation are mainly estimated by the number of stress spells, their impact on daily life, and damage to agriculture crops (Unicef and Organization, 2017).

Inclusive, pro-poor growth is a central objective of development policy. As climate resilience emerges as an equally important development concern, it is worth asking to what extent existing growth policies are compatible with the adaption needs of developing countries. Low-income countries are much more vulnerable to climate change than richer nations (Mason and Asher, 2010). The reason is a combination of three features: a higher physical exposure in many areas (e.g., proximity to temperature thresholds), a higher economic sensitivity to climate events (e.g., heavier reliance on agriculture), and a lower adaptive capacity (e.g., a lower

ability to deal with climate stress). The cumulative effects of global climate change will depend on how the world responds to increasing emissions. The evidence indicates that climate change has already resulted in extreme weather events and sea level rises (Yeghicheyan et al., 2013), with added threats to agricultural production in many parts of the world (Plano et al., 2000). However, standard economic forecasts of the impact of climate change very considerably, with early estimates showing mild effects on the world economy (Tol, 2005). Some of these views have softened subsequently, (Etienne et al., 2012) but aggregate damages still remain relatively small for most temperature ranges.

Both (Stern, 2013); Weitzman (2012), among others, have warned the current economic modeling may seriously underestimate the impacts of potentially catastrophic climate change and emphasize the need for a new generation of models that give a more accurate picture of damages. In particular, they have pointed out two key weaknesses of the current class of economic model: their limited spatial coverage, including averaged impacts across countries and regions, and unreasonable assumptions on the discount rate, which translate into a relative lack of forward-looking behavior in economic forecasts and resulting negative impacts on future generations. The aim of this thesis is to present a modeling framework to create scenarios of climate change effect on GDP change in the future that can be used as an input in integrated assessment modeling and other climate research applications with require GDP projections in the very long run. This projection model has several advantages that make it particularly well suited to serve as an instrument in climate change impact assessment at the ASEAN region level. On the one hand, its underlying structure is based on macroeconomics such as GDP in the agriculture and non-agriculture sectors in the ASEAN region, labor force, the current account balance in percent change yearly, inflation (consumer price index), and total investment in percent change yearly, with climate change variables including total precipitation, variance precipitation, average temperature and variance temperature.

The purpose of this thesis is to examine the economic impacts of climate change. More specifically, I review estimates of the total economic impact of climate change and distribution of those impacts around ASEAN, discuss the interactions

between economic development and climate change. This thesis takes a different approach. Rather than identifying mechanisms one-by-one and summing up, we examine the effects of temperature and precipitation on a single aggregate measure: economic growth. Specifically, we construct historical temperature and precipitation data for each country and year in ASEAN from 1995 to 2018 and combine this dataset with historical growth data. The main identification strategy uses year-to-year fluctuations in temperature and precipitation within countries to estimate the potential impacts of climate and non-climate variables on GDP in the ASEAN region.

1.2 Research objective

The major objectives of the study are to measure the potential impact of climate and non-climate variables on Gross Domestic Product in the ASEAN region. Which includes GDP in agriculture, GDP non-agriculture, and total GDP. The research objectives are as follows

- To analyze the relationship between climate and non-climate variables on economic development indicators in ASEAN region countries.
- To simulate the potential impact of climate change on economic development indicators in ASEAN. In order to create scenarios of climate change effect on GDP in the future

1.3 Expected benefit from research

Expected benefits from climate change research on Gross Domestic Product in the ASEAN region are as follows

- Know the relationship between climate and non-climate variables and Gross Domestic Product in the ASEAN region countries
- Know the potential impacts of climate change on Gross Domestic Product in the ASEAN region countries
- Use the results of the study to guide studies on what is relevant to the future of climate change.

- Use the results of the study to raise awareness and understanding of the impact of society. Arising from the climate that affects gross domestic product in each country's region of ASEAN.

1.4 Research scope

The scope of the research on climate change with Gross Domestic Product in the ASEAN region is as follows

- Data scope: In the research "The potential impacts of climate change on Gross Domestic Product in ASEAN" is a quantitative research analyzing the relationship of weather to Gross Domestic Product in the ASEAN by using statistical data from year 1995-2018 of ten countries in ASEAN
- Scope of variables: In the research "The potential impacts of climate change on Gross Domestic Product in the ASEAN region" in the analysis of climate relations with Gross Domestic Product in ASEAN region. From literature reviewing which statistics are used in the form of annual countries, established by research from 1995 until 2018. The model comprises almost eleven variables: 3 dependent variables of analyze include $gdpagr$ (Gross domestic product in agriculture sector, US$), $gdpnonagr$ (Gross domestic product non-agriculture sector, US$), $tgdp$ (Gross domestic product in Total, US$), the independent variables include: precipitation, variance-precipitation, average temperature, variance-temperature, current account balance, labor-force, inflation (average consumer prices), and total investment

1.5 Terminology

- Climate change in the ASEAN region refers to temperature changes that occur on a regular and continuous basis, such as precipitation, variance precipitation, average temperature, and variance temperature.
- Economic development indicators such as Gross Domestic Product in Agriculture, US $, Gross Domestic Product in Non-Agriculture, US$, and

Gross Domestic Product in Total, US$ are a measure of a country's total economic output divided by the number of people and adjusted for inflation. It’s used to compare the standard of living between countries and over time.

UNIT 2

THEORY AND LITERATURE REVIEW

2.1 Related concepts and theories

2.1.1 ASEAN Cooperation on Climate Change

The vulnerability to and impact of climate change is a major concern to ASEAN. According to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change (IPCC) released in late 2007, warming of the climate system is evident from observations of increases in global average air and ocean temperatures, widespread melting of snow and ice, and rising global. average sea level. Since IPCC's first assessment report in 1990, assessed projections have suggested that global averaged temperature increases between about 0.15 degree Celsius and 0.3 degree Celsius per decade for 1990 to 2005. The IPCC projects that, without further action to reduce greenhouse gas emissions, the global average. Temperature is likely to rise by a further 1.8 to 4.0 degrees Celsius this century, and by up to 6.4 degrees Celsius in the worst-case scenario. The projected global warming is likely to trigger serious consequences for humankind and other life forms, including a rise in sea levels of between 18 and 59 centimeters, which will endanger coastal areas and small islands, and a greater frequency and severity of extreme weather events.

Southeast Asia is highly vulnerable to climate change as a large proportion of the population and economic activity is concentrated along coastlines; the region is heavily reliant on agriculture for livelihoods; there is a high dependence on natural resources and forestry; and the level of extreme poverty remains high. A study carried out by Asian Development Bank (ADB) revealed that the mean temperature in the region increased by 0.1 to 0.3 degree Celsius per decade between 1951 and 2000; rainfall trended downward from 1960 to 2000; and sea levels have risen 1 to 3 millimeters per year. Heat waves, droughts, floods, and tropical cyclones have also become more intense and frequent.

The same study projects a 4.8 degrees Celsius rise in mean annual temperature and 70 centimeters rise in mean sea level by 2100 in Indonesia,

Philippines, Thailand and Vietnam. A rise in sea level would result in major problems for many of ASEAN's largest coastal cities, such as Jakarta, Bangkok and Manila. Millions of people may have to be resettled and massive expenditures incurred to protect the coastal cities. Projections of economic losses by the ADB study include a decline up to 50 percent of rice yield potential by 2100 and a loss of 6.7 percent of combined gross domestic product (GDP) each year by 2100. Other effects of climate change to the region include an increase of GHGs in the atmosphere partly due to low carbon sequestration potential of forests, increasing water stress, as well as adverse impact on human health. ASEAN Member States, though not the source of significant emission of greenhouse gases, have taken actions to address climate change through various environmental, economic and social activities over the years. Several ASEAN Member States have announced voluntary mitigation targets, including Indonesia (emission reduction of 26% from business-as-usual (BAU) by 2020, and can be increased to 41% with enhanced international assistance), Malaysia (reduction of 40% in terms of energy intensity of GDP by 2020 compared to 2005 levels), Philippines (deviate by 20% from BAU of their emission growth path), and Singapore (emission reduction of 16% below BAU by 2020). Many ASEAM Member States have also started strengthening their adaptive capacity through mainstreaming climate change adaptation in development planning. It has been projected that annual benefit (avoided damage) is likely to exceed the annual cost by 2060 and by 2100; benefits could reach 1.9 percent of GDP, compared to the cost at 0.2 percent of GDP.

2.1.2 ASEAN joint statement on climate change

ASEAN has played its active and leadership role in addressing climate change in the global community. The stewardship comes from the ASEAN Heads of State and Government themselves. The ASEAN Leaders at the regional level have issued Declarations/Statements related to climate change at their 2007, 2009 2010, 2011, and 2014 Through the Statements, the ASEAN Leaders expressed ASEAN's common understanding/position and aspirations towards a global solution to the challenge of climate change and their resolve to achieve an ASEAN community resilient to climate

change through national and regional actions. In the 2014 Statement, ASEAN Member State declare to among others: Call all Parties to (i) work effectively and in good faith towards adopting a protocol, legal instrument or agreed outcome with legal force applicable to all by the end of 2015; (ii) take immediate action on ratifying the Doha Amendments to the second commitment period of the Kyoto Protocol; and (iii) table Nationally Determined Contributions well in advance of COP 21 in Paris in December 2015. Urge developed countries to show leadership and increase commitments in terms of assistance to developing countries and least developed countries for key elements being considered in the development of the 2015 agreement, among others:

1. Adaptation
2. Mitigation
3. Loss and damage
4. Technology development and transfer
5. REDD+
6. Financing (such as through Green Climate Fund and Adaptation Fund, REDD+ financing mechanism)
7. Transparency of action and support (including Measurement, Reporting and Verification (MRV)

Reiterate commitment for AMS to (i) enhancing cooperation to improve ASEAN's collective capacity to address climate change; and (ii) strengthening rapid response capacity to be more efficient and effective in the event of natural disasters through existing mechanisms under the ASEAN Agreement on Disaster Management and Emergency Response (AADMER); and (iii) pursuing a successful COP 20 leading to 2015 agreement at COP 21. ASEAN-US Joint Statement on climate change was also issued in 2014 to articulate ASEAN and US commitment to addressing climate change issues. Collectively, ASEAN countries have been responding to climate change by focusing on the implementation of relevant actions in the ASEAN Socio-Cultural Community (ASCC) Blueprint 2009-2015.

Strategic Objective: Enhance regional and international cooperation to address the issue of climate change and its impacts on socio-economic

development, health and the environment, in ASEAN Member States through implementation of mitigation and adaptation measures, based on the principles of equity, flexibility, effectiveness, common but differentiated responsibilities, respective capabilities, as well as reflecting on different social and economic conditions. The actions include:

1. Encourage ASEAN common understanding on climate change issues and where possible, engage in joint efforts and common positions in addressing these issues;
2. Encourage the efforts to develop an ASEAN Climate Change Initiative (ACCI);
3. Promote and facilitate exchange of information/knowledge on scientific research and development (R&D), deployment and transfer of technology and best practices on adaptation and mitigation measures, and enhance human resource development;
4. Encourage the international community to participate in and contribute to ASEAN's efforts in afforestation and reforestation, as well as to reduce deforestation and forest degradation;
5. Develop regional strategies to enhance capacity for adaptation, low carbon economy, and promote public awareness to address effects of climate change;
6. Enhance collaboration among ASEAN Member States and relevant partners to address climate related hazards, and scenarios for climate change;
7. Develop regional systematic observation system to monitor impact of climate change on vulnerable ecosystems in ASEAN;
8. Conduct regional policy, scientific and related studies, to facilitate the implementation of climate change convention and related conventions;
9. Promote public awareness and advocacy to raise community participation on protecting human health from the potential impact of climate change;

10. Encourage the participation of local government, private sector, non-governmental organizations, and community to address the impacts of climate change;
11. Promote strategies to ensure that climate change initiatives lead to economically vibrant and environment friendly ASEAN Community taking into account win-win synergy between climate change and the economic development.

Completed Projects: Some key regional activities on climate change that have been completed under environment sector include:

- A US$ 15 million regional project titled "Rehabilitation and Sustainable Use of Peatland Forests in Southeast Asia", (2009-2013) is being implemented to undertake measures to prevent peatland fires, the major source of smoke haze in the region. The Project on "Biodiversity and Climate Change" (2010-2015) with financial assistance from Germany amounting to Euro 2,500,000 is being implemented to assist ASEAN in developing and implementing strategies and instruments in the field of biodiversity and climate change.

- A Workshop and Exchange on Climate Resilient Cities: Identifying Best Practices was recently held on 18-19 January 2010 in Jakarta, Indonesia for representatives from ASEAN city and national governments to exchange best practices, lessons learned and experiences in addressing the current and future impacts of climate change.

- Workshops on Risks and Impacts from Extreme Events of (i) Floods and (ii) Droughts in ASEAN Countries were held on 9-10 June 2010 in Indonesia and 22-23 September 2010 in Thailand respectively. The Workshops assessed the capacity of ASEAN Member State with regard to flood and drought management, to review their individual and collective preparedness to engage in risk mitigation and adaptation planning, and to exchange best practices of flood and drought management solutions.

- The ASEAN Plus Three Youth Environment Forum: Creating a Climate for Change was held on 22-25 April 2010 in Brunei Darussalam as a part of the implementation of the ASEAN Environmental Education Plan (AEEAP) 2008-2012. The

Forum aimed at generating interest and awareness of youths from ASEAN and Plus Three countries on climate change issues. The Forum concluded with a 'Statement on ASEAN Plus Three Youth Actions on Environment' which amongst others outlined the youths' pledges and resolution to play their part in safeguarding the environment.

- The annual ASEAN Plus Three Leadership Programme on Sustainable Production and Consumption is also one of the AEEAP 2008-2012 activities. The Programme aims at equipping business and industry leaders with necessary knowledge, skills and tools to develop strategies for sustainable development.

2.1.3 ASEAN region at a glance

The ASEAN region lies within the waters of the Pacific Ocean, Indian Ocean, Andaman Sea, and the South China Sea, and stretches more than 3,300 kilometers from north to south (latitudes 30° North to 11° South) and 5,600 kilometers from west to east (longitudes 92° West to 142° East). ASEAN borders China to the north, India, and Bangladesh to the northwest, and East Timor and Papua New Guinea to the southeast. The region also has a long coastline, measuring about 173,000 kilometers in total, and is surrounded by major seas and gulfs such as the South China Sea, the Andaman Sea, and the Gulf of Thailand. In view of its proximity to the equator, the region enjoys a warm and humid climate throughout the year.

Natural Resources: The ASEAN region is endowed with rich natural resources that sustain essential life support systems both for the region and the world. The rich marine life and abundant mineral resources support important economic activities such as oil exploration, commercial and small-scale fisheries, and tourism. Apart from providing water, food, and energy, these natural resources play an important role in sustaining a wide range of economic activities and livelihoods. The ASEAN region is blessed with a variety of unique ecosystems such as the Mekong River Basin, Ha Long Bay, and Lake Toba. The strategic location of ASEAN has also brought about numerous economic advantages to the region, particularly through international shipping and foreign trade.

Population: ASEAN is highly populated. The total population of AMS in mid-2008 was about 580 million, which accounted for 8.7 percent of the world's total. In terms of regional distribution, the ASEAN region has the fourth largest population after South-Central Asia, Eastern Asia, and Sub-Saharan Africa. Indonesia is the most populous country in the region with 229 million people and the fourth most populous country in the world after China, India, and the United States. Six AMS are among the top 50 most populous countries in the world, namely, Indonesia, Philippines, Vietnam, Thailand, Myanmar, and Malaysia.

Climate change as an issue: Climate change has become a defining and most challenging sustainable development issue of the twentieth-first century. It is defining in the sense that it is now dictating the pace and nature of economic growth, development, and social progress, while potentially becoming the greatest threat to humankind and survival if left unchecked. It is challenging because of its multifaceted nature, affecting almost all sectors and the basic means and lifestyle of human existence. It is no more a mere environmental issue that can be fixed by technology or finite human and capital resources. It is more urgent in the sense that we are talking in terms of years or at most a few decades to address climate change before the earth reaches a turning point at which stage the climate change devastating impacts becomes irreversible.

The climate change crisis aptly amplifies the consequences of not acting in a holistic and integrated manner. It cannot be fixed by technology or finite human and capital resources alone. It is also the most urgent in the sense that, if remedial measures are not taken, a point of no return would be reached in the next few decades. The climate change crisis is the embodiment of what can go wrong if action is not taken globally based on the principle of common but differentiated responsibility.

The authoritative Intergovernmental Panel on Climate Change (IPCC), the scientific advisory body to the United Nations Framework Convention on Climate Change (UNFCCC) has estimated that globally, emissions reductions of 25-40% of 2000 levels are needed if the global temperature fluctuations are to be maintained within a range of 2℃, a level which is generally taken to sustain life without any

irreversible damage. The Stern Review on the Economics of Climate Change has estimated that the cost of inaction could cost up to 20% or more of global GDP, while in contrast the costs of action undertaken now to address climate change to avoid the worst impacts can be limited to 1% of global GDP each year.

In the on-going negotiations for renewed and urgent actions on climate change, the debate on mitigating greenhouse gases, essentially carbon dioxide, is fast turning into a development issue, how much growth each nation can pursue given the constraints on the limiting capacity of atmospheric carbon space. The key argument is that the developed countries, with their historically unfettered industrial growth, have enjoyed these rights and have crowded out the carbon space, which is now limiting the development potential of developing countries, given that they too should have the right to equitable development. This draws attention to the stark reality that the environment cannot be separated from economic growth and social development. Each has to support and complement the other. ASEAN is particularly vulnerable to the impacts of climate change due to the concentration of people and economic activities in the coastal areas, its rich biological diversity, resource-based economies, and the increased vulnerability of the people especially the poor. Due to its geological and geographical factors, the region is also one of the world's vulnerable regions to suffer from a range of climatic and natural hazards such as earthquakes, typhoons, sea-level rise, volcanic eruptions, droughts, heatwaves, and tsunamis which are becoming more frequent and severe. In addition, the geophysical and climatic conditions shared by the region have also led to common and trans-boundary environmental concerns such as air and water pollution, urban environmental degradation, and trans-boundary haze pollution.

ASEAN Climate Change Initiative: The ASEAN Environment Ministers have endorsed the Terms of Reference of the ASEAN Climate Change Initiative (ACCI). ACCI is envisaged to be a consultative platform to further strengthen regional coordination and cooperation in addressing climate change and to undertake concrete actions to respond to its adverse impacts. The scope of collaboration through the ACCI will include (i) policy and strategy formulation; (ii) information sharing; (iii) capacity building; and (iv) technology transfer. The ASEAN Environment Ministers have also

established an ASEAN Working Group on Climate Change (AWGCC) to implement the ACCI and D10 actions of the environment ASCC Blueprint. The ACCI seeks to enhance regional and international cooperation to address climate change and its impacts on socio-economic development, health, and the environment, in AMS through the implementation of mitigation and adaptation measures, based on the principles of equity, flexibility, effectiveness, common but differentiated responsibilities, respective capabilities, as well as reflecting on different social and economic conditions. The ASEAN Climate Change Initiative is being coordinated by the ASEAN Working Group on Climate Change chaired by Thailand and shall be reporting to the ASOEN.

To attain these objectives the project supports ASEAN in facilitating an exchange of information and knowledge of climate-smart land use within and between different stakeholder groups, such as ASEAN working groups, the ASEAN Climate Resilience Network (ASEAN-CRN), decision-makers and practitioners from AMS, scientific institutions, civil society organizations and private companies working on land use and climate change in the region. It builds capacities for specific climate-smart practices in agriculture and forestry through workshops, training courses and communication and networking activities. It also facilitates the development of joint ASEAN positions on climate change and land use and their introduction into international forums such as the United Nations Framework Convention on Climate Change.

Together with working groups and networks, the project supports the development of guidelines and recommendations related to land use and climate change through ASEAN bodies and networks, and promotes their implementation in the member states. The project facilitates matchmaking between support needs in the countries and the support on offer for implementing climate-smart and climate-resilient approaches for land use. The project activities contribute to achievement of the 2030 Agenda for Sustainable Development goals as well as the Paris Agreement.

2.1.4 Situation of Climate Change in ASEAN region

Southeast Asia is highly vulnerable to climate change as a large proportion of the population and economic activity is concentrated along coastlines; the region is heavily reliant on agriculture for livelihoods; there is a high dependence on natural resources and forestry; and the level of extreme poverty remains high. Visualization of ASEAN's future climate change 30–100 years by downsizing. The results of the global climate model on ASEAN region according to patterns of future developments that will affect the concentration of greenhouse gases in the atmosphere at different levels divided into 2 cases

(1) Case B2 at the greenhouse gas concentration of 800 ppm.

(2) Case A2 at a concentration of 1,250 ppm (IPCC 2007).

Using 2 models, it was found that all models showed consistent results, that overall temperature increase notwithstanding, the rate of temperature rise was different. Some models show an average temperature increase of 4 degrees Celsius over the next 100 years, while rainfall changes have not the trend is clear, although most models predict an increase in rainfall in the future. (Office of Research Fund 2011), Office of Natural Resources and Environmental Policy and Planning, in collaboration with the Academic Service Center of Chulalongkorn University By the Center for Network Analysis Research and trainings for the global transformation of Southeast Asia has made a project study the effects of climate change and climate variability in the future and adaptation of key sectors by reviewing the long-term future climate forecasting studies, it was found that the highly spatial resolution of climate simulations for ASEAN were found. As well as Southeast Asia in the first phase the study was performed using the Conformal Cubic Atmospheric Model (CCAM), the condition used to define the input data. In this study, the concentrations of 360 parts per million of atmospheric greenhouse gases in the atmosphere were the concentrations used to calculate the climate at the present time to use. As a base for comparison and increasing greenhouse gas concentrations to 540 parts per million and 720 parts per million to simulate future climate conditions.

The Conformal Cubic Atmospheric Model (CCAM) indicates that the trend of temperature in Southeast Asia will decrease slightly under atmospheric greenhouse

gas conditions increased to 540 parts per million. However, the temperature will rise more than today when greenhouse gases in the atmosphere has increased to 720 parts per million. Future temperature changes under the circumstances, this simulation will be in the range of 1-2 degrees Celsius compared to the present. Nevertheless, the change in the time period has hot or cold weather is more evident, the number of hot days, or days with the highest temperature above 33 degrees Celsius that increase 2-3 weeks per year, and the number of cold days or days below 15 degrees Celsius decreases another 2-3 weeks per year. In the future, summers in the region will be longer and winters will be shorter. Show that the future climate conditions in which the concentration of greenhouse gases in the atmosphere soared to 540 and 720 parts per million. There will be more rainfall of about 10-20 percent throughout the region (Southeast Asia START Regional Center 2006). The summary is from future climate simulations in the project "Climate Simulation Future for ASEAN region", which is the result of cooperation between the centers of The Global Change Research and Training Network in Southeast Asia and The Met Office Hadley Center for Climate Change, a research unit of Climate change in the UK By simulating the climate that is high spatial resolution, along with cover the entire area of ASEAN region to achieve the understanding of climate change trends in the region as a result of Climate change in the future under three trends of atmospheric greenhouse gas changes:

1. The A2 approach is one that is similar to the past-to-present aspects of the world development, that is the world of economically different and diverse. Politics and access to technology, where development focuses on economic growth rather than environmental sustainability. Furthermore, this led to an atmospheric greenhouse gas concentration of 1,250 parts per million by the end of the 21st century.

2. The B2 approach is a balanced development approach. And change to development in conjunction with Sustainable preservation of nature focuses on solving local problems. Both economically, socially and environmentally sustainable, leading to an atmospheric greenhouse gas concentration of 800 ppm. By the end of the 21st century. According to the study period in terms of mean, variance, and

deviation from each other. In the future weather characteristics by country. Here, the results of the study are summarized as follows:

Rainfall: November to January period, above normal rainfall is predicted for the ASEAN region south of the equator, as well as the Philippines and parts of Vietnam, Lao PDR, and Cambodia. Lanina conditions are present over the tropical Pacific Ocean and most climate models predict Lanina conditions, which typically bring wetter-than-normal conditions over the Southeast Asia region, to persist for this period. The results of the calculation show that the average annual rainfall tends to increase. Increased in all ASEAN region in terms of both the amount and distribution of the area where rainfall increases, especially at the end of the century. As for the number of rainy days in the year which uses the criteria days when the precipitation of more than 3 mm or more. It was found that the average number of days of rain each year in almost every area remains close to what it was in the past. Shows the nature and length of the season the rain may still not change much from what is currently. However, the rainfall in each year of almost all areas will increase. It may indicate that the amount of rain that falls each time in the future will increase or it may be said that each rainfall is heavier than it has been in the past, which means the risk of floods, flashes, floods, and natural disasters that will result from several types of floods.

Maximum temperature: Under the situation of greenhouse gas changes according to the development guidelines. The A2 economy and society found that the average maximum temperature in ASEAN region at the beginning of the century had not changed much from the late century. Although in the middle and late centuries, there was a tendency for the highest temperature to increase with every sector, the highest temperature conditions in the future under the situation of the greenhouse gas change following the B2 economic and social development approach is also in the direction of increasing in almost all areas in ASEAN region. However, it was slightly higher than the A2 guidelines for the hot period of the year. The days with a maximum temperature equal to or higher than 35 degrees Celsius. The results show that at the end of the last century, the hottest days were in the central, western and central southern regions, with hot days lasting 5-6 months per year, and

7-8 months per year in some countries. Longer in almost every area in ASEAN region could be a few months longer than before at the end of this century.

Minimum temperature: While warmer-than-normal temperature is expected to continue over much of the Maritime Continent for the next three months, parts of Viet Nam, Lao PDR, Cambodia, and Thailand may experience below-to near-normal temperatures. With wetter conditions expected in November, the hotspot activities in the southern ASEAN region are forecast to remain subdued, although isolated hotpots and localized smoke plumes may still be detected during brief periods of drier weather. A gradual increase in hotspot activities may be expected over the northern ASEAN region from December 2020 as this is the period when the region enters its traditional dry season with the onset of Northeast Monsoon. Future climate change conditions show that areas across ASEAN region is likely to have the lowest average daily temperature will rise. This may increase 3-4 degrees Celsius during the end of the century under the situation of greenhouse gas changes according to the development approach economy and society model A2. Under the scenario of type B2, the lowest average daily temperature over the year has a rising trend, but it was at a level lower than the A2 approach, about 2-3 ℃. As for the average cooling time of the year, at the beginning of this century, the northern and upper northeastern regions had the longest days below 16 ℃, about 1–2.5 months, with longer than 2–2.5 months below 16 ℃. The months are visible in the upper part of the area. However, this cool period will shrink, beginning in the middle of the century and become evident at the end of the century under the greenhouse gas transition situation in accordance with the A2 Economic and Social Development Guidelines. However, the situation under the B2 transition will change less, with parts of the upper North and the upper Northeast still having a period when the weather is cold for about 1 month, but the area is likely to decline.

Wind direction and speed: The Southwest Monsoon gradually made way for inter-monsoon conditions in early November 2020, as the prevailing winds over the ASEAN region became generally weak and variable. Inter-monsoon conditions are characterized by increased shower activities over most parts of the southern ASEAN region as the monsoon rain band lies close to the equatorial region. The inter-

monsoon conditions are expected to last for around one month before transitioning to the Northeast Monsoon. During the Northeast Monsoon, the northern ASEAN region enters its traditional dry season while the southern ASEAN region can expect more rainy weather. The results of calculations show that the upper area of ASEAN region of residence deep in the land: North, Northeast, and Upper Central - over the next 100 years, there hasn't been much change in wind pattern. By the direction of the wind blowing the cover cape still has the same average as it was in the past. Changes in wind direction and speed began to appear in areas near the coast from the lower central and eastern regions, and in the area. The southern region, which is a peninsula jutting out of the land, can clearly see changes. However, using data from this climate model should take into account the inconsistencies. This is due to local phenomena such as the influence of local climatic conditions from the local environment. Therefore, the study of projecting the future of change the climate in the next phase, Therefore, influences should be considered. At the local level that may affect to the climate in each area for further correction of the error of the climate model (Center of Network Analysis Research and training for the global transformation of East Asia Southeastern Chulalongkorn University, 2011).

2.1.5 Concepts of impacts from climate change

Impact on agriculture: Climate change resulting in disaster more violent nature both problems of drought, flood, disease and pest outbreak, and variability of the seasons impact on agricultural production in addition, concerns about the problem. The environment made consumers aware of the need to change their behavior towards their consumption which more environmentally friendly to get an opportunity to expand the production of environmentally friendly products and services to meet the needs of consumers. Produced according to the sustainable agriculture system, which will help resolve environmental problems in the long term (Department of Agricultural Extension, 2015). Climate to productivity the most detailed agricultural studies in the past are studies under the project. Effects of global warming on rice, sugarcane, cassava and corn production in Thailand. The results of the study showed that agricultural products in Thailand are generally not

affected by climate change except cassava that forms the variability of the weather in which happening in the future as a result, agricultural products are varied as well. Although the output overall of that country not many drastic changes. However, some areas are classified as critical areas in the future, there will be lots of changes in the future production, including the area of rainwater or rice paddies, as well as sugarcane and cassava plantations in the north of the country during the dry season, the affected paddy fields and corn acreage are expanded to many areas. Resulting in decreased rice yield, including soil nutrients, and the distribution of rain. As soil properties and rainfall do not correlate to temperature changes are the main problems in the lower northern regions. In addition, corn yields which reducing due to the lack of water during the flowering period as part of assessing the likely effecting from climate change in Thailand (Office of Policy and Planning Natural Resources and Environment., 2015).

Impact on coastal areas: As the global average sea level in the past 100 years has risen between 10 and 25 centimeters, coastal areas have been flooded and greatly eroded. The rise in global temperatures is expected to cause sea level rise by about 50 centimeters in 2000, if it was true, it would be caused the country's coastal areas to be lost. In addition, which making the sea level rise may also cause space the ice is reduced to a vertical formation of water and waves. This has led to a change in the sea water circulation system, which affecting the productivity of marine resources, nutrients, ecosystem structure and the role of the ecology.

Impact on water resources: Climate change is raising global temperatures, as a result, the amount and frequency of precipitation changes from the use of conditional change modeling climatic analysis of the scenario where there is an increase in carbon dioxide from 2000 levels. By 1990, that it doubled, which was found that the world's rainfall will increase 5 percent. However, the rainfall will be different according to region precipitation is greater in some areas and falling in others. By region near The North Pole may have more floods, due to the more rainfall while in other areas, the amount of rain will decrease. Moreover, the areas with more rainfall will flood. The area with reduced rainfall will have water flowing

into the reservoir is reduced (Office of Natural Resources and Environmental Policy and Planning, 2015).

From the review of studies to predict the situation of changing conditions. Climate and impacts on various sectors in the future It can be seen that ASEAN region still has the limitations of the organization. The knowledge in this area is high because there is still a small amount of research and research studies in all areas. Impacts and climate relations in addition to forecasting the situation change climate using basic information from the global climate model with scenarios. Various greenhouse gas emissions are also limited in the uncertainty of both projections from effects of climate phenomena including various weather conditions connected and interconnected, local impact including continually adapting to the changes that occur human ecosystems and systems. In addition, the atmospheric greenhouse gas concentration scenario used in the model is a global state, dependent on international development directions. There can be some discrepancies in terms of timing because the future is so hard to predict, the effects of climate may or may not occur, and if they do, what are the patterns? Still high uncertainty preparation for each system and sector, both social, economic and environmental. Therefore, a risk management approach must be used as a basis. However, climate change does not directly pose a risk to systems or sectors. But the effect of climate change on various biological biological systems. Therefore, it affects the risk of the sector which dependence on those systems results in the effects on such physical biological systems as a proxy for climate change risk assessment. Climate risk at a particular time depends on the exposure of the system and sector. It takes into account the sensitivity of a system or sector to the potential impacts of climate change. However, the level of risk will vary according to the context of the region depending on the model of relevance. The relationship that systems or sectors have on various impacts including different geographic locations may affect the degree of susceptibility to different climatic variables. Assessment the risks or impacts of climate change can take several forms, both assessments using different opinions or models of use include agricultural or water resource models, for example, crop models and hydrological models, which are somewhat more advanced. On the other

hand, the results obtained from the analysis by the model are quantitatively easy to assess, and can be done quite conveniently, but this does not mean that the results will always be correct or best which from time to time there may also be an opinion to be considered as well.

Which is a qualitative analysis, then linked between this effect and the risks, within the context of the future development direction that has been created that they can continue to develop towards their goals, set in the future or not which, if able to continue the expected development direction under the climate situation. Some modifications may indicate that the system or sector is not vulnerable (Vulnerability). However, it has adequate coping capacity. On the other hand, if that development path cannot be continued, that system or sector should be taken additional measures to cope with climate change. It should also be analyzed which taking measures in terms of cost and return, which, if in the scope of receiving such measures, is considered a reasonable approach. But if we do not have to go back and review the direction of development as expected, it may not be suitable for the context of the area. The vulnerability can be summarized in the form of a relationship of risk or exposure and climate sensitivity to the limit. The ability to handle as follows, where any system or sector is more or less vulnerable to climatic conditions depending on the proportion of risks and coping capacities. However, keeping the risk to a minimum or the vulnerability is very little to do this by maximizing the ability to handle very high; it is often difficult, both economically and technologically. Therefore, the most part, systems and sectors in society need to manage risks in an attempt to fit the risks and coping ability. In addition, another area of concern for risk assessment is the time and spatial (geographic) scale for the response to climatic and climatic phenomena. Where the system or sector there will be several levels and there will be relationship in time which is a matter of climate processes in a nutshell, it is called weather event or weather characteristics which will look like that happens from time to time or weather a period of approximately 10 years or a decade, with a system or sector at the household, sub-district or district level, generally responding to weather or weather events in a shorter period of time, or it will be of immediate interest for a period of less than 2-3 years. Interested in

the daily level, but if it is responding to the climate of the system or sector at a larger scale, such as at the regional, watershed and national levels up to a scale of millions of rai or millions of rai. It is more important to look at the issue of climate events in the long term, because it is a long-term strategy, which may span more than 30 years or even centuries. Therefore, preparation for adapting to this long-term change has to be formatting in a way that is a continuous process. The knowledge is continuously transferred and communicated with stakeholders in the area in accordance with or appropriate to the management level of the area. (Center of Network Analysis Research and trainings for the global transformation of East Asia South-Eastern, Chulalongkorn University, 2011).

2.2 Related concepts and theories

2.2.1 How growth can cushion climate-change impacts

Vulnerability to climate change is a function of two socio-economic variables. Economic growth almost always increases the adaptive capacity of people. A society's ability to cope with climate events is highly correlated with basic development indicators such as income, education, and institutional quality. However, economic growth can either increase or decrease the sensitivity of a country to climate change. Diversification away from agriculture into manufacturing, for example, is likely to reduce the severity of climate change impacts. In contrast, agricultural expansion that increases reliance on scarce water resources could increase potential impacts, as could economic development in hazard zones (e.g., flood plains or low-lying coastlines). The net impact of these effects is unclear a priori. However, the empirical evidence suggests that the positive effects tend to dominate. Raddatz (2009) concluded that climate-related disasters had a higher GDP impact in low-income countries than in the middle-income countries, which were in turn more affected than high-income ones. (Cavallo and Noy, 2009) found that certain development indicators were associated with a lower GDP loss from a given climate-related disaster, including GDP per capital, literacy, strong institutions, trade openness and depth of financial markets.

There is further evidence from case studies that poverty tends to exacerbate the costs of climate change. (Benson and Clay, 1998) suggested a U-shaped relationship between development and vulnerability to climate change: the economic impact of climate-related shock such as drought was higher for economies that had moved from a 'simple stage' of water-intensive agriculture and subsistence sector to an 'intermediate stage,' characterized by labor-intensive low-technology manufacturing, but vulnerability was lower where economies had become more diversified and developed.

2.2.2 Natural capital

Traditional growth policies tend to neglect the environmental impacts of growth, but it is key both for adaptation and sustainable development. Climate change makes safeguards for ecosystems an even more important policy goal. Climate change will compound existing pressures on ecosystems, speeding up their destruction and loss of biological diversity. Removing baseline pressure by managing natural resources sustainably would strengthen their resilience and increase their ability to adapt naturally to climate change (Parry et al. 2007). Healthy ecosystems can themselves contribute to adaptation (e.g., coastal protection through mangrove forests or wetland zones). Hornbeck (2009), analyzing the 1930s Dust Bowls, showed how environmental degradation, in this case over-farming, can have significant economic effects and trigger deep structural change (many farmers were forced off the land and left unemployed).

2.2.3 Infrastructure

The need for infrastructure investment over the coming decade is enormous. Climate change does not alter this need but may increase its costs. Climate change may also affect where infrastructure is built and how it is designed. There may be a need for additional infrastructure, dedicated to climate protection, such as sea defenses and flood protection. Making infrastructure resilient to climate change is an important and early adaptation challenge. This is not cheap: infrastructure adaptation tends to dominate adaptation cost estimates (Fankhauser 2010). It also requires

sophisticated decision-making, given how little we know about future climate effects at the regional level (Ranger et al. 2010). However, starting this process is important. Infrastructure assets are long-lived and have the potential to lock in development patterns for a long time (World Bank 2010).

2.2.4 Human capital

Two areas of human capital are of particular concern in dealing with a changing climate-education and health. Both are key to improving resilience to climate shocks as well as priority development goals. However, additional stress from global warming will also make it more difficult to achieve existing development targets for health and education. More and better education can help people to understand, cope with and respond to changes in climatic conditions (Toya and Skidmore, 2007). This finding is particularly strong for the education of women. Climate-specific know-how and information are a powerful factor in improving agricultural performance. Trained farmers with access to accurate information make better management decisions (for example choosing crop varieties that are less dependent on volatile rainfall; (Di Falco et al. 2010) and are likely to use insurance as a risk mitigation tool. Conversely, climate shocks may affect human capital accumulation. Evidence from rural India shows that those born during floods in the 1970s were 19% less likely to have attended primary school (Brown, 2007). (Cuaresma et al., 2009) found that, as the risk of natural disasters increases, the accumulation of human capital (measured as secondary school enrolment rates) falls. Worsening health outcomes have a similarly detrimental effect on human capital (Parry et al. 2007). The occurrence of tropical diseases such as malaria not only limits countries' ability to develop but also their capacity to deal with climate shocks.

2.2.5 Macroeconomic stability

A higher probability of extreme events may make fiscal sustainability both more important and more difficult to achieve (Bowen et al., 2012). Government budgets may come under pressure if more funding is required for emergency services and reconstruction. There may also need to be an expansion of the availability of international capital to counter climate shocks. Fiscal pressure may be compounded by a temporary fall in revenues in the aftermath of a disaster and by the risk of moral hazard if private actors rely on public emergency coverage (Heipertz and Nickel, 2008). Macroeconomic effects will depend on the economic cycle. Hallegatteand Ghil (2008) show that some output flexibility may be good in the face of a negative climate shock. In the world with underemployed factors of production, such resources can be deployed to assist reconstruction after a climate shock, thus limiting the loss in output. However, if the shock hits the economy in a boom, when there is little spare capacity to rebuild, output may fall over the medium term. The policy implication clearly to foreign labor and capital resources that can be deployed in periods of full capacity utilization.

2.2.6 The institutional and regulatory framework

Climate change strengthens the case for institutional policies, which have both growth and adaptation benefits. It is possible that the two objectives require different types of capacity or institutions (e.g., related to the business environment in one case and emergency services in the other). However, it is likely that strong generic institutions will build up and evolve endogenously to tackle problems as they arise. The empirical literature finds that better institutions result in a faster, more efficient response to climate shocks and that the shock itself does less damage to output (Cavallo and Noy, 2009). Dell et al (2008,2009) suggest that support for institutional reform directly helps to increase adaptability within the economy, and indirectly increases adaptability by increasing income levels (thus reducing a country’s vulnerability to climate change and shocks).

2.2.7 Access to market

Trade openness is associated with faster growth, but from an adaptation point of view, there are both positives and negative associated with reliance on international markets. There is some evidence that openness to trade makes economics more resilient to climate shocks by making producers less reliant on domestic markets and consumers less reliant on domestic production (Bowen et al., 2012). However, openness also makes it easier for local climate effects to spread internationally. The UK Government Office for Science (2011) concluded that the consequences for the UK of climate change occurring in other parts of the world could be as important as the direct domestic effects. Moreover, if trade engenders grater specialization, that may expose countries to additional risks, if the specialization is in climate-sensitive areas or if countries become reliant on a vulnerable trade infrastructure. As a non-climate example, Kenya's flower industry lost heavily when a volcanic ash cloud grounded freight flights to Europe in 2010. Greater openness may also drive workers into less productive and more vulnerable informal sectors, as has happened in Africa and Latin America according to (McMillan and Rodrik, 2011). (Gassebner et al., 2010) find that natural disasters have a negative impact on trade flows in the short run, reducing both imports and exports, which suggests that both effects may operate and the type of shock is crucial in determining the outcome.

2.2.8 Access to capital

Climate change reinforces the need for better access to capital. At the macro level, access to funds for reconstruction is likely to become more important, while micro-finance generally targets those most vulnerable to climate change. However, the products offered may need to change, e.g., by expanding opportunity to insure against climate shocks. Openness to capital markets has been shown to increase climate resilience, through inflows for reconstruction. This could replace the need for domestic buffer stock saving in case re-building is necessary (see discussion on macroeconomic stability above). However, over-reliance on inflows prior to the shock can result in the opposite effect, as capital flight after the shock worsens the

country's capital account position. A strong domestic financial system and access to domestic capital are equally important. Resilience to climate shocks will require domestic financial firms to be fully diversified, in particular not overly reliant on the vulnerable agricultural sector. Hornbeck's (2009) study of the Dust Bowl shows over-specialization of the financial system makes it vulnerable to climate shocks and how this can have both level and growth rate effects on income. Agrawalaand Carraro (2010) ague that micro-finance may be an effective way to encourage resilience and adaptation. Many micro-finance initiatives are implicitly tackling climate change already, e.g., through investment in crop diversification and support for disaster relief. At the same time, many of the projects financed by micro-finance institutions are vulnerable to climate change. Which estimating that 70% of micro-portfolio in Bangladesh could be affected climate change, and usually negatively so.

2.3 Panel data regression

Theorical model for analyzing the effects of changing conditions climate towards economic development indicator in ASEAN region. Define theorical model to analyze the relationship of climate change and Gross Domestic Product per capita in ASEAN region be able to apply concepts creating econometric model for data in panel format. The advantage of the model is the effects of spatial and time differences can be analyzed by using the panel data model as in equation 1

$$\hat{Y}_{it} = \propto + X'_{it}\beta + u_{it} \quad (1)$$

One-way error component model in the equation 2

$$u_{it} = \mu_i + v_{it} \quad (2)$$

Where $\hat{Y}_{it}$ is the Gross Domestic Product per capita of country i at the time t

X'_{it} is the vector of the described variables of country i at the time t

β is the vector of the coefficient that must be estimated from the model

u_{it} is the random error

μ_i is the unobservable individual-Specific Effect

v_{it} is the remainder error term

Regression analysis is studied the relationship between climate change and Gross Domestic Product per capita in ASEAN region. Define a function where y is the GDP per capita which depending on the relevant factors under the risk non-factors can be controlled is the climate, namely average temperature, precipitation, etc.

The above model definition can analyze the influence of the variables that affect the variables which are Gross Domestic Product per capita in ASEAN region. That will result in the estimation results regression equations, efficiency, and statistical reference processes with high confidence levels. However, in the model analysis to obtain unbiased and effective analysis requires Model Specification Test is as follows:

Data stillness test by unit root panel test (Panel unit root test)

Stationary testing is a test of time series data, which is a set of data that is collected for a consecutive period in a systematic way. In general, time series data consists of 4 components: Trend (T), Seasonal (S), Cycle (C), and Irregular (I) events. These elements will be causing data instability non-Stationary is the cause of the spurious regression between time series variables. Both variables can be seen from the regression equation between two time series variables, most of which have a high level of R^2 and statistically significant t despite the relationship of those variables by the theory has no economic meaning.

To test the stillness of the data by testing the unit root (Panel nit root test) is a test that all variables defined from this model or the equation Stationary data, with any correlation rating I (0) I (1) or I (2) using the Unit Root Test offered by Dickey and Fuller (1979) using the Dickey Fuller Test (A). Information Unit Root Test by Augment Dickey-Fuller (ADF) and Fuller, 1981 are as follows

$$\Delta y_t = \alpha + \delta t + \beta y_{t-1} + \sum_t^k = \gamma_j \Delta y_{t-1} + \varepsilon_t \quad (3)$$

Where y_t is the variable that is tested for unit root values?

α is a constant

$\delta, \beta, \& \gamma$ is the coefficient

t is the trend value

ε_t is the error term

The hypotheses test are as follows

$$H_0 = \beta = 0\ (Non\ Stationary)$$
$$H_1 = H_0\ not\ true\ (Stationary)$$

If β is equal to 0, then y_t has Unit Root. That is, the data is unstable. The mean and the variance change over time. The value y_t must be used to find the difference continuously until rejection H_0 the number of times. Looking for differences will let us know the order of integration (d) which is in the level of $[y_t \sim I(d); d > 0]$

The variables studied by Augmented Dickey-Fuller Unit Root Test, in which the Fisher-Type Test is proposed, the p-value as the sum of each unit's ADF test i as in equation (4)

$$p_e^c = \frac{-2\sum inp_e^c(i) - 2N}{\sqrt{4N}} \quad where\ N(0,1) \tag{4}$$

Set $p_e^c(i)$ to be the p-value of the ADF tests for each unit i

Static data testing with Fisher-Type Test using - ADF. The main assumptions of this data are unstable data. (Non-Stationary). If the P-value$< 0.05,$ will reject H_0. Show the data qualified as Stationary at the significant level of 0.05

The assumption is

H_0: Data has unstable characteristic (non-Stationary)

H_1: Data has stationary characteristics (Stationary)

The unit root test using the methods of Levin, Lin and Chu Test is a unit root test based one the hypotheses of Fisher ADF and Fisher PP as in equation (5)

$$\Delta y_{it} = p_i y_{it-1} + \sum_{j=1}^{pi} \emptyset_{ij} \Delta y_{it-j} + \varepsilon_{it-j} \quad i = 1, \dots, N; t = 1, \dots, T \tag{5}$$

Where y_{it} is variable of interest

ρ & θ are parameters

p_i is a number of Lag Order for difference term $\varepsilon_{it} \sim i.i.d\ (0, \sigma_\varepsilon^2)$

If the statistical values accept the key assumptions H_0 or accept alternative hypotheses. H_1 will indicate that the variable which is interested does not have a unit root or the data is stationary. There is an assumption

$H_0: \rho_i = 0 \rightarrow$ Data has unstable characteristics (non-Stationary)

$H_1: \rho_i < 0 \rightarrow$ Data has stationary characteristics (Stationary)

The method of testing Im, Pesaran and Shin (IPS) (Im, Pesaran and Shin, 2003) developed a unit testing for the panel data from Levin, Lin and Chu's work is due to the LLC method. The ρ value must not be different for every unit i while the IPS method allows the unit coefficient ρ has different values for each cross-section's unit under the alternative hypothesis the test hypotheses for the IPS method is as follows:

$$H_0 : \rho_i = 0 \ \forall_i$$
$$H_1 : \rho_i < 0 \ \ i = 1, \dots, N_1$$
$$: \rho_i = 0 \ \ i = N + 1, \dots, N_1$$

Therefore, if the statistical values accept the primary hypothesis H_0, then all units of the cross-section of the data, the panel has a unit root and if you accept the alternative hypotheses H_1, it can be said that only some cross-sectional units of the data have the unit root.

If the data were tested, stationary data showed that time series data had the same mean and variance throughout the study period. Variables that have passed the stillness test can be analyzed to find relationships by using the Panel Data Estimation Model following the next steps.

If the data is tested, the variable data is unstable (non-Stationary) shows that serial data with mean and variance are not equal throughout the study period. The variables that have been tested have been unstable and cannot be analyzed because they cause problems Spurious regression therefore must make the unstable data to remain stable. Of information first to avoid the problem of unrelated relationships by finding the difference of First Differencing data or converting it to

Logarithm or testing relationships in long term data (Cointegration), which after the conversion of the data, then test the stillness to know that the static data is not influenced by trend of time, season, cycle, and unforeseen event. When found, the static data can be estimated in the next step.

Multivariate linear hypothesis testing (Multicollinearity)

Is a test of common conditions that the variables described in the matrix are related to each other. If having a relationship with just one pair is called Collinearity, but if there are many relationships, it is called Multicollinearity which can explain that those variables or those variables are not independent of one another. Which will not be based on Guass Markov's hypothesis. The least squares estimation gives unsatisfactory results which causing the result of the relationship between the described variables that are as follows:

The ability to enumerate the influence of each described variable decreases. While normally the coefficient will be interpreted as is the result of a change of variable as the variable describes, with other factors being stable, the decreasing accuracy comes from the variance of the coefficient has higher values

The coefficients that have been estimated do not differ significantly from 0. Statistic and may make us decide to cut that variable out of the model. This is not because of that variable is not influence, buy the example given cannot accurately distinguish the influence or effect. That the coefficient of decision (R^2) or statistics (F) clearly shows that the model has significant power to explain.

The estimator is sensitive to increasing or decreasing the sample size. Cutting or adding few observation units can change estimates or cut out unexplained variables importantly, leaving the model is also effective.

Despite the difficulty in separating the variables of each variable, but the ability of forecasting variable values may still be accurate. In forecasting outside of the sample values as well if the relationship model between those variables has not change.

In the summery, the linear relationship between variables may cause problems of Multicollinearity if the problem is true, one or some coefficients may have very low accuracy, which means that the sample data does not matte

(information) that is sufficient to related to the parameter which solving this problem the information must be reliable. To test linear co-relations (Multicollinearity) when there is a model for analysis. Data for empirical analysis may have linear relationship problems and would like to test this problem with the objective of this test

1. Is there linear relationship problem?
2. How serious is the problem?
3. What is the format of the problem?

In the tests used in the research, the method is using the (simple correlation: r) the value r_{jk} between two descriptive variables with high value of 0.8 or 0.9 indicates the problem value. Relationship depending on how severe or similar which comparing r_{jk} with decision coefficients R^2, if r is higher than R^2, then it means that the relationship problem is so high that it adversely affects the model. Deciding how serious the problem of joint relations which an arbitrary decision, and the pair-by couple relationships of variables be able to inform the relationship between them which complexing. When variables have more than 3 or more from equation 6

$$r_{23} = \frac{\sum_{i=1}^{n}((x_{i2}-\bar{x}_2)(x_{i3}-\bar{x}_3))}{\sqrt{\sum_{i=1}^{n}(x_{i2}-\bar{x}_2)^2(x_{i3}-x_3)^2}} \quad (6)$$

Or in the form of standard deviation equation 7

$$r_{23} = \frac{\sum_{i=1}^{n}\dot{x}_{i2}\dot{x}_{i3}}{\sqrt{\sum_{i=1}^{n}(\dot{x}_{i2})^2(\dot{x}_{i3})^2}} \quad (7)$$

Which can test statistics on whether $\boldsymbol{X}_2$ and $\boldsymbol{X}_3$ are related at the selected severity level. Equation 8

$$t = \frac{x_{22}\sqrt{n-2}}{\sqrt{(1-r^2)}} \qquad n-2 = Degree\ of\ Freedom \quad (8)$$

Will get the following assumptions

$$H_0: r = 0$$
$$H_1: r \neq 0$$

If choosing the severity level with the criteria of 0.50 as equation 9

$$H_0: r = 0.50$$
$$H_1: r > 0.50$$

$$t = \frac{(r-0.50)\sqrt{n-2}}{(1-(r-0.50)^2)^{\frac{1}{2}}} \quad (9)$$

Tests for inconstant variation in error (Heteroskedasticity)

The problem of variance in the error is not constant. (Heteroskedasticity) is the error problem caused by each variable has a variable value. The problem often occurs with information that is the cross-section with the least-squares forwarding (Ordinary Least Square) yields inefficient results from the model estimation. Where the estimator must not be the lowest error and from which the value of variance does not have the lowest value. As a result, the T-test and F-test had a statistically significant decrease in the number of variables. The cause of the problem the variance of the error is not constant, which is

1. Techniques, sampling methods, and data collection.
2. The nature of the data in which the error is naturally inconsistent, such as cross-section data.
3. Omitting some important independent variables that were not introduced into the model.

In this research, there is a chance that there is an inconsistent deviation problem because this study is a study on gross domestic product per capita in the countries in ASEAN region with differences. Spatial due to the area of various countries have the amount of gross domestic per capita that are different by factors of economics. Resulting in a high probability that there will be a problem of variance in the error is not constant.

In which to test the variance of the error is not constant was wrong. The least-squares method which has hypothesized that the error must have constant variance, using cross-section data, there is often a chance that the tolerance varies with the size or in order to have a problem of variance, an unstable shift tolerance makes a coefficient estimator. Regression equations are also unbiased and

appropriate. Therefore, the problem must be tested the variance of the error is not constant with the assumption that

H_0 : The variance of the error is constant (Homoscedasticity)

H_1 : The variance of the error is not constant (Heteroskedasticity)

If the test results showed that the calculated Chi-Square statistic was higher than the critical value ($Prob.> \alpha$), then rejected the main hypothesis, indicating that the regression problem had an inconsistent deviation problem. The problem of the variance of the error is not constant. The problem can be solved in the event of an inconsistent deviation problem with the least square estimation method (Generalized Least Square, GLS) (Nirot Sinnarong, 2015).

Of the variance: from the fundamental assumptions of Regression models, either multiple regression models or simple regression models, are Assume that the variance of the error [var [Σi]] is (homoscedasticity) equal to σ^2 for all samples under the assumptions above. The part that helps encourage the estimator obtained from the least-squares method possesses the properties of an oriented estimator. The best unbiased straight line

In this section, the regression model is considered in the event of the variance of the error or heteroscedasticity. Which will result in

$$e[\varepsilon\varepsilon'] = \begin{bmatrix} \sigma_1^2 & o & o \\ o & \sigma_2^2 & o \\ o & o & \sigma_n^2 \end{bmatrix}$$

Whereas σ_i^2 is the variance of the error and $i = 1, k, n$

The reasons for the inconsistency in the variance are as follows:

1. The learning of the sample, such as collecting the relationship between the number of working hours practice typing on the computer with the number of typos. As the number of training hours increases this will result in a lower number of typos or a lower number of typos distributions, resulting in lower variance. Does not have a constant based on the underlying assumptions.

2. Change of external variable this resulted in a wide range of internal variables, for example the case of consumption models. The externally variable income increases, resulting in consumers have more choices of consumption. Distribution of consumption that is an internal variable increased distribution causing the variance of the error to increase as well.

3. Development of techniques for better data collection makes the data used in the model match more reality resulting in the error value is lower and of course the variance of the error is reduced.

4. Structural changes such as changes in law, change period or change in the exchange rate system due to structural changes on behavior between external and internal variables in which the results of the structural changes that occur are expressed in error this may cause the model of the distribution of the error, especially the variance, to change.

5. Use of time series data that is collected at each interval. From the unequal number of samples, such as the collection of ASEAN region consumption data c_{it} and income y_{it} as follows:

Year 1 use the sample number n_1 to get

$$\sum_{t=1}^{n_1} c_{i1} \quad and \quad \sum_{i=1}^{n_1} y_{i1}$$

Year 2 use the sample number n_2 to get

$$\sum_{t=1}^{n_1} c_{i2} \quad and \quad \sum_{i=1}^{n_1} y_{i2} \ : \ n_1 \neq n_2$$

Year t use the sample number n_t to get

$$\sum_{t=1}^{n_1} c_{it} \quad and \quad \sum_{i=1}^{n_1} y_{it}$$

When the above information is written in a simple regression model, we will have an equation 10 is obtained.

$$c_t = \beta_0 + \beta_1 y_t + \varepsilon_t \tag{10}$$

Whereas

$$\sum_{t=1}^{n_t} c \ , y_t = \sum_{t=1}^{n_t} y \ \ and \ \ \varepsilon_t \sum_{i=1}^{n_t} \varepsilon_{it}$$

Consider the variance of the error or

$$Var[\varepsilon_i] = Var[\sum_{t=1}^{n_t} [\varepsilon_I]]$$

$$Var[\varepsilon_i] = Var[\sum_{t=1}^{n_t} Var[\varepsilon_I]$$

$$Var[\varepsilon_i] = Var[\sum_{t=1}^{n_t} n_t \, \sigma^2$$

Showed that If the number of samples for each year (n_t) is used the same, $n1 = n2 =, \ldots, = (n_t) \ and \ Var[\varepsilon_i]$ is constant. Will cause $Var[\varepsilon_i]$ to be inconsistent.

6. Use of data cross-section (Cross-Section Data) because the use of cross-section data will have the difference of each sample expressed by the tolerance. Which will give the appearance the error distribution of each sample varies.

Breusch-Pagan-Godfrey Test, which is a test of the inconsistency of the variance of the error under the assumption is inconsistencies arising from a variety of factors

$$\sigma_i^2 = f[z_1, z_2, \ldots, z_m] \tag{11}$$

Where z_i is any variable, possibly external, and $i = 1,2, \ldots, m$ the Breusch-Pagan-Godfrey Test. Let the relationship between $\sigma_i^2 \ and \ z_i$ be Straight lines can be written as follows.

$$\sigma_i^2 = \alpha_0 + \alpha_1 z_{i1} + \alpha_2 z_{i2} + \cdots + \alpha_m z_{im} + v_i \tag{12}$$

Whereas v_i is the error of the equation.

Then, equation 12 is estimated with the least-squares using p_i as the approximation of σ_i^2, where p_i is calculated from

$$p_i = \frac{e_i^2}{\tilde{\sigma}_i^2} \tag{13}$$

Whereas e_i^2 is the error in the estimated regression model, and $\tilde{\sigma}_i^2 = \frac{\sum_{i=1}^{n} e_i^2}{n}$

$$p_i = \alpha_0 + \alpha_1 X_{i1} + \alpha_2 X_{i2} + \cdots + \alpha_m X_{im} + v_i \tag{14}$$

After estimating Equation 14, Residual Sum of Square (RSS) is calculated for use in calculating statistical value X^2 as follows:

$$X_{m-1}^2 = \frac{ESS}{2} \tag{15}$$

Whereas $m-1$ is the order of freedom. The X^2statistic was then used to test the hypothesis.

H_0 : (Homoscedasticity)

H_1 : (Heteroskedasticity)

Testing the form of equations of Fixed and Random Effect

To test an appropriate model when characterizing the relationship between the influence of factors that cannot be observed with explanatory variables from this study, Panel Data is used, which is data that consists of multiple samples and independent variables. That comes from the same body and at the same time, several points at the same time for several consecutive periods. The analysis of this kind of data differs as follows.

Panel Data has a Time-Invariant Variable: a_i is a variable always constant no matter how the time changes and cannot be measured because it is hidden outside the equation different samples may be influenced by different variables, hence a_i become the Unobserved Individual Specific Effect inherent in the equation and causing Serial Correlation and Heteroskedasticity problems. Following the above

problem, Panel Data Analysis offers two methods for arranging Time Invariant: a_i that can be done in 2 ways as follows:

1. Random Effect Model is an analysis given that a_i can be made to have Feasible Generalized Least Square (FGLS) method was used to solve the problem of Serial Correlation. This random effect model would cause a_i to be combined with the error μ_{it} to become the new error v_{it}. The key assumption is that a_i must not correlate with any independent variable. In the equation there is a mean of 0 and a variance $\sigma^2 a$, then the variable form is FGLS.

2. Fixed Effect Model is analyzed by means of control a_i by eliminating this influence. Away from the equation, not to interfere with the Demean analysis, where the hypothesis is a_i must be related to the independent variable in the equation and must not be related to each other or $Cov(a_i, a_j) = 0; i \neq j$, where Demean separates the variable a_i from the error v_{it} before becoming $a_i + u_{it}$, then subtracting the sample's mean by the mean of the sample variable and adding it to the total sample time, that example of constant behavior over time, no matter how many external influences affect it, there is no change in behavior.

Since the time-invariant has a latent value in the equation, when we take the variable values in each survey unit minus the mean of the variables in each survey unit, the result is the factor. Fixed to be eliminated subtraction by the mean of the variables in the survey unit is called demean as in Equation (16).

$$C_{it} = \beta_{1i} + \beta_2 Q_{it} + \beta_3 PF_{it} + \beta_4 PL_{it} + u_{it}; i = 1,2,\dots,N;\ \ t = 1,2,\dots,T_i \qquad (16)$$

Therefore

$$\bar{C_i} = \beta_{1i} + \beta_2 \bar{Q_i} + \beta_3 \overline{PF_i} + \beta_4 \overline{PL_i} + \bar{u_i}; i = 1,2,\dots,N \qquad (17)$$

Subtract equation (16) from equation (17), we will get the equation (18), and (19) as the following equation below:

$$C_{it} - C_i = \beta_2 (Q_{it} - Q_i) + \beta_3 (PF_{it} - \overline{PL_i}) + \beta_4 (PL_{it} - \overline{PL_i}) + (u_{it} - \bar{u}_i) \qquad (18)$$

$$or\ \ C_{it} = \beta_2 q_{it} + \beta_3 pf_{it} + \beta_4 pl_{it} + u_{it}; i = 1,2,\dots,N; t = 1,2,\dots,T \qquad (19)$$

From equations (18) and (19), the Unobserved time - Invariant variable equations were eliminated. When analyzed, the study results were obtained at unbiased slope estimates. Disappear when the sample size of the observations is larger (called consistent). However, if Observed time -Invariant is included in Equation (16), for example in the Keynesian Consumption Function, which consists of income and investment if there are interest rate variables and the relatively stable economic growth rate in the short term is associated with independent variables. Implementing the demean or differencing method, which will be discussed further, will allow the two variables, interest rate and the gross domestic product growth rate.

2.4 Literature review

There is a considerable debate about what is the sensible policy response to the environmental problems as a consequence of the continued build-up of greenhouse gases. Incidentally, the nascent literature has considerably expounded on the relationship between environmental sustainability and economic growth. In this section, we give an updated review of the economics of the problem and appraise the appropriate literature both empirically and theoretically concerning the relationship between climate and economic growth.

(Desmet and Rossi-Hansberg, 2015) identifies on the spatial economic impact of global warming. They propose a dynamic spatial theory to analyze the geographic impact of climate change. They model a hemisphere of the Earth and calibrate the model using current data and a variety of projections on temperature and economic growth. Even though global warming interacts with specialization patterns and innovation in complex ways, one of its main effects is to shift production and population to the north as it makes some of these regions warmer. Since technology is better in the north, in the absence of migration restrictions, temperature change can lead to small positive welfare effects. So, if the impact of pollution on temperature is small, an economy can gain from temperature change. If, on the other hand, the effect of carbon emissions on temperature is very large, the welfare cost can be substantial.

(Baarsch et al., 2020) estimates the impact of climate change on incomes and convergence in Africa. While rapid and sustained economic growth should support Africa's poorest countries and populations converge with the continent's richest, projections of inequality across countries under the two warming scenarios show otherwise. Even though climate change is not projected to increase inequalities or reverse income convergence between African countries, it is projected to significantly slow these processes. The slowdown in inequality reduction emphasizes the uneven distribution of climate-change-induced impacts, with Sahel countries, for example, being among the most affected by temperature and precipitation extremes in both climate change scenarios, in addition to already vulnerable economies and communities.

(Kompas et al., 2018) is examined the effects of climate change on GDP by countries and the global economic gain from complying with the Paris climate accord. This work extends a large dimensional intertemporal CGE trade model to account for the various effect of global warming on GDP growth and level for 139 countries. GHG emission growth and its global warming consequences are a significant threat to the earth’s future. However, assessing climate change impacts on the global economy and national incomes, as well as the potential benefits of climate change agreements, is a complex task that necessitates large-scale modeling to even approach a comprehensive answer. For economists, the standard tool is CGE modelling. But, here, save for a few valuable country studies and some dynamic recursive modelling efforts, current models are either dimensionally too small or bound by myopic forecasting rules to be completely useful or compelling.

Millinerand Dietz (2011) has also examined the potential theoretical channels through which climate change may affect long-run economic growth. They maintain that the dichotomy between adaption and growth on one hand, mitigation and development on the other is clearly ambiguous. An important conclusion from (Milliner and Dietz, 2011) is that the task of apportioning investment between productive capital and adaption investments is a subtle one. Implicit in this finding then is that as an economy develops over time, it will automatically insulate itself from the perils of climate change. For instance, the structural changes that go with

economic development will mean less dependence on the more sensitive sectors to climate change such as agriculture.

Abidoyeand Odusola (2015) empirically examined the impact of climate change on economic growth in Africa. Using annual data for 34 countries spanning the period 1961 to 2009, they found a negative impact of climate change on economic growth in Africa. Their study revealed that a 1 ℃ rise in temperature reduces economic growth by approximately 0.27 percentage points for the region. Considering a sub-sample in the time dimension over the period 1961 to 2000, they reported a greater negative effect of climate change on growth. Growth falls by 0.41 percentage points per ℃ rise in temperature in Africa. Jonesand Olken (2010) analyses the trade effects and export performance of developing countries to climate change and conclude that warmer temperature tends to dampen the export performance of developing countries, predominantly for agriculture and light manufacturing.

Lanzafame (2014) investigates the effects of temperature and rainfall on economic growth in Africa using annual data from 1962 to 2000 for 36 African countries. Using an autoregressive distributed lag model for panel data, the study found that the evidence of both short-and long-run relationships between temperature and per capita income growth. However, the impact of rainfall on growth has little support from the data. The important lesson of Lanzafame (2014) is that African countries have not adapted well to weather shocks, and without proper intervention, mechanisms to arrest the alarming effects of climate change growth may be hampered. From the foregoing discussion, it goes without saying that the deleterious effects of climate change on growth are well-established in the literature, particularly for SSA economics: warmer temperatures and falling precipitation reduce the capacity to utilize irrigation to grow crops and to support export-based agriculture and light industry. This has a feedback loop on growth and poverty reduction efforts. However, the debate so far seems to be one-sided. There have been alternative explanations pointing to the need for caution in interpreting evidence presented from the climate data.

Alternatively, (Weitzman, 2012) has warned that we might be considerably underestimating the welfare losses from climate change by using conventional quadratic damage functions and thin-tailed temperature distribution and suggests severe limits on GHG levels to guard against catastrophic climate risk. A study by the Global Humanitarian (Forum, 2009) also provides a worrisome picture of the social impacts (e.g., on environment and health) of climate change in the developing world. The loss from global warming, here, includes climate-related deaths from worsening floods and droughts, malnutrition, the spread of malaria, and heat-related ailments. According to the Global Humanitarian Forum (2009), the current global warming process already causes 300,000 deaths and US$ 125 billion in economic losses annually.

(Akram, 2013) conducted a study on climate change as a barrier to economic growth in the Asia. The objective is to study the effects and analyze the results from climate to economic development in the Asia. The sample selected to study in Asia countries. Which using the time-series data from 1972-2009 was used by econometric tools using the Seemingly Unrelated Regression method. A statistically significant cross with economic development is the average annual temperature. Cumulative rainfall population growth rate and factors correlated with economic growth. The economy is statistically significant, the percentage of urban population and human development index the most, but will have the least impact on the industry.

(Du et al., 2017) has a study entitled “The Impact of Climate Change on Developed Economies” with the objective of studying the impact and the relationship between the rise in temperature and economic growth of the US and EU analyzed data using the Linear Spline Regression Models method, using data from 1995-2005. The study found that the effects of temperature increase on economic development were found in the temperature will rise not less than 6 degrees from the analysis from the IPCC found that the change of temperature was significantly inversely correlated with economic growth.

(Alagidede et al., 2016) studied the effect of climate change in economic growth: Evidence form Sub-Saharan Africa as an estimate of the action. Climate change and long-term economic growth data from 1970–2009 from 18 Sub-Saharan

African countries were studied using the Panel Ordinary Least Square Estimator method for long-term studies. The study found that the values, divided into two models from model 1, describe the flexibility of the climate change was found to have an adverse effect on economic growth. But uncontrollable factors, including international trade financial development affects economic growth was statistically significant in model 2, it is an approximation of the flexible found temperature has a positive effect, but rainfall has a negative effect on economic growth. And financial development factors have a substantial effect on economic growth in the Sub-Saharan Africa region.

Table 1 The summarize topic of the impact of climate change on economic growth

Title (Authors: year)	Objective	Variables	
		Factors out control	Factors in control
On the spatial economic impact of global warming (Desmet and Rossi-Hansberg: 2015)	A dynamic spatial theory to analyze the geographic impact of climate change	Yearly temperature	Economic growth
The impact of climate change on incomes in Africa (Baarsch et al., :2020)	Detrimentally affect African countries' economic development.	Temperature Precipitation	Income Economic growth
The effects of climate change on GDP by countries (Kompas et al., :2018)	Effect of global warming on GDP growth and level for 139 countries	Global warming GHG emission	GDP growth
The potential theoretical channels through which climate change may affect long run economic growth (Millinerand:2011)	Maintain the dichotomy between adaption and growth	Temperature	Economic development indicators, Agriculture production
The impact of climate change on economic growth in Africa (Abidoyeand:2015)	The impact of climate change on economic in Africa, using annual data for 34 countries 1961 to 2009	Temperature Precipitation	GDP growth Agriculture manufacturing Export-Import
The effects of temperature and rainfall on economic growth in Africa (Lanzafame:2014)	Using the panel data to find evidence of both short-and long-run	Precipitation Weather shocks Warmer temperature	GDP growth Export of agriculture Poverty reduction

GHG Targets as insurance against catastrophic climate change (Weitzman: 2012)	Investigate what might happen to an economic analysis of climate change	Current global warming Floods & Droughts	Economic losses The spread of malaria
Is climate change hindering economic growth of Asia economics (Akram:2013)	Analyze the results from climate to economic development in the Asia	Annual temperature Cumulative rainfall	Population growth Economic growth Industry output
The impact of climate change on developed economies, by using data from 1995-2005 (Du:2017)	The relationship between temperature and economic growth of the US and EU	Temperature	Economic growth
The effect of climate change on economic growth: evidence from Sub-Saharan Africa (Alagidede:2016)	The effect of climate change on long-run economic growth for selected sample of SSA	Climate change Temperature Rainfall	International trade Economic growth Financial development

Source: Rossi-Hansberg., Baarsch et al., Kompas et al., Millinerand., Abidoyeand.

From research studies related to the potential impacts of climate change on development economic indicator in ASEAN region. It was found that there were 10 studies involved. The first research is identified on the spatial economic impact of global warming. They propose a dynamic spatial theory to analyze the geographic impact of climate change. Second research is estimated the impact of climate change on incomes and convergence in Africa. While rapid and sustained economic growth should support Africa's poorest countries and populations converge with the continent's richest, projections of inequality across countries under the two warming scenarios show otherwise. Even though climate change is not projected to increase inequalities or reverse income convergence between African countries, it is projected to significantly slow these processes. The third research is examined the effects of climate change on GDP by countries and the global economic gain from complying with the Paris climate accord. This work extends a large dimensional intertemporal CGE trade model to account for the various effect of global warming on GDP growth and level for 139 countries. GHG emission growth and its global warming consequences are a significant threat to the earth’s future. The fourth research has also examined the potential theoretical channels through which climate change may affect long-run economic growth. The fifth research is empirically examined the

impact of climate change on economic growth in Africa. Using annual data for 34 countries spanning the period 1961 to 2009, they found a negative impact of climate change on economic growth in Africa. Their study revealed that a 1 ℃ rise in temperature reduces economic growth by approximately 0.27 percentage points for the region. Some researchers have warned that we might be considerably underestimating the welfare losses from climate change by using conventional quadratic damage functions and thin-tailed temperature distribution and suggests severe limits on GHG levels to guard against catastrophic climate risk. The objective is to study the effects and analyze the results from climate to economic development in the Asia. The sample selected to study in Asia countries.

The concepts and theories involved in the analysis of panel regression is used to analyze the impacts of climate change on gross domestic product in the ASEAN region, in data analysis and the statistical correlation test sequence in order to provide the most efficient estimation based on econometric principles. In this regard, there are 3 dependent variables including GDP in agriculture sector, GDP in-non agriculture sector, and total GDP and the independents variables including total precipitation, variance-precipitation, average temperature, variance temperature, labor-force, current account balance, inflation rate, investment rate, and trend from time to time. To bring about the simulation of the effects condition change climate and non-climate change variables towards gross domestic product in ASEAN region in the future hence, it pawned the frame related concepts and research.

2.5 Research conceptual framework

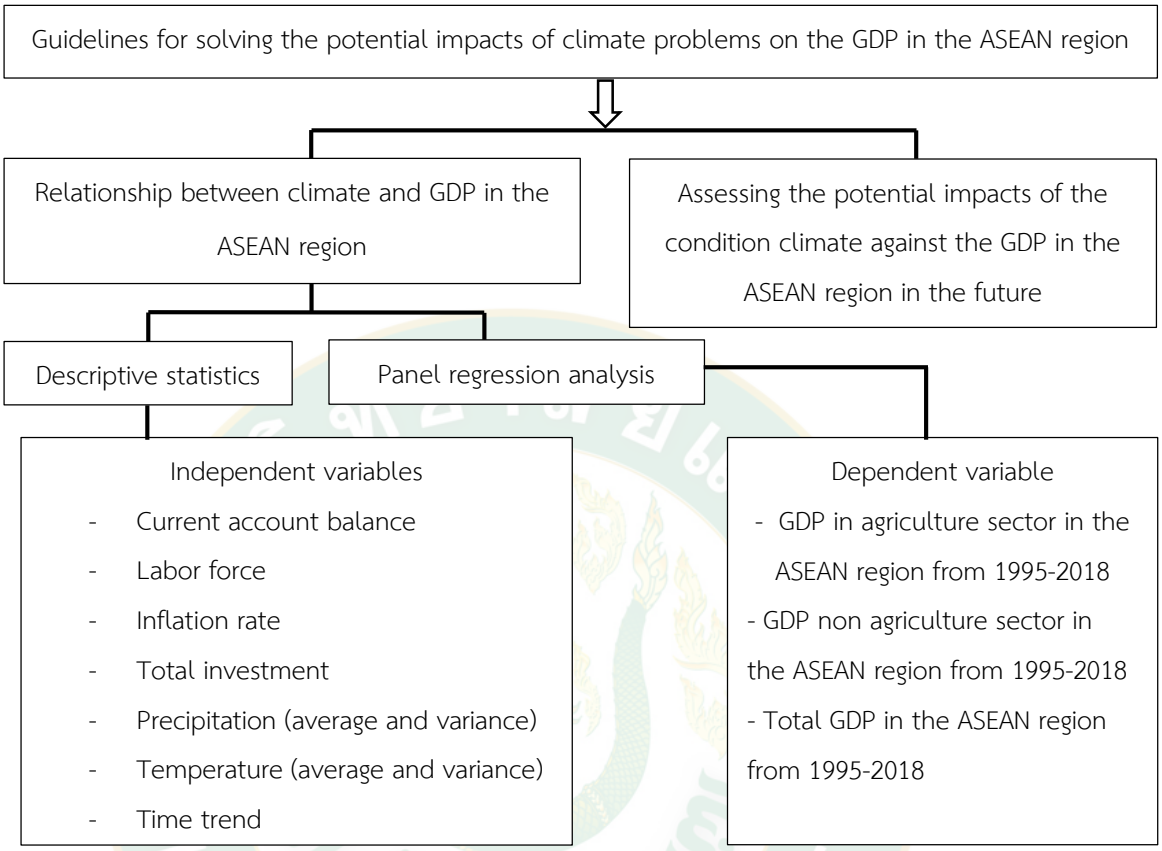

Figure 1 Research conceptual framework

UNIT 3

RESEARCH METHODOLOGY

3.1 Overview of the Data

Information that is relevant to the research on "The potential impacts of climate change and non-climate change variables on the gross domestic product in the ASEAN region is quantitative research which using secondary analysis data in spatial form, time series and cross-section data that analyzing each region which statistic is used in the form of annual countries, established by research from 1995 until 2018. The model comprises almost 10 variables: while there are 3 dependent variables of model analysis which including $gdpagr$ (Gross domestic product in the agriculture sector, US$), $gdpnonagr$ (Gross domestic product non-agriculture sector, US$), $tgdp$ (Gross domestic product in Total, US$), the independent variables include precipitation, variance-precipitation, average temperature, variance-temperature, current account balance, labor-force, inflation (average consumer prices), total investment rate, and time trend.

Precipitation happens when water falls down to Earth's surface. This water might be in a liquid or solid state. Rain made if liquid water droplets falls when temperatures in the air and at the surface are above freezing (32°F, 0°C). Rain can start as water droplets or ice crystals in a cloud but always falls as liquid water. The supply of water is directly affected by weather and climate. Next to the critical water input through precipitation at daily, monthly and seasonal scales, also the loss through evapotranspiration should be taken into consideration. Particularly high temperature, low humidity and high winds can efficiently remove water from the land surface. Equally, the demand for water is expected to evolve under climate change, particularly as they relate to often rapidly changing demographic and economic settings. These changes generally increase the operational challenges and risk for the water sector. The degree to which rainfall amounts vary across an area or through time is an important characteristic of the climate of an area. This subject

area in climatology is called "rainfall variability." There are two types (or components) of rainfall variability, areal and temporal.

Calculating average temperature gives us a more accurate picture of the temperature in a specific location than a single measurement ever could. Temperature fluctuates throughout the day over the course of a week, month to month and year to year. Calculate the mean daily temperatures of an area, usually a town or city, for each day of year. Take the temperature readings on the hour for a 24 hours period. Add the hourly readings together, the divide that number by 24 to get the mean daily temperature. Record the first measurement at midnight and the last at 11 p.m. of the same day. Calculate the average of the 12 mean monthly temperatures. Add the mean monthly temperatures for the months of the calenda year, January to December, together, and then divide by 12. This will be the mean annual temperature. The meaning in meteorology, diurnal temperature variation is the variation between a high temperature and a low temperature that occurs during the same day. It is important to evaluate how the climate has varied and changed in the past. The monthly mean historical precipitation and temperature data can be mapped to show the baseline climate and seasonality by month, for specific years, and for precipitation and temperature.

The mathematical equation that allows us to determine the current account balance tells us whether the current account is in deficit or surplus (whether it has more credit or debit). This will help understand where any discrepancies may stem and how resources may be restructured to allow for a better functioning economy.

$$CAB = (X - M) + (NY + ACT)$$

Where:

X= Exports of goods and services

M= Imports of goods and services

NY= Net income abroad

NCT= Net current transfers

Theoretically, the current account balance (CAB) should be zero, but, in the real world, this is improbable. If the current account has surplus or deficit, it informs

on the government and state of the economy in question, both on its own and in comparison, to other world markets.

The labor force, or work force, is the total number of people who are currently employed plus the number of people who are unemployed and seeking employment. This number does not include people who are unemployed and not seeking employment, such as students and retirees. People who would like a job but are not current looking for one are also not considered part of the labor force. In short, the workforce includes those who either have a job or are actively seeking one (Lebovitz and Eddington, 2019). The labor pool does not include the jobless who are not looking for work. The size of the labor force depends not only on the number of adults but also how likely they feel they can get a job. Consequently, the labor pool shrinks during and after a recession. That's true even though the number of people who would like a full-time job if they could get it may stay the same. The real unemployment rate measures all the jobless, even if they are no longer in the labor force.

Economics theory states that there are two sources of inflation, cost-push and demand-pull inflation (Lipsey and Chrystal, 2003). When in a country there is demand-pull inflation, due to increasing demand for food, producers are expected to invest more in the agricultural sector, resulting in increased production and as a consequence increasing demand pull inflation should lead to increasing percentage contribution of agriculture to GDP. Inflation is the decline of purchasing power of given currency over time. A quantitative estimate of the rate at which the decline in purchasing power occurs can be reflected in the increase of an average price level of basket of selected goods and services in an economy over some period of time. The rise in the general level of prices, often expressed as a percentage, means that a unit of currency effectively buys less than it did in prior periods. Inflation is the rate at which the value of a currency is falling and consequently the general level of prices for goods and services is rising. It can be viewed positively or negatively depending on the individual viewpoint and rate of change.

Investment refers to an increase in capital assets, and typically includes investment by business, investment in property and investment by governments in

‘social’ capital. The level of investment in an economy tends to vary by a greater extent than other components of aggregate demand. This is because the underlying determinants also have a tendency to change. Investment is a sacrifice, which involves taking risks. This means that businesses, entrepreneurs, and capital owners will require a return on their investment in order to cover this risk, and earn a reward. In terms of the whole economy, the amount of business profits is a good indication of the potential reward for investment. Investment is inversely related to interest rates, which are the cost of borrowing and the reward for lending. Investment is inversely related to interest rates for two main reasons. Firstly, if interest rates rise, the opportunity cost of investment rises. This means that a rise in interest rates increases the return on funds deposited in an interest-bearing account, or from making a loan, which reduces the attractiveness of investment relative to lending. Hence, investment decisions may be postponed until interest rates return to lower levels. Secondly, if interest rates rise, firms may anticipate that consumers will reduce their spending, and the benefit of investing will be lost. Investing to expand requires that consumers at least maintain their current spending. Therefore, a predicted fall is likely to discourage firms from investing and force them to postpone their investment decisions.

3.2 Panel Data Analysis

“Panel data” is set of data obtained by observation of the characteristics of a variety of units (cross-sectional variables) over time. Panel data set have both cross-sectional and time-series dimensions. The size of the time series is formed by monitoring the same cross-section units during a given period. When each subject (cross sectional unit) has the same number of observations, this type of panel is called a balanced panel data set. If some subjects have different number of observations, this situation is known as the unbalanced data case. Panel data sets that thousands of the cross-sectional units observed through the time are used in many micro-economic researches. Panel data provide more informative data, more variability, more degrees of freedom, less collinearity among the variables and more efficiency. Panel data analysis can be considered as a combination of regression and

time series analysis. This analysis is based on repetitive variance models because the observations of the units are repetitive through time dimension.

The main superiority of panel data due to working with the one-dimensional cross-sectional series or repeated cross-sectional series that same units are not observed through the time the time is to loosen the standard assumptions. By studying the repeated cross section of observations, panel data can better detect and measure effects that cannot be observed in pure cross section or pure time series data. Analyzing the observations of cross section and time series provide more flexibility compared to when used them separately by increasing the quantity and quality of data. In panel data analysis, the cross-sectional units are considered heterogenous and controlled for the variation (heterogeneity). Pure time series or cross section studies which are not controlling this heterogeneity may run the risk of obtaining biased results. Panel data are able to control variables which are subject or time invariant.

Because panel data has time-based dynamic with the observations of cross-sectional data repeated through time, the effect of unmeasured variables can be controlled. With the use of cross-sectional observation over time, panel data analysis privates more clarification character, less collinearity and more degrees of freedom and efficiency than only cross-sectional analysis or time series analysis.

In static panel data models, the covariance estimators (pooled panel data), fixed effects and random effects estimators are widely used. When the cross-sectional units are homogenous, pooled ordinary least squares panel model is used. In the presence of unit-specific or time-specific effects, in the case of assuming these effects to be fixed parameters to be estimated, model is called as the fixed effects. The term “fixed effects” expresses nonrandom quantities are accounted for the heterogeneity. If the subject specific effects are assumed random and not correlated with the regressors (independent variables), the model becomes random effects. These effects are included to the random effects model as a component of the error term. The panel models that do not have any lagged values of the dependent and independent variables in the model as a regressor are called “static model”. From first objective is to research the relationship between climate and non- climate variables and gross domestic product in

the ASEAN region conducts data analysis on a sector-by-sector which having GDP in agriculture, GDP in non-agriculture, and total GDP, using statistical methods. By using descriptive statistics and econometric relationship analysis, the steps are as follows:

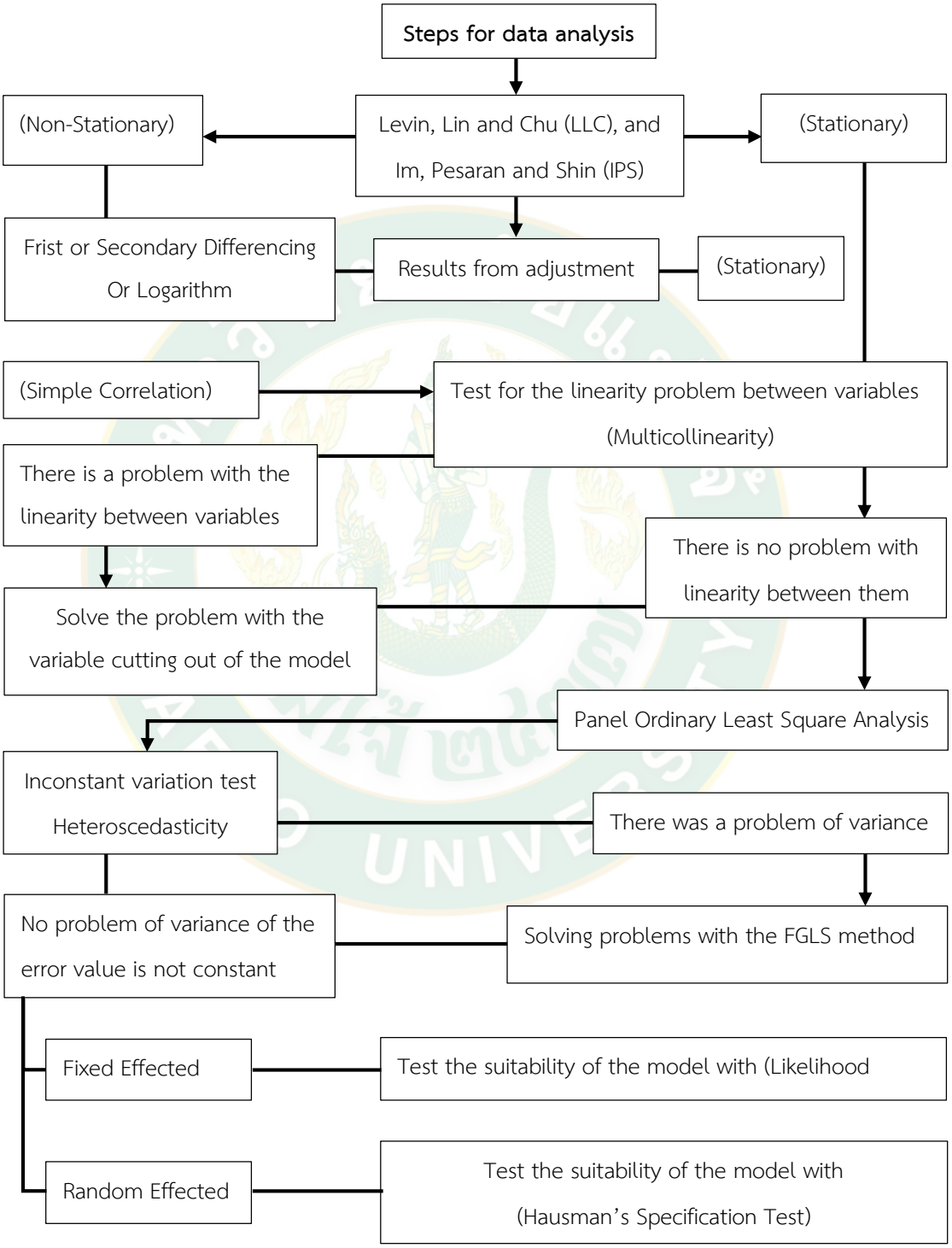

Figure 2 Procedure diagram for econometric relationship testing

Source: Badi H. Baltagi., Georges Bresson., Alain Pirotte

There are the steps for analyzing data in purpose one. Which is to find the relationship between climate and non-climate variables and GDP in the ASEAN region.

The first step is to check the stability of the information. By using the test of stability by Augmented Dickey-Fuller Unit Root Test If data is stable, use the next step. But if the data is still unstable (non-Stationary) will need to adjust the data to keep the data still first. By doing Differencing or adding a Logarithm to the data in order to make the data stable after successfully tested with all variables. The next step will be to test the linear relationship. Multicollinearity to study which variables relate to other variables in form common linearity this solves the problem by eliminating the variables from the model to reduce the problem. Relationship and make the model more reliable. Will be tested by means of how to use simple coefficients (Simple Correlation) to see the relationship between variables when passed the linearity relationship test has been completed. The next step will be analyzed. Panel Regression Analysis to look at the relationships between variables in the model Least-squares. After that, we will test for the inconsistent error variance problem. (Heteroscedasticity) to test the variance of the error that occurred in the model and solve the problem of the inconsistent error with the quadratic interpolation method. Minimal (Generalized Least Square, GLS) and performs a pattern test of Random Effect and Fixed Effect to see which test is best for the model. Which has the form or alternatively, the Hausman's Specification Test was used to determine whether the model was used as an alternative. Which fixed effect or random effect can produce the best results?

Fixed effects model and random effects model can be shown as follow:

Fixed Effects Model:

$$y_{it} = \alpha_i + \sum_{k=1}^{K} \beta_k x_{kit} + u_{it} \qquad (1)$$
$$i = 1, \dots, N, \qquad t = 1, \dots, T$$

Random Effects Model

$$y_{it} = \sum_{k=1}^{K} \beta_k x_{kit}(\alpha_i + u_{it}) \qquad (2)$$
$$i = 1, \dots, N, \qquad t = 1, \dots, T$$

We will examine the implications for Feasible Generalized Least Squares (FGLS) estimation under the alternative assumption that α_i is uncorrelated with x_{kit} for all $t = 1, \dots, T$ (referred to as "random effect model"), α_i is allowed to arbitrarily correlated with x_{kit} for all $t = 1, \dots, T$ (referred to "fixed effects model"), α_i is assumed to linearly depend on x_{kit} (referred to as correlated random effects model").

Where y_{it} is the log of total GDP observed for country, Index i differentiates the subjects and ranges from 1 to N which the number of 10 countries in the ASEAN region including Brunei, Cambodia, Singapore, Indonesia, Lao PDR, Myanmar, Vietnam, Thailand, Malaysia, and Philippines. Each country is observed T time and the index t differentiates the observation times through 1 to T that set for 24 years (1995-2018). K is the number of the explanatory (independent) variables including precipitation, variance precipitation, temperature, variance temperature, labor-force, current account balance, inflation rate, total investment and time trend, $(\alpha_i + u_{it})$ is the composite error term for the random effects model.

The second objective data analysis step is to simulate the effects of the climate change and GDP in the ASEAN region in the future. Using the research results from the estimation of each area from the first objective. To simulate Impacts of Climate Change on GDP in the Future. Simulation of the impacts and effects of climate change adaptation (Climate Change Impact Projection) with a numerical simulation (Simulation) by using estimation results. Climate by sector: contains information from multiple climate indicators and indices relevant for key economic sectors. Simple narratives can help researcher interpret and extract summaries of penitential climate change impact at the sector level. Vulnerability allows us to explore the susceptibility of livelihoods and natural systems to impacts from climate variability and change and facilitate the exploration of socioeconomic and development data and its relationships with natural hazards vulnerable areas. Impacts: this section allows us to explore the climate information from multiple climate indicators and present them with simple, embedded interpretation for an informative, high-level summary if potential for future climate change impacts on key socioeconomic sectors. Adaptation: this section helps us grasp key national

adaptation policies and reports, explore options for key sectors, and understand current adaptation gaps and needs for enhances climate smart planning.

After obtaining the results of the research in the first objective will use the results of the study from the objective from the first point, it is used to compare the effects of climate change influencing the GDP in the ASEAN region by comparison with the change with the temperature in percentage that resulted in the change of GDP has changed. Which is thought in the form of a percentage of change taking place in which changes in weather parameters are predicted.

3.2.1 Statistical data collected from 2 main resources

(1) In this study, by using a database consists of the panel data set of 10 countries (N) for the 1995-2018 terms (T), a total of 24 yearly data and because of the limitation of some countries such as Lao PDR, Myanmar, and Cambodia that why we had set the data for 24 years. Dataset is balanced panel and has N x T x k = 10x24x10 = 2,240 observations. Each variable has N x T= 10x24 = 240 observations. There are 3 dependent variables include $gdpagr$ (Gross domestic product in agriculture sector, US$), $gdpnonagr$ (Gross domestic product non agriculture sector, US$), $tgdp$ (Gross domestic product Total, US$), and there are 9 independent variables.

(2) The explore historical and projected climate data, climate data by sector, impacts, key vulnerabilities and what adaptation measures are being taken. Explore the overview for a general context of climate change is affecting. The climate science community sources a suite of global climate models to help decision makers understand the projections of future climate change and related impacts, among the most the most widely used are the Coupled Model Intercomparison Project, Phase 5 (cmip5) models included in the IPCC's Fifth Assessment Report (AR5). Key projected climate trends are summarized: temperature by mean annual temperature is projected to increase by 2℃ by 2050, the highest temperature increased is projected for June-August, warming is projected to be more rapid in the interior regions than in areas close to the coast. The higher warming is projected in the northwest and southeast. The number of consecutive dry days is projected to increase by 5, while

the number of frost days are projected to decrease by 13. Precipitation: mean annual precipitation is projected to decrease by 11% by 2050. IPCC GCMs precipitations for ASEAN region indicate a decrease with the greatest reduction during September-November and March-May. Precipitation in June-August is projected to increase by 2%. This section provides the options to visualize climate variables and indices derived from scientifically vetted CMIP5 projections for different timeframes, statistics, emission scenarios, and climate models. Meta data: future climate information is derived from 35 available global circulation models (GCMs) used by the Intergovernmental Panel on Climate Change (IPCC) 5th Assessment Report. Data is presented at a 1℃x1℃ global grid spacing, produced through bi-linear interpolation. Data snapshots: mean annual temperature will raise by 2.32℃ (1.48℃ to 3.66℃) in 2040-2059 (RCP 8.5, Ensemble). Annual precipitation will decrease by -22.17mm (-106.22mm-67.67mm) in 2040-2059 (RCP 8.5, Ensemble)

3.2.2 There are 3 parts of the analysis as follows:

(1) Descriptive statistical analysis

(2) Econometrics model, in order to analyze the impact factors effecting mean GDP in the panel data, set 24 yearly 1995-2018 by the panel data model and defining the dependent variable and the descriptive variable in the model as follows

There are 3 dependence variables which including $gdpagr_{it}$ is (gross domestic product US$) in agriculture sector in the ASEAN region; $gdpnonagr_{it}$ is (gross domestic product US$) in non-agriculture sector; $tgdp_{it}$ is (the total gross domestic product US$); where pre_{it} is monthly total precipitation for the growing season in millimeter, $varpre_{it}$ is the variation of precipitation that is used to capture the effects of precipitation variable, $avtem_{it}$ is the monthly average temperature for the growing season in degree Celsius, $vartem_{it}$ is the variation of temperature that is used to capture the effects of temperature variable, lf_{it} is the labor force yearly panel data which collecting in people, cab_{it} is current account balance yearly panel data which calculating in percent of GDP (when the current account calculated is equal the export minutes import of goods and services plus the net income from

abord and plus the net current transfers), inf_{it} is inflation rate (average consumer prices) which estimating in percent change, $tinv_{it}$ is the total of investment which counting in percent of GDP, T_{it} is time trend variable, as the table 2 below.

Table 2 Dependence and independence variables used for panel data (1995-2018)

Code	Variable	Units	Expected results
Dependent Variable			
Gdpagr	GDP in agriculture	US$/Year	
gdpnonagr	GDP in the non-agriculture	US$/Year	
Tgdp	GDP in Total	US$/Year	
Independent Variable			
Pre	Precipitation	millimeter	+
Var-pre	Variance precipitation	millimeter	-
Var-temp	Variance temperature	℃	+
Aver-temp	Average Temperature	℃	-
Lf	Current account balance	People	+
Cab	Current account balance	Percent of GDP	+
Inf	Inflation, average consumer prices	Percent change	-
Tinv	Total investment	Percent of GDP	+
T-trend	Time trend	Yearly	+

Source: World bank group

(3). Simulating the impacts of climate change using the estimated from try the econometric way to join the topic projection data, climate change projections in an area for predicting future impacts.

3.3 Static Linear Panel Data Models

To determine the relationship between 3 dependent variables of analyze include $gdpagr$ (Gross domestic product in agriculture sector, US$), $gdpnonagr$ (Gross domestic product non agriculture sector, US$), $tgdp$ (Gross domestic product in Total, US$), and the independent variables, the fixed model and the random effects model which are the most common static linear panel data analysis models

are used $gdpagr$, $gdpnonagr$, and $tgdp$ are modeled as a function of the 10 factors. The fixed effects model

$$gdpagr_{it} = \alpha_i + \beta_1 pre_{it} + \beta_2 varpre_{it} + \beta_3 avtem_{it} + \beta_4 vartem_{it} + \beta_5 lf_{it} + \beta_6 cab_{it} + \beta_7 inf_{it} + \beta_8 tinv_{it} + \beta_9 T_{it} + u_{it}$$

$$gdpnonagr_{it} = \alpha_i + \beta_1 pre_{it} + \beta_2 varpre_{it} + \beta_3 avtem_{it} + \beta_4 vartem_{it} + \beta_5 lf_{it} + \beta_6 cab_{it} + \beta_7 inf_{it} + \beta_8 tinv_{it} + \beta_9 T_{it} + u_{it}$$

$$tgdp_{it} = \alpha_i + \beta_1 pre_{it} + \beta_2 varpre_{it} + \beta_3 avtem_{it} + \beta_4 vartem_{it} + \beta_5 lf_{it} + \beta_6 cab_{it} + \beta_7 inf_{it} + \beta_8 tinv_{it} + \beta_9 T_{it} + u_{it}$$

and the random effects model are

$$gdpagr_{it} = \beta_1 pre_{it} + \beta_2 varpre_{it} + \beta_3 avtem_{it} + \beta_4 vartem_{it} + \beta_5 lf_{it} + \beta_6 cab_{it} + \beta_7 inf_{it} + \beta_8 tinv_{it} + \beta_9 T_{it} + (\alpha_i + u_{it})$$

$$gdpnonagr_{it} = \beta_1 pre_{it} + \beta_2 varpre_{it} + \beta_3 avtem_{it} + \beta_4 vartem_{it} + \beta_5 lf_{it} + \beta_6 cab_{it} + \beta_7 inf_{it} + \beta_8 tinv_{it} + \beta_9 T_{it} + (\alpha_i + u_{it})$$

$$tgdp_{it} = \beta_1 pre_{it} + \beta_2 varpre_{it} + \beta_3 avtem_{it} + \beta_4 vartem_{it} + \beta_5 lf_{it} + \beta_6 cab_{it} + \beta_7 inf_{it} + \beta_8 tinv_{it} + \beta_9 T_{it} + (\alpha_i + u_{it})$$

i Stands for the country number, t stands for the year, u_{it} is the error term for the fixed effects model and $(\alpha_i + u_{it})$ is the composite error term for the random effects model. If the country effects are uncorrelated with the regression, they are known as random effects. In the random effects model, because there is no correlation between the country specific effects and the regressors, country specific effects are parameterized as additional random disturbances. If the country effects are correlated with the regressors, then they are known as fixed effects. If there is no country specific effect in the model, then the model becomes the pooled ordinary least squares regression which is the model specification, and the model for data estimation is given as:

$$lngdpagr_{it} = \mu + \beta_1 lnpre_{it} + \beta_2 lnvarpre_{it} + \beta_3 lnavtem_{it} + \beta_4 lnvartem_{it} + \beta_5 lnlf_{it} + \beta_6 cab_{it} + \beta_7 inf_{it} + \beta_8 tinv_{it} + \beta_9 T_{it} + u_{it}$$

$$lngdpnonagr = \mu + \beta_1 lnpre_{it} + \beta_2 lnvarpre_{it} + \beta_3 lnavtem_{it} + \beta_4 lnvartem_{it} + \beta_5 lnlf_{it} + \beta_6 cab_{it} + \beta_7 inf_{it} + \beta_8 tinv_{it} + \beta_9 T_{it} + u_{it}$$

$$lntgdp_{it} = \mu + \beta_1 lnpre_{it} + \beta_2 lnvarpre_{it} + \beta_3 lnavtem_{it} + \beta_4 lnvartem_{it} + \beta_5 lnlf_{it} + \beta_6 cab_{it} + \beta_7 inf_{it} + \beta_8 tinv_{it} + \beta_9 T_{it} + u_{it}$$

Where $lngdpagr_{it}$ is GPD in agriculture sector, in USD$ in the ASEAN region, $lngdpnonagr$ is GPD in non-agriculture sector, in USD$ in the ASEAN region, and $lntgdp_{it}$ is the total GDP in USD$ in the ASEAN region, $lnpre_{it}$ is precipitation in millimeters, $lnvarpre_{it}$ is variance precipitation in millimeters, $lnavtem_{it}$ is average temperature in Celsius, $lnvartem_{it}$ is variance temperature, $lnlf_{it}$ is labor-force in amount, cab_{it} is current account balance in percent change, inf_{it} is inflation (average consumer price), $tinv_{it}$ is total investment in percent change, T_{it} is time trend, i stands for 10 countries in the ASEAN region, t stands for the year, u_{it} is the error term for the fixed effects model.

3.4 How climate change can affect economic growth

3.4.1 Evidence from simulation models

The standard neoclassic models of economic growth are those associated with Ramsey, Cass and Koopmans, in which is a function of saving, investment and capital accumulation. Unfortunately, they are not particularly well suited to the question of how growth in developing countries might be affected by climate change. The important channels through which climate change can affect growth, such as population growth, migration patterns, productivity levels and capital depreciation are treated as exogenous in the basic model. This makes it difficult to model the impact of, for example, a greater prevalence of vector-borne diseases on population growth, of reduced agricultural productivity, or of the accelerated depreciation of the capital as a result of climate-related disasters.

Some attempts at quantification have nevertheless been made, typically using integrated assessment models, many of which have a neoclassical structure. However, they tend to focus on the 'level' effect rather than growth rates. An exception is (Fankhauser and Tol, 2005). Using the DICE model (Nordhaus and Boyer, 2000), they found that the impact of climate change on output via reduced growth was larger than the direct 'level' effect. But both effects were small, totaling less than a 0.2 percentage point reduction in the per capita global annual growth rate and very much less in the short run. More research is needed using endogenous

growth models and allowing for variations in the speed of convergence towards the global technological frontier.

(Hallegatte et al., 2007) focused specifically on climate variability. They argued that the long-term growth models commonly used in climate-change economics cannot capture the adverse effects of extreme weather events. They showed how, if the frequency of extreme events passes the threshold, economies can fall into a downward spiral in which they do not have the capacity to make good productive capacity lost. The implication is that adaptative needs to take account of the whole distribution of possible climate-change, not just the mean. Impacts in the 'bad' tail of the probability distribution ought to be guarded against because they can have devastating effects on growth over the longer term. Climate change can affect output beyond the first-round impacts through general equilibrium adjustments that result in impacts through trade and factor markers, possibly subject to their own market imperfections. Most general equilibrium studies (Bowen et al., 2012; Carrera et al., 2015) find that the economy-wide second-order effects generally increase the impact of climate of climate change on welfare, although not necessarily in every economic sector and region. (Bosello et al., 2007) concluded that direct costs are "a bad approximation of general equilibrium welfare effects".

3.4.2 Empirical evidence

The results from simulation models, which project the future impacts of climate change, can be contrasted with the smaller body of empirical evidence about the historical impact of climate on growth. There are very few studies that look at the link between climate (and average temperature) and economic output. The best evidence come from Dell et al. (2008,2009), who found that, in poor countries over the period 1950 to 2003, a 1 ℃ rise in temperature in a given year tended to reduce economic growth in that year by 1.1 percentage points, the effects on growth tended to be persistent. The estimated temperature effects over 10- or 15- year horizons were similar to the annual panel data estimate, with the implication that these effects represented changes to growth rates, not simply 'level' effects on income. Unless offset by some other factor, such temperature effects

would be sufficiently large to produce a much steeper relationship between temperature and income across countries than is actually seen in the data. The obvious offset is adaptation; their results implied that, eventually, adaptation offsets about half the negative effects of temperature variation on income. The authors found a similar relationship in state and local data.

There is more evidence about the impact of climate change variation on growth. It suggests that extreme weather events can have a significant adverse effect on growth in the short run. (Raddatz, 2009) found that natural disasters, especially climate ones, have had a moderate but significant negative effect on real GDP per capita over the past four decades. He calculated that, at a conservation estimate, the macroeconomic cost of a climate disaster affecting at least half a percent of a country's population reduced real GDP per capital by 0.6%. (Hallegatte and Ghil, 2008) pointed out that economies may be able to respond more effectively to natural disasters if they underutilized resources available. Hence, perhaps surprisingly, the costs of climate change and adaptation may be reduced by the presence of Keynesian unemployment or surplus labor. They argued that this is why some reviews of the costs of natural disasters have not found them to be particularly high. (Landon-Lane et al., 2009) found that at the time of the Dust Bowl in the USA in the 1930s, climatic stress hit the banking system, impairing financial intermediation and recovery for a prolonged period. Thus climate-related disasters can have long echoes through the financial system. (Lis and Nickel, 2009) showed how natural disasters tend to have an adverse impact on government budgets.

UNIT 4

THE RESULTS OF THE RESEARCH

4.1 The analysis results of the relationship between climate change and gross domestic product in the ASEAN region

4.1.1 The research results of climate change on gross domestic product in agriculture sector in the ASEAN region

1. The descriptive results of GDP in the ASEAN region's agriculture sector from 1995 to 2018. The mean calculated is 16,814 million US dollars, with a standard deviation of 25,155 million US dollars, and the minimum and maximum value displayed are 59 million US dollars and 133,570 million US dollars, respectively. Total precipitation resulted in a mean of 2,333.14 mm with a standard deviation of 568.77 mm. The minimum and maximum total precipitation in the research area were down to 1,530.37 mm and 3,179.85 mm respectively. The calculated mean of variance-precipitation noted is 11,019.83 mm with a maximum value of 28,403.44 mm and the minimum is 2,580.82 mm whereas the standard deviation premeditated is 8,341.07 mm. The mean average temperature is 25.86℃ with a minimum and maximum of 23.5℃ and 27.70℃ respectively, while the standard of deviation is 1.44℃. The mean of variance temperature calculated is 2.71℃ with the standard deviation of 2.99℃ while the minimum and maximum of 0.07℃ and 7.15℃ correspondingly. There are 4 non-climatic variables that are brought into the model. The mean of current account balance calculated is 11.77% with a standard deviation of 11.58% while the minimum and maximum values are shown as 0.03% and 48.21% sequentially. The mean of the labor force approximated 27 million people with the standard deviation of 31 million people while the minimum and maximum value appeared to be 0.131 million people and 133 million people correspondingly. The inflation rate resulted in a mean of 7.36% (percent change) with the standard deviation of 13.33%. The minimum and maximum in this research area are noted are 0.02% and 125.27% sequentially. The calculated mean of total investment noted is

5.60% with a minimum and maximum of 0.06% and 28.89% respectively, while the standard deviation is 5.59%.

Table 3 Descriptive statistic of variables used for panel data (1995-2018)

Variables	Mean	Std.Dev.	Min	Max
$dpagr$ (Million US$)	16,814	25,155	59	133,570
Total-Precip (mm)	2,333.14	599.54	1,530.37	3,179.85
Var- Precip (mm)	11,019.83	8,341.07	2,580.82	28,403.44
Avg-temp (℃)	25.86	1.44	23.54	27.70
Var-temp (℃)	2.71	2.99	0.07	7.15
CAB (%)	11.77	11.58	0.03	48.21
LF (M ppl)	27	31	0.131	133
Inflation rate (%)	7.36	13.33	0.02	125.27
Total investment (%)	5.60	5.59	0.06	28.89

Source: World bank group

2. Testing for data suitability (Pre-estimation Specification Test) for the yearly GDP in the agriculture sector in the ASEAN region, panel data (1995-2018)

Regression analysis with panel data in case of variance problem. Inaccurate (Heteroscedasticity) it is necessary to test the suitability of the data first. To obtain effective analysis results in a regression analysis model, research and testing are required. The stability of the panel data (unit root) of each variable prior to regression analysis. To avoid spurious correlation, perform a stability test of balance panel data using 2 methods. 1) Levin, Lin and Chu (LLC) and 2) Im, Pesaran and Shin (PIS). The results of the tests revealed that the GDP, precipitation, variance-precipitation, average-temperature, variance-temperature, current account balance, labor force, inflation rate, and total investment are all stationary. Hence, it is not necessary to determine the difference between the data before performing the regression analysis. In addition, we have also tested the problem of the variance of inconstant error. To find the relationship, the variance describes the error in the form

of experiments of the long-term variables and the error in the climate change model with gross countries' product in the agricultural sector by means of The Breusch-Pagan-Godfrey test is used to determine. Relationship between the square error and the explanatory variable and the autoregressive method. Conditional Heteroscedasticity (ARCH) was determined by determining the relative square of values error with the lag from the test results of both methods, and it was discovered that the variance of the error was not constant. Hence, the general regression analysis feasible (FGLS) is appropriate for the analysis of climate change with GDP in the agriculture sectors as shown in table 4.

Table 4 Unit root test of variables used for panel data analysis (1995-2018)

Variables	LLC Test	IPS Test
$dpagr$ (Million US$)	-2.621***	-1.92**
Total-Precip (mm)	-8.482***	-8.531***
Var- Precip (mm)	-7.743***	-6.954***
Avg-temp (℃)	-9.627***	-8.594***
Var-temp (℃)	-7.627***	-8.155***
CAB (%)	-2.171**	-0.446
LF (M ppl)	-1.814**	-0.583
Inflation rate (%)	-13.75***	-10.362***
Total investment (%)	-3.12***	-4.098***
Heteroskedasticity Breush-Pagan-Godfrey Test		6.588***
Heteroskedasticity ARCH Test		79.304***

Source: World bank group

*, ** and *** indicate that the null hypothesis of nonstationary is rejected at the 1, 5 and 10% level of significance

3. Estimation of climate change model with GDP in agriculture sector in the ASEAN region. The results of the model parameter estimation climate change and the GDP in agricultural sector by countries of the ASEAN region. From the estimation,

the coefficient is the elasticity of the factor affecting GDP in the agricultural sector in the ASEAN region in general, the estimation panel data model can be estimated in 2 types: Fixed Effect (FE) model that assign variables that are not imported into a model (omitted variables) with differences between them. Each country has a constant value over time and a Random Effect (RE), model given that variables that are not imported into the model (omitted variables) may be constant when the time has changed, but there are differences between each other in each country in this study, the study will be conducted. Redundant Fixed Effects Test for model selection which requires F-statistic value that shows an acceptance of the main hypothesis refers to using a fixed-effect model to give an approximation consistent and efficient.

In this research, there are two analytical techniques were used to test the sensitivity of the estimator from each of the descriptive variables affecting GDP in an agriculture sector in the ASEAN region. Agriculture consists of the Least Squares techniques for Panel information (Panel Least Square) and a cross-sectional fixed-effect model technique with the least possible square method (Cross Section weigh), in the second method, is an analytical technique for solving the problem of variance. The error was not constant (Cross Section Heteroskedasticity). The second technique was compared the test was the highest Adjusted R-square value, so the model was used to describe the relationship between climate change data with GDP in the agricultural sector in the ASEAN region.

The FGLS procedure is used to estimate the parameters. The estimation results of the fixed effect model from panel data are illustrated in Table 4. For the gross domestic product in the agriculture sector in the ASEAN region, the effects of time trend (T) on the GDP are all positive and statistically significant at 95% confidence level. This indicates that technological progress is significant during the sample period. Precipitation revealed an insignificant effect on gross domestic product in the agriculture sector, implying precipitation did not affect the GDP in the agriculture sector in the research area. The findings also confirmed that the agricultural sector's variance-precipitation contribution to GDP is insignificant. Furthermore, both average-temperature and variance-temperature did not affect the GDP in the agriculture sector in the research area. The effect of the labor

force shows a negative impact where a 1% increase in the labor force induces a decrease in GDP in the agriculture sector in the ASEAN region by 1.17%. The results also show that an increase in current account balance could induce a decrease in GDP in the agriculture sector by 0.0005%. The fallout further declared the inflation rate statistically significant at a degree of 1% but with a negative coefficient; for instance, a 1% inflation rate increase leads to GDP in the agriculture sector declining by 0.003%. Furthermore, the agriculture sector's total investment in percent change shows a positive and significant contribution to GDP.A 1% increase in total investment in percent change will increase GDP in the agriculture sector in the ASEAN region by 0.004%. The results show some significant and insignificant variation of climate change and non-climate change variables with the GDP in non-agriculture in the ASEAN region.

Table 5 Estimation from climate change model to the GDP in the agriculture sector

Variables	Panel Least Square	LOG Panel Least Square	LOG FGLS
constant	2.71	45.02***	41.75***
	(4.57)	(7.29)	(2.04)
LNPRE	0.14**	-0.05	-0.01
	(0.06)	(0.06)	(0.01)
LNVARPRE	-0.13***	0.02	-0.01
	(0.03)	(0.03)	(0.01)
LNAVTEM	1.44	-0.96	-0.49
	(1.32)	(1.45)	(0.43)
LNVARTEM	0.11***	0.05	-0.0005
	(0.04)	(0.05)	(0.01)
LNLF	0.089***	-1.27***	-1.17***
	(0.03)	(0.32)	(0.07)
CAB	-0.001	-0.01*	-0.005***
	(0.01)	(0.003)	(0.001)
INF	-0.01***	-0.01***	-0.003***
	(0.01)	(0.001)	(0.001)
TINV	-0.12***	0.01	0.004**
	(0.01)	(0.01)	(0.002)
T-trend	0.05***	0.09***	0.04**
	(0.01)	(0.01)	(0.002)
R-squared	92.21	98.36	99.71
Adjusted R-squared	91.91	98.23	99.69
F-statistic	302***	739***	4287***

Source: World bank group

Number in parentheses are standard errors

*, **, and *** indicate that the significant at the 90%, 95% and 99% respectively

4.1.2 The research results of climate change on gross domestic product in the non-agriculture sector in the ASEAN region

1. The descriptive results of the GDP in the non-agriculture sector in the ASEAN region from 1995 to 2018, the mean calculated is 132,000 million US dollars, with a standard deviation of 173,000 million US dollars, and the minimum and maximum value appeared are 841 million US dollars and 909,000 million US dollars, respectively. Total precipitation resulted in a mean of 2,333.14 mm with a standard deviation of 599.54 mm. The minimum and maximum precipitation in the research area were down to 1,530.37 mm and 3,179.85 mm respectively. The calculated mean of variance-precipitation noted is 11,19.83 mm with a maximum value of 28,403.44 mm and the minimum is 2,580.82 mm whereas the standard deviation premeditated is 8,341.07 mm. The mean average temperature is 25.86℃ with a minimum and maximum of 23.54℃ and 27.70℃ respectively, while the standard of deviation is 1.44℃. The mean of variance temperature calculated is 2.71℃ with the standard deviation of 2.99℃ while the minimum and maximum of 0.07℃ and 7.15℃ correspondingly. The model incorporates four non-climate variables, yielding a mean current account balance of 11.77% with a standard deviation of 11.58% and minimum and maximum values of 0.03% and 48.21%, respectively. The mean labor force approximated 27 million people with the standard deviation of 31 million people, while the minimum and maximum value appeared to be 0.131 million people and 133 million people correspondingly. The inflation rate resulted in a mean of 7.36% with a standard deviation of 13.33%, with the minimum and maximum values in this research area being 0.02% and 125.27%, respectively. The calculated mean of total investment noted is 5.60% with a minimum and maximum of 0.06% and 28.89% respectively, while the standard of deviation is 5.59%.

Table 6 Descriptive statistic of variables used for panel data (1995-2018)

Variables	Mean	Std.Dev.	Min	Max
$dpanongr$ (Million US$)	132,000	173,000	841	909,000
Total-Precip (mm)	2,333.17	599.54	1,530.37	3,179.85
Var- Precip (mm)	11,019.83	8,341.07	2,580.82	28,403.44
Avg-temp (℃)	25.86	1.44	23.54	27.70
Var-temp (℃)	2.71	2.99	0.07	7.15
CAB (%)	11.77	11.58	0.03	48.21
LF (M ppl)	27	31	0.131	133
Inflation rate (%)	7.36	13.33	0.02	125.27
Total investment (%)	5.60	5.59	0.06	28.89

Source: World bank group

2. Testing for data suitability (Pre-estimation Specification Test) for the yearly GDP in non-agriculture sector in the ASEAN region, panel data (1995-2018)

Regression analysis with panel data in case of variance problem. Inaccurate (Heteroscedasticity) it is necessary to test the suitability of the data first. To obtain effective analysis results in a regression analysis model, research and testing are required. The stability of the panel data (unit root) of each variable prior to regression analysis. To avoid spurious correlation, perform a stability test of balance panel data using 2 methods. 1) Levin, Lin and Chu (LLC) and 2) Im, Pesaran and Shin (PIS). The results of the tests revealed that the gross domestic product in agriculture, precipitation, variance-precipitation, average-temperature, variance-temperature, current account balance, labor force, inflation rate, and total investment are all stationary. Hence, it is not necessary to determine the difference between the data before performing the regression analysis. In addition, we have also tested the problem of the variance of inconstant error. To find the relationship, the variance describes the error in the form of experiments of the long-term variables and the error in the climate change model with gross countries' product in the agricultural sector by means of The Breusch-Pagan-Godfrey test is used to determine. Relationship between the square error and the explanatory variable and the

autoregressive method. Conditional Heteroscedasticity (ARCH) was determined by determining the relative square of values error with the lag from the test results of both methods, and it was discovered that the variance of the error was not constant. Hence, the general regression analysis feasible (FGLS) is appropriate for the analysis of climate change with gross countries' product in non-agriculture sectors as shown in table 7 below.

Table 7 Unit root test of variables used for panel data analysis (1995-2018)

Variables	LLC Test	IPS Test
$gdpnonagr$ (Million US$)	-7.421***	-4.322***
Total-Precip (mm)	-8.482***	-8.531***
Var- Precip (mm)	-7.743***	-6.954***
Avg-temp (℃)	-9.627***	-8.594***
Var-temp (℃)	-7.627***	-8.155***
CAB (%)	-2.171**	-0.446
LF (M ppl)	-1.814**	-0.583
Inflation rate (%)	-13.75***	-10.362***
Total investment (%)	-3.12***	-4.098***
Heteroskedasticity Breush-Pagan-Godfrey Test		3.372***
Heteroskedasticity ARCH Test		52.588***

Source: World bank group

*, ** and *** indicate that the null hypothesis of nonstationary is rejected at the 90%, 95% and 99% level of significance

3. Estimation of climate change model with GDP in the non-agriculture sector in the ASEAN region. The results of the model parameter estimation of climate change and the GDP in the non-agricultural sector by countries of the ASEAN region. From the estimation, the coefficient is the elasticity of the factor affecting GDP in the non-agricultural sector in the ASEAN region in general. The estimation panel data model can be estimated into 2 types: Fixed Effect (FE) model that assigns variables

that are not imported into a model (omitted variables) with differences between them. Each country has a constant value over time and a Random Effect (RE), model given that variables that are not imported into the model (omitted variables) may be constant when time has changed, but there are differences between each other in each country in this study, the study will be conducted. Redundant Fixed Effects. The test for model selection, which requires F-statistic value that shows an acceptance of the main hypothesis, refers to using a fixed-effect model to give an approximation consistent and efficient.

In this research, there are two analytical techniques were used to test the sensitivity of the estimator from each of the descriptive variables affecting GDP in the non-agriculture sector in the ASEAN region. GDP in non-agriculture consists of the Least Squares techniques for Panel information (Panel Least Square) and a cross-sectional fixed-effect model technique with the least possible square method (Cross Section weigh). The second method, is an analytical technique for solving the problem of variance. The error was not constant (Cross Section Heteroskedasticity). The second technique was compared to the test that had the highest Adjusted R-square value, so the model was used to describe the relationship between climate change data and gross domestic product in the ASEAN region's non-agricultural sector.

The estimation results of the fixed effect model from panel data are illustrated in Table 7. For the GDP in the non-agriculture sector in the ASEAN region, the effects of time trend (T) on the GDP in the non-agriculture sector are all positive and statistically significant at a 99% confidence level. This indicates that the technological progress is significant during the sample period. The effect of total precipitation varies across region and shows a negative impact and is statistically significant at 99% confidence level, where a 1% increase in total precipitation induces a decrease in the GDP in the non-agriculture sector by 3.83%. Variance-precipitation under the GDP in the non-agriculture sector revealed an insignificant effect on gross domestic product in the non-agriculture sector, implying that variance-precipitation had no effect on gross domestic product in the ASEAN region. The findings also confirmed that the average temperature's contribution to GDP in

the non-agriculture sector is negligible. The fallout further declared variance-temperature statistically significant at degree 5% but with a negative coefficient that means the variance-temperature has a negative impact on the GDP in the non - agriculture sector in the ASEAN region. A 1% increase in the variance-temperature will decrease GDP in the non-agriculture sector in the ASEAN region by 4.30%. The effect of the labor force shows a negative impact and is statistically significant at a 99% confidence level where a 1% increase in the labor force induces a decrease in GDP in the non-agriculture sector in the ASEAN region by 1.42%. The findings estimate that the current account balance has a negative impact on the GDP in the non-agriculture sector in the ASEAN region, and that an increase in the current account balance could cause a decrease in the non-agriculture sector in the ASEAN region, which is statistically significant at degree 1% by 5.90%.The outcome illustrated that the increase in the percent of the inflation rate has an insignificant at a 99% confidence level and positive impact on GDP in the non-agriculture sector in the ASEAN region. Additionally, the total investment in percent change has a significant and positive impact on GDP in the non-agriculture sector in the ASEAN region where a 1% increase in total investment in percent change will boost GDP in the non-agriculture sector in the ASEAN region by 1.21%. The results show some significant and insignificant variation of climate change and non-climate change variables with GDP in non-agriculture in the ASEAN region.

Table 8 Estimation from climate change model to the GDP in non-agriculture sector

Variables	Panel Least Square	LOG Panel Least Square	LOG FGLS
constant	-1.09	3.60*	2.77***
	(6.68)	(1.95)	(3.56)
LNPRE	-1.76*	-6.96***	-3.83***
	(9.30)	(1.49)	(5.20)
LNVARPRE	-3.94***	-3.12	-2.41
	(4.77)	(9.33)	(1.50)
LNAVTEM	1.46	-1.25	-1.03
	(1.93)	(3.86)	(7.28)
LNVARTEM	-3.57***	-8.25	-4.30**
	(5.48)	(1.22)	(1.96)
LNLF	5.19***	-1.82**	-1.42***
	(4.82)	(8.64)	(1.24)
CAB	1.31	-2.57	-5.90***
	(8.34)	(9.59)	(1.61)
INF	-4.33	4.14	7.44
	(5.08)	(4.57)	(5.09)
TINV	1.01	1.64	1.21***
	(1.14)	(1.67)	(2.14)
T-trend	9.61***	1.45***	1.26***
	9.05	(1.99)	(6.06)
R-Squared	73.59	81.53	91.38
Adjusted R-squared	72.55	80.02	90.68
F-statistic	71***	54***	130***

Source: World bank group

Number in parentheses are standard errors

*, **, and *** indicate that the significant at the 90%, 95% and 99% respectively

4.1.3 The research results of climate change on total of gross domestic product in the ASEAN region

1. The descriptive results of the total gross domestic product in the ASEAN region from 1995 to 2018, the mean calculated is 149,000 million US dollars with a standard deviation of 196,000 million US dollars, while the minimum and maximum values appeared to be 1,280 million US dollars and 1,040,000 million US dollars, respectively. Total precipitation resulted in a mean of 2,333.14 mm with a standard

deviation of 599.54 mm. The minimum and maximum total precipitation in the research area were down to 1,530.37 mm and 3,179.85 mm respectively. The calculated mean of variance-precipitation noted is 11.019.83 mm with a maximum value of 28,403.44 mm and the minimum is 2,580.82 mm whereas the standard deviation premeditated is 8,341.07 mm. The mean average temperature is 25.86℃ with a minimum and maximum of 23.54℃ and 27.70℃ respectively, while the standard of deviation is 1.44℃. The mean of variance temperature calculated is 2.71℃ with the standard deviation of 2.99℃ while the minimum and maximum of 0.07℃ and 7.15℃ correspondingly. There are 4 non-climate variables that are brought into the model. The mean of current account balance calculated is 11.77% with a standard deviation of 11.58% while the minimum and maximum values are shown as 0.03% and 48.21 % sequentially. The mean of the labor force approximated 27 million people with the standard deviation of 31 million people while the minimum and maximum value appeared to be 0.131 million people and 133 million people correspondingly. The inflation rate resulted in a mean of 7.36% with the standard deviation of 13.33% the minimum, and the maximum in this research area is noted is 0.02% and 125.27% sequentially. The calculated mean of total investment noted is 5.60% with a minimum and maximum of 0.06% and 28.89% respectively, while the standard deviation is 5.59%.

Table 9 Descriptive statistic of variables used for panel data (1995-2018)

Variables	Mean	Std.Dev.	Min	Max
$TDGP$ (Million US$)	149,000	196,000	1,280	1,040,000
Total-Precip (mm)	2,333.14	599.54	1,530.37	3,179.85
Var- Precip (mm)	11,019.83	8,341.07	2,580.82	28,403.44
Avg-temp (℃)	25.86	1.44	23.54	27.70
Var-temp (℃)	2.71	2.99	0.07	7.15
CAB (%)	11.77	11.58	0.03	48.21
LF (M ppl)	27	31	0.131	133
Inflation rate (%)	7.36	13.33	0.02	125.27
Total investment (%)	5.60	5.59	0.06	28.89

Source: World bank group

2. Testing for data suitability (Pre-estimation Specification Test) for the yearly total GDP in the ASEAN region, panel data (1995-2018)

Regression analysis with panel data in case of variance problem. Inaccurate (Heteroscedasticity) it is necessary to test the suitability of the data first. In order to get effective analysis results in the regression analysis model, research is needed to take the test. The stability of the panel data (unit root) of each variable prior to regression analysis. To avoid spurious correlation, perform a stability test of balance panel data using 2 methods. 1) Levin, Lin and Chu (LLC) and 2) In, Pesaran and Shin (PIS). The test results showed that the total gross domestic countries' product, precipitation, variance-precipitation, average-temperature, variance-temperature, current account balance, labor force, inflation rate, and total investment are stationary level. Hence, it is not necessary to determine the difference between the data before performing the regression analysis. In addition, we have also tested the problem of the variance of inconstant error. To find the relationship, the variance describes the error in the form of experiments of the long-term variables and the error in the climate change model with gross countries' product in the agricultural sector by means of The Breusch-Pagan-Godfrey test is used to determine. Relationship

between the square error and the explanatory variable and the autoregressive method. Conditional Heteroscedasticity (ARCH) was determined by determining the relative square of values error with the lag from the test results of both methods, and it was discovered that the variance of the error was not constant. As a result, as shown in table 10, the general regression analysis feasible (FGLS) is appropriate for the analysis of climate change with total gross domestic product.

Table 10 Unit root test of variables used for panel data analysis (1995-2018)

Variables	LLC Test	IPS Test
$TGDP$ (Million US$)	-1.592***	-0.581
Total-Precip (mm)	-8.482***	-8.531***
Var- Precip (mm)	-7.743***	-6.954***
Avg-temp (℃)	-9.627***	-8.594***
Var-temp (℃)	-7.627***	-8.155***
CAB (%)	-2.171**	-0.446
LF (M ppl)	-1.814**	-0.583
Inflation rate (%)	-13.75***	-10.362***
Total investment (%)	-3.12***	-4.098***
Heteroskedasticity Breush-Pagan-Godfrey Test		3.224***
Heteroskedasticity ARCH Test		46.309***

Source: World bank group

*, **, and *** indicate that the null hypothesis of nonstationary is rejected at the 90% , 95% and 99% level of significance

3. Estimation of climate change model with total gross domestic product in the ASEAN region. The results of the model parameter estimation of climate change and the total gross domestic product by countries of the ASEAN region. From the estimation, the coefficient is the elasticity of the factor affecting total gross domestic product in the ASEAN region in general. The estimation panel data model can be estimated into 2 types: Fixed Effect (FE) model that assigns variables that are not

imported into a model (omitted variables) with differences between them. Each country has a constant value over time and a Random Effect (RE), model given that variables that are not imported into the model (omitted variables) may be constant when time has changed, but there are differences between each other in each country in this study, the study will be conducted. The Redundant Fixed Effects Test for model selection, which requires F-statistic value that shows an acceptance of the main hypothesis, refers to using a fixed-effect model to give an approximation consistent and efficient.

In this research, there are two analytical techniques were used to test the sensitivity of the estimator from each of the descriptive variables affecting total gross domestic product in the ASEAN region. Total gross domestic product consists of the Least Squares techniques for Panel information (Panel Least Square) and a cross-sectional fixed-effect model technique with the least possible square method (Cross Section weigh). The second method, is an analytical technique for solving the problem of variance. The error was not constant (Cross Section Heteroskedasticity). The second technique was compared to the test that had the highest Adjusted R-square value, so the model was used to describe the relationship between climate change data and total GDP in the ASEAN region.

The FGLS procedure is used to estimate the parameters of the equation. The results of fixed effect from panel data are illustrated in Table 10. The effect of total precipitation varies across regions and shows a positive impact and is statistically significant at 90% confidence level, where 1% increase in total precipitation induces an increase in the total gross domestic product by 0.03%. Furthermore, variance-precipitation has a negative impact on total GDP and is statistically significant at the 95% confidence level, with a 1% increase in variance-precipitation decreasing total GDP by 0.02%.The findings also confirmed that the average temperature contribution to total GDP is statistically significant at the 99% confidence level, with a 1% increase in average temperature decreasing total GDP by 0.10%.The fallout further declared variance-temperature statistically significant at a degree of 5% with a positive coefficient that means the variance-temperature has a positive impact on the total gross domestic product where a 1% increase in the variance-temperature will boost

total gross domestic product by 0.02%. The effect of the labor force shows a negative impact and is statistically significant at 99% confidence level, where a 1% increase in the labor force induces a decrease of 0.57% in the total gross domestic product. The results also show that an increase of 1% in current account balance could induce a decrease of 0.003% in the total gross domestic product in the ASEAN region and is statistically significant at 99% confidence level. The results showed that a 1% increase in the percentage of inflation rate reduces total gross domestic product by 0.04%, indicating that the inflation rate has a positive impact on total gross domestic product and is statistically significant at the 99% confidence level. In addition, the total investment in percent change has a significant and positive impact on total gross domestic product where a 1% increase in total investment in percent change will boost total gross domestic product by 0.01%. The findings show a significant and insignificant relationship between climate change and non-climate change variables and total GDP.

Table 11 Estimation from climate change model to total GDP in the ASEAN region

Variables	Panel Least Square	LOG Panel Least Square	LOG FGLS
constant	7.44*	41.11***	36.23***
	(4.03)	(6.24)	(1.75)
LNPRE	0.66***	0.05	0.03*
	(0.05)	(0.04)	(0.15)
LNVARPRE	-0.38***	-0.03	-0.02**
	(0.03)	(0.02)	(0.01)
LNAVTEM	-0.14	-2.34*	-0.10***
	(1.66)	(1.23)	(0.38)
LNVARTEM	-0.41***	0.06	0.02**
	(0.03)	(0.04)	(0.01)
LF	0.96***	-0.63**	-0.57***
	(0.03)	(0.28)	(0.08)
CAB	0.03***	-0.003	-0.003***
	(0.01)	(0.003)	(0.001)
INF	-0.01***	-0.01***	-0.04***
	(0.003)	(0.001)	(0.001)
TINV	0.04***	0.02***	0.01***
	(0.01)	(0.001)	(0.001)
T-trend	0.07***	0.10***	0.10***
	(0.01)	(0.01)	(0.003)
R-squared	89.96	98.01	99.83
Adjusted R-squared	89.57	97.85	99.82
F-statistic	229***	605***	7602***

Source: World bank group

Number in parentheses are standard errors

*, **, and *** indicate that the significant at the 90%, 95% and 99% respectively

4.2 Simulation of the impacts of climate change on gross domestic product in the ASEAN region in the future.

Two climate scenarios are applied to predict the impacts of climate change on the gross domestic product in the ASEAN region and its variance for the coming decade. The overview investigates climate projections for 2039, 2059, 2079, and 2099 for a general context of how climate change is affecting. The climate science community sources a suite of global climate models to help decision-makers understand the projections of future climate change and related impacts. Among the most widely used are the Coupled Model Intercomparison Project, Phase 5 (CMIP5) models included in the IPCC's Fifth Assessment Report (AR5). Key projected climate trends are summarized: temperature by mean annual temperature is projected to increase by 2℃ by 2050. The highest temperature increase is projected for June-August. Warming is projected to be more rapid in the interior regions than in areas close to the coast. The higher warming is projected in the northwest and southeast. The number of consecutive dry days is projected to increase by 5, while the number of frost days is projected to decrease by 13. Precipitation: mean annual precipitation is projected to decrease by 11% by 2050. IPCC GCMs precipitations for the ASEAN region indicate a decrease with the greatest reduction during September-November and March-May. Precipitation in June-August is projected to increase by 2%. This section provides the options to visualize climate variables and indices derived from scientifically vetted CMIP5 projections for different timeframes, statistics, emission scenarios, and climate models. Metadata: future climate information is derived from 35 available global circulation models (GCMs) used by the Intergovernmental Panel on Climate Change (IPCC) 5th Assessment Report. Data is presented at a 1℃x1℃ global grid spacing, produced through bi-linear interpolation. Data snapshots: mean annual temperature will rise by 2.32℃ (1.48℃ to 3.66℃) in 2040-2059 (RCP 8.5,

Ensemble). Annual precipitation will decrease by-22.17mm (-106.22mm-67.67mm) in 2040-2059 (RCP 8.5, Ensemble)

The projected climate change scenarios related to the temperature and precipitation for the ASEAN region are presented in Table 11. The simulation reveals a tendency for the average temperature to increase unevenly throughout the country compared to the baseline period in this study (1995-2018). Simulation of impacts from climate change (Climate Change Projection) with numerical simulation (Simulation) by estimating the coefficient of climate variables. (Key Driven Variable) including average temperature and total precipitation. From the econometric models together with the projected image data to predict climate change (Climate Change Projection) at the local level under the circumstances, according to the Special Report on Emissions Scenarios (SRES) in accordance with the National Economic and Social Development Guidelines Southern Region. The situations A2 and B2 have a pattern of change as follows:

Table 12 Patterns of change in the situation A2 and B2 in the future

Variation	A2 (Non-adaptation)	B2 (Adaptation)
Population growth	High level	Intermediate level
Economic growth	Intermediate level	Intermediate level
Energy utilization	Intermediate level	Intermediate level
Policy change utilization	High level	Intermediate level
Quantity of natural resources	Low level	Intermediate level
Direction of technological change	Slow level (Depends on areas)	Intermediate level (normal change)

Source: (Nebojsa Nakicenovic et al, 2000)

When A2 is a situation where the future of the world is diverse, self-reliant in the region. Preserving local identity, the population increases throughout economic development. Depending on the growing region Economic and technological change is slower than other forms of change, and it is distributed locally and regionally. The B2 section focuses on solving local, economic, social, and environmental problems that are sustainable, civil, and civil society. The number is steadily increasing, but less than A2, focusing on environmental protection at local and regional levels. The

world population is increasing steadily but less at a lower rate than A2 has moderate economic development. Various technological changes by protecting the environment and providing social equality with an emphasis on local and regional with a climate change projection in the future of ASEAN is the average in each ASEAN region.

Table 13 Projection of future aver-temperature changes 2039, 2059, 2079, and 2099

Countries	2039		2059		2079		2099	
	A2	B2	A2	B2	A2	B2	A2	B2
Brunei	27.552	27.426	28.232	27.826	28.692	28.077	28.836	28.277
Cambodia	28.148	27.967	29.163	28.39	30.001	28.636	30.193	28.816
Singapore	28.626	28.437	29.370	28.791	29.883	29.043	30.059	29.155
Indonesia	26.948	26.822	27.649	27.161	28.089	27.408	28.325	27517
Lao	25.527	25.337	26.801	25.861	27.747	26.160	28.225	26.295
Myanmar	24.561	24.389	25.579	24.811	26.367	25.151	26.841	25.312
Vietnam	25.463	25.667	26.570	25.771	27.429	26.022	27.789	26.23
Thailand	28.630	28.398	29.743	28.848	30.606	29.150	30.877	29.292
Malaysia	26.410	26.252	27.214	26.333	27.708	26.882	27.919	27.004
Philippines	26.210	26.039	26.978	26.379	27.494	26.628	27.789	26.752

Sources: Climate change knowledge portal for development practitioners and policy makers

Table 14 Projection of future total precipitation changes 2039, 2059, 2079, and 2099

Countries	2039		2059		2079		2099	
	A2	B2	A2	B2	A2	B2	A2	B2
Brunei	3,281.73	3,239.69	3,104.51	3,266.28	3,233.61	3,260.15	3,003.82	3,323.01
Cambodia	2,034.35	2,004.45	2,151.35	2,015.79	2,176.51	2,047.45	2,309.86	2,054.45
Singapore	2,560.40	2,537.24	2,591.47	2,546.79	2,697.33	2,581.00	2,721.65	2,641.22
Indonesia	3,049.60	2,958.25	2,774.83	2,992.66	2,738.24	3,004.31	2,564.01	3,025.00
Lao	1,689.14	1,637.06	1,616.77	1,644.27	1,733.83	1,700.78	1,566.08	1,719.79
Myanmar	2,177.74	2,126.31	2,236.34	2,162.27	2,289.23	2,201.15	2,226.00	2,224.27
Vietnam	1,918.05	1,907.29	1,869.98	1,922.22	1,863.02	1,952.36	1,858.01	1,967.68
Thailand	1,637.17	1,547.09	1,741.92	1,556.66	1,881.71	1,624.03	1,890.13	1,624.94
Malaysia	3,278.53	3,271.88	3,234.64	3,311.09	3,355.69	3,332.53	3,338.13	3,379.79
Philippines	2,850.52	2,631.95	2,740.63	2,628.80	2,754.81	2,689.04	2,745.39	2,676.72

Sources: Climate change knowledge portal for development practitioners and policy makers

This study simulates the effects of climate change on GDP in the ASEAN region in the years 2039, 2059, 2079, and 2099 for adaptation simulation scenario following the steps as below.

1. Define the main weather parameters, including average temperature and total rainfall, and make data selection and forecasting for the future average temperature and precipitation for 2039, 2059, 2079, and 2099 from the nearby area data coordinates, weather stations in each area of each country and find regional average for greenhouse gas situations A2 and B2

2. Calculation of percentage change, average temperature and rainfall, and amount of future total rainfall according to patterns A2 and B2 (hundred change of A2, percentage change of B2) compared with the data of this study is the average temperature and total rainfall during the year 1995-2018, which is defined as a database (Baseline-Temp, Baseline-Rain)

3. Simulate future impacts of climate change by comparing the intersection of the coefficient of the mean temperature variables (Elastic-Temperature) from the database results, which is in the percentage of change in the ASEAN region's GDP. When the temperature is average, there is a 1% change in future temperature will be affected by future temperature change on GDP in the ASEAN region (Effect

Temperature) and calculate the effect of future rainfall changes on GDP in the ASEAN region (Elastic-Precipitation) as well as the change in temperature.

4. Combines the effects of future temperature and rainfall changes (Effect-Temperature and Effect-Rain) is the effect of climate change (Effect-CC) on the GDP in the ASEAN region in each region of ASEAN.

4.2.1 Simulation of impacts of climate change on GDP in the agriculture sector in the ASEAN region in 2039

From the simulation of the effect of climate change (Effect Climate Change: Effect CC) on GDP in the agriculture sector in the ASEAN region. The effect of A2 emissions demonstrated the effects of climate change on GDP in the ASEAN region's agriculture sector in 2039 when precipitation and temperature change. In the year 2039, the average has changed in ten ASEAN countries, with GDP in the agriculture sector declining in the region as a result of climate change. Most in Lao PDR at 2.221% of the effect of A2 emissions. It was found that the effects of simulating projected images of climate change in 2039 in 10 countries of the ASEAN will have a decrease in GDP in the agriculture sector, which Lao PDR will be the most affected by climate change at 1.808% of the effect of B2 emissions.

Table 15 Impact of climate change on GDP in the agriculture sector in the ASEAN region in 2039

Countries	BN	KH	SG	ID	LA	MM	VT	TH	MY	PH
Elastic-Temp	-0.49	-0.49	-0.49	-0.49	-0.49	-0.49	-0.49	-0.49	-0.49	-0.49
Elastic-Rain	-0.01	-0.01	-0.01	-0.01	-0.01	-0.01	-0.01	-0.01	-0.01	-0.01
Baseline Temp	26.72	27.19	27.70	26.09	24.44	23.54	24.43	24.62	25.51	25.36
Baseline Rain	3,111.85	1,964.75	2,475.10	2,903.46	1,628.89	2,108.08	1,889.43	1,530.37	3,179.85	2,539.61
TEMP A2(%Δ)	3.096	3.537	3.327	3.270	4.457	4.325	4.219	3.669	3.508	3.345
RAIN A2(%Δ)	5.459	3.542	3.446	5.033	3.699	3.304	1.515	6.979	3.103	12.242
TEMP B2(%Δ)	2.626	2.869	2.644	2.788	3.679	3.596	3.4176	2.830	2.887	2.671
RAIN B2(%Δ)	4.108	2.021	2.511	1.887	0.502	0.865	0.954	1.093	2.894	3.636
Effect Temp(A2)	-1.517	-1.733	-1.630	-1.602	-2.184	-2.119	-2.067	-1.798	-1.719	-1.639
Effect Rain(A2)	-0.055	-0.035	-0.034	-0.050	-0.037	-0.033	-0.015	-0.070	-0.031	-0.122
Effect Temp(B2)	-1.286	-1.406	-1.295	-1.336	-1.803	-1.762	-1.675	-1.387	-1.414	-1.309
Effect Rain(B2)	-0.041	-0.020	-0.025	-0.019	-0.005	-0.009	-0.009	-0.011	-0.029	-0.036
Effect CC(A2)	-1.572	-1.768	-1.664	-1.652	**-2.221**	-2.152	-2.082	-1.868	-1.750	-1.761
Effect CC(B2)	-1.327	-1.426	-1.320	-1.355	**-1.808**	-1.771	-1.684	-1.398	-1.443	-1.345

Source: Climate change knowledge portal for development practitioners and policy make

4.2.2 Simulation of impacts of climate change on GDP in the agriculture sector in the ASEAN region in 2059

The average has changed in the year 2059 in ten ASEAN countries, with GDP in the agriculture sector declining in ten ASEAN countries as a result of climate change. Most in Lao PDR at 4.743% of the effect of A2 emissions. It is estimated that the effects of simulating projected images of climate change in 2059 in 10 countries of the ASEAN will cause a decrease in GDP in the agriculture sector, which Lao PDR will be the most affected by climate change at 2.863% of the effect of B2 emissions.

Table 16 Impact of climate change on GDP in the agriculture sector in the ASEAN region in 2059

Countries	BN	KH	SG	ID	LA	MM	VT	TH	MY	PH
Elastic-Temp	-0.49	-0.49	-0.49	-0.49	-0.49	-0.49	-0.49	-0.49	-0.49	-0.49
Elastic-Rain	-0.01	-0.01	-0.01	-0.01	-0.01	-0.01	-0.01	-0.01	-0.01	-0.01
Baseline Temp	26.72	27.19	27.70	26.09	24.44	23.54	24.43	24.62	25.51	25.36
Baseline Rain	3,111.85	1,964.75	2,475.10	2,903.46	1,628.89	2,108.08	1,889.43	1,530.37	3,179.85	2,539.61
TEMP A2(%Δ)	5.641	7.270	6.013	5.959	9.695	8.651	8.752	7.701	6.660	6.371
RAIN A2(%Δ)	-0.236	9.497	4.702	-4.430	-0.744	6.084	-1.029	13.823	1.723	7.915
TEMP B2(%Δ)	4.122	4.426	3.922	4.088	5.824	5.387	5.481	4.460	4.383	4.012
RAIN B2(%Δ)	4.963	2.598	2.896	3.072	0.944	2.571	1.735	1.718	4.127	3.512
Effect Temp(A2)	-2.764	-3.563	-2.946	-2.920	-4.750	-4.240	-4.289	-3.773	-3.263	-3.122
Effect Rain(A2)	0.002	-0.095	-0.047	0.044	0.007	-0.061	0.010	-0.138	-0.017	-0.079
Effect Temp(B2)	-2.020	-2.169	-1.922	-2.003	-2.854	-2.640	-2.686	-2.185	-2.148	-1.966
Effect Rain(B2)	-0.050	-0.026	-0.029	-0.031	-0.009	-0.026	-0.017	-0.017	-0.041	0.035
Effect CC(A2)	-2.762	-3.658	-2.993	-2.876	**-4.743**	-4.261	-4.279	-3.911	-3.280	-3.201
Effect CC(B2)	-2.070	-2.195	-1.951	-2.034	**-2.863**	-2.666	-2.703	-2.202	-2.189	-2.001

Source: Climate change knowledge portal for development practitioners and policy makers

4.2.3 Simulation of impacts of climate change on GDP in the agriculture sector in the ASEAN region in 2079

The effect of A2 emissions demonstrated the effects of climate change on GDP in the ASEAN region's agriculture sector in 2079 when precipitation and temperature change. In the year 2079, the average has changed in ten ASEAN countries, with GDP in the agriculture sector declining in the region as a result of climate change. Most in Lao PDR at 6.699% of the effect of A2 emissions. It was expressed that the effects of

simulating projected images of climate change in 2079 in 10 countries of the ASEAN will have a decrease in GDP in the agriculture sector which Lao PDR will be the most affected by climate change at 3.478% for the effect of B2 emissions.

Table 17 Impact of climate change on GDP in the agriculture sector in the ASEAN region in 2079

Countries	BN	KH	SG	ID	LA	MM	VT	TH	MY	PH
Elastic-Temp	-0.49	-0.49	-0.49	-0.49	-0.49	-0.49	-0.49	-0.49	-0.49	-0.49
Elastic-Rain	-0.01	-0.01	-0.01	-0.01	-0.01	-0.01	-0.01	-0.01	-0.01	-0.01
Baseline Temp	26.72	27.19	27.70	26.09	24.44	23.54	24.43	24.62	25.51	25.36
Baseline Rain	3,111.85	1,964.75	2,475.10	2,903.46	1,628.89	2,108.08	1,889.43	1,530.37	3,179.85	2,539.61
TEMP A2(%Δ)	7.362	10.351	7.865	7.645	13.541	11.996	12.269	10.823	8.596	8.408
RAIN A2(%Δ)	3.913	10.778	8.979	-5.690	6.442	8.593	-1.389	22.958	5.530	8.474
TEMP B2(%Δ)	5.061	5.330	4.831	5.033	7.049	6.832	6.508	5.552	5.356	4.991
RAIN B2(%Δ)	4.766	4.209	4.279	3.473	4.413	4.415	3.331	6.120	4.801	5.884
Effect Temp(A2)	-3.608	-5.072	-3.854	-3.746	-6.635	-5.878	-6.012	-5.304	-4.212	-4.120
Effect Rain(A2)	-0.039	-0.108	-0.090	0.057	-0.064	-0.086	0.014	-0.230	-0.055	-0.085
Effect Temp(B2)	-2.470	-2.612	-2.367	-2.466	-3.434	-3.347	-3.189	-2.721	-2.625	-2.446
Effect Rain(B2)	-0.048	-0.042	-0.043	-0.035	-0.044	-0.044	-0.033	-0.061	-0.048	-0.059
Effect CC(A2)	-3.647	-5.180	-3.944	-3.803	**-6.699**	-5.964	-6.026	-5.534	-4.267	-4.205
Effect CC(B2)	-2.518	-2.654	-2.410	-2.501	**-3.478**	-3.391	-3.222	-2.782	-2.673	-2.505

Source: Climate change knowledge portal for development practitioners and policy makers

4.2.4 Simulation of impacts of climate change on GDP in the agriculture sector in the ASEAN region in 2099

The effect of A2 emissions showed that the effects of climate change on GDP in the agriculture sector in the ASEAN region in 2099 when there was precipitation and temperature change. In the year 2099, the average has changed in ten ASEAN countries, with GDP in the agriculture sector declining in the region as a result of climate change. Most in Lao PDR at 5.106% of the effect of A2 emissions. It is expected that the effects of simulating projected images of climate change in 2099 in 10 countries of the ASEAN will have a decrease in GDP in the agriculture sector, which Lao PDR will be the most affected by climate change at 3.781% for the effect of B2 emissions.

Table 18 Impact of climate change on GDP in the agriculture sector in the ASEAN region in 2099

Countries	BN	KH	SG	ID	LA	MM	VT	TH	MY	PH
Elastic-Temp	-0.49	-0.49	-0.49	-0.49	-0.49	-0.49	-0.49	-0.49	-0.49	-0.49
Elastic-Rain	-0.01	-0.01	-0.01	-0.01	-0.01	-0.01	-0.01	-0.01	-0.01	-0.01
Baseline Temp	26.72	27.19	27.70	26.09	24.44	23.54	24.43	24.62	25.51	25.36
Baseline Rain	3,111.85	1,964.75	2,475.10	2,903.46	1,628.89	2,108.08	1,889.43	1,530.37	3,179.85	2,539.61
TEMP A2(%Δ)	4.661	7.265	5.007	5.112	10.571	9.283	9.138	7.847	5.714	6.025
RAIN A2(%Δ)	-8.468	13.543	6.298	-15.923	-7.285	2.216	-3.130	15.451	1.818	-3.688
TEMP B2(%Δ)	5.688	5.992	5.237	5.451	7.601	7.515	7.361	6.065	5.836	5.481
RAIN B2(%Δ)	6.786	4.565	6.712	4.186	5.580	5.512	4.141	6.180	6.288	5.399
Effect Temp(A2)	-2.283	-3.560	-2.453	-2.505	-5.179	-4.549	-4.477	-3.845	-2.800	-2.952
Effect Rain(A2)	0.085	-0.135	-0.063	0.159	0.073	-0.022	0.031	-0.155	-0.018	0.037
Effect Temp(B2)	-2.787	-2.936	-2.566	-2.671	-3.725	-3.682	-3.607	-2.972	-2.860	-2.686
Effect Rain(B2)	-0.068	-0.046	-0.067	-0.042	-0.056	-0.055	-0.041	-0.062	-0.063	-0.054
Effect CC(A2)	-2.198	-3.695	-2.516	-2.346	**-5.106**	-4.571	-4.446	-4.000	-2.818	2.915
Effect CC(B2)	-2.855	-2.982	-2.633	-2.713	**-3.781**	-3.737	-3.648	-3.034	-2.923	-2.740

Source: Climate change knowledge portal for development practitioners and policy makers

4.2.5 Simulation of impacts of climate change on GDP in the non-agriculture sector in the ASEAN region in 2039

The effect of A2 emissions demonstrated the effects of climate change on GDP in the ASEAN region's non-agriculture sector in 2039 when precipitation and temperature change. In the year 2039, the average has changed in ten ASEAN countries, with GDP in the agriculture sector declining in the region as a result of climate change. Most in the Philippines at 50.334% of the effect of A2 emissions. It is expected that the effects of simulating projected images of climate change in 2039 in 10 countries of the ASEAN will have a decrease in GDP in the non-agriculture sector which Brunei will be most affected by climate change at 18.438% for the effect of B2 emissions.

Table 19 Impact of climate change on GDP in non-agriculture sector in the ASEAN region in 2039

Countries	BN	KH	SG	ID	LA	MM	VT	TH	MY	PH
Elastic-Temp	-1.03	-1.03	-1.03	-1.03	-1.03	-1.03	-1.03	-1.03	-1.03	-1.03
Elastic-Rain	-3.83	-3.83	-3.83	-3.83	-3.83	-3.83	-3.83	-3.83	-3.83	-3.83
Baseline Temp	26.72	27.19	27.70	26.09	24.44	23.54	24.43	24.62	25.51	25.36
Baseline Rain	3,111.85	1,964.75	2,475.10	2,903.46	1,628.89	2,108.08	1,889.43	1,530.37	3,179.85	2,539.61
TEMP A2(%Δ)	3.096	3.537	3.327	3.270	4.457	4.325	4.219	3.669	3.508	3.345
RAIN A2(%Δ)	5.459	3.542	3.446	5.033	3.699	3.304	1.515	6.979	3.103	12.242
TEMP B2(%Δ)	2.626	2.869	2.644	2.788	3.679	3.596	3.4176	2.830	2.887	2.671
RAIN B2(%Δ)	4.108	2.021	2.511	1.887	0.502	0.865	0.954	1.093	2.894	3.636
Effect Temp(A2)	-3.189	-3.643	-3.427	-3.368	-4.591	-4.455	-4.346	-3.779	-3.613	-3.445
Effect Rain(A2)	-20.908	-13.568	-13.199	-19.278	-14.167	-12.656	-5.801	-26.728	-11.886	-46.889
Effect Temp(B2)	-2.704	-2.955	-2.723	-2.872	-3.790	-3.704	-3.520	-2.915	-2.974	-2.751
Effect Rain(B2)	-15.734	-7.739	-9.616	7.227	-1.921	-3.312	-3.620	-4.184	-11.085	13.926
Effect CC(A2)	-24.097	-17.211	-16.626	-22.646	-18.758	-17.111	-10.147	30.507	15.499	**-50.334**
Effect CC(B2)	**-18.438**	-10.694	-12.339	-10.099	-5.711	-7.016	-7.140	-7.099	-14.059	-16.677

Source: Climate change knowledge portal for development practitioners and policy makers

4.2.6 Simulation of impacts of climate change on GDP in the non-agriculture sector in the ASEAN region in 2059

In the year 2059, the average has changed in ten ASEAN countries, with GDP in the non-agriculture sector declining in the region as a result of climate change. Most in Cambodia at 43.864% of the effect of A2 emissions. It was estimated that the effects of simulating projected images of climate change in 2059 in 10 countries of the ASEAN will have decreased. Brunei's GDP in the non-agriculture sector will be also the most affected by climate change, accounting for 23.253% of the effect of B2 emissions, as shown in Table 20.

Table 20 Impact of climate change on GDP in non-agriculture sector in the ASEAN region in 2059

Countries	BN	KH	SG	ID	LA	MM	VT	TH	MY	PH
Elastic-Temp	-1.03	-1.03	-1.03	-1.03	-1.03	-1.03	-1.03	-1.03	-1.03	-1.03
Elastic-Rain	-3.83	-3.83	-3.83	-3.83	-3.83	-3.83	-3.83	-3.83	-3.83	-3.83
Baseline Temp	26.72	27.19	27.70	26.09	24.44	23.54	24.43	24.62	25.51	25.36
Baseline Rain	3,111.85	1,964.75	2,475.10	2,903.46	1,628.89	2,108.08	1,889.43	1,530.37	3,179.85	2,539.61
TEMP A2(%Δ)	5.641	7.270	6.013	5.959	9.695	8.651	8.752	7.701	6.660	6.371
RAIN A2(%Δ)	-0.236	9.497	4.702	-4.430	-0.744	6.084	-1.029	7.823	1.723	7.915
TEMP B2(%Δ)	4.122	4.426	3.922	4.088	5.824	5.387	5.481	4.460	4.383	4.012
RAIN B2(%Δ)	4.963	2.598	2.896	3.072	0.944	2.571	1.735	1.718	4.127	3.512
Effect Temp(A2)	-5.811	-7.489	-6.193	-6.138	-9.990	-8.911	-9.015	-7.932	-6.859	-6.562
Effect Rain(A2)	0.903	-36.375	-18.007	16.968	2.850	-23.303	3.943	-29.962	-6.599	-30.316
Effect Temp(B2)	-4.246	-4.556	-4.040	-4.210	-5.999	-5.549	-5.646	-4.594	-4.515	-4.132
Effect Rain(B2)	-19.007	-9.950	-11.093	11.767	-3.616	-9.845	-6.647	-6.580	-15.807	13.451
Effect CC(A2)	-6.714	**-43.864**	-24.200	10.830	-7.140	-32.214	-5.072	-37.885	-13.458	-36.878
Effect CC(B2)	**-23.253**	-14.506	-15.133	7.557	-9.615	-15.394	-12.293	-11.174	-20.322	9.319

Source: Climate change knowledge portal for development practitioners and policy makers

4.2.7 Simulation of impacts of climate change on GDP in the non-agriculture sector in the ASEAN region in 2079

In the year 2079, the average has changed in ten ASEAN countries, with GDP in the non-agriculture sector declining in the region as a result of climate change. Most in Cambodia at 51.942% of the effect of A2 emissions. It is expected that the effects of simulating projected images of climate change in 2079 in 10 countries of the ASEAN will have decreased. Thailand's GDP in the non-agriculture sector will be the most affected by climate change, accounting for 29.159% of the effect of B2 emissions.

Table 21 Impact of climate change on GDP in non-agriculture sector in the ASEAN region in 2079

Countries	BN	KH	SG	ID	LA	MM	VT	TH	MY	PH
Elastic-Temp	-1.03	-1.03	-1.03	-1.03	-1.03	-1.03	-1.03	-1.03	-1.03	-1.03
Elastic-Rain	-3.83	-3.83	-3.83	-3.83	-3.83	-3.83	-3.83	-3.83	-3.83	-3.83
Baseline Temp	26.72	27.19	27.70	26.09	24.44	23.54	24.43	24.62	25.51	25.36
Baseline Rain	3,111.85	1,964.75	2,475.10	2,903.46	1,628.89	2,108.08	1,889.43	1,530.37	3,179.85	2,539.61
TEMP A2(%Δ)	7.362	10.351	7.865	7.645	13.541	11.996	12.269	10.823	8.596	8.408
RAIN A2(%Δ)	3.913	10.778	8.979	-5.690	6.442	8.593	-1.389	7.958	5.530	8.474
TEMP B2(%Δ)	5.061	5.330	4.831	5.033	7.049	6.832	6.508	5.552	5.356	4.991
RAIN B2(%Δ)	4.766	4.209	4.279	3.473	4.413	4.415	3.331	6.120	4.801	5.884
Effect Temp(A2)	-7.583	-10.662	-8.102	-7.875	-13.948	-12.356	-12.637	-11.148	-8.854	-8.661
Effect Rain(A2)	-14.986	-41.280	-34.388	21.794	-24.674	-32.912	5.353	-34.309	-21.179	-32.454
Effect Temp(B2)	-5.213	-5.490	-4.976	-5.184	-7.260	-7.037	-6.703	-5.719	-5.517	-5.141
Effect Rain(B2)	-18.252	-16.121	-16.387	13.303	-16.903	-16.909	-12.756	-23.440	-18.390	22.536
Effect CC(A2)	-22.539	**-51.942**	-42.490	13.919	-38.622	-45.265	-7.284	-45.457	-30.033	-41.115
Effect CC(B2)	-23.465	-21.611	-21.363	8.119	-24.193	-23.946	-19.459	**-29.159**	-23.907	17.395

Source: Climate change knowledge portal for development practitioners and policy makers

4.2.8 Simulation of impacts of climate change on GDP in the non-agriculture sector in the ASEAN region in 2099

In the year 2099, the average has changed in ten ASEAN countries, with GDP in the non-agriculture sector declining in the region as a result of climate change. Most in Cambodia at 59.352% of the effect of A2 emissions. It was estimated that the effects of simulating projected images of climate change in 2079 in 10 countries of the ASEAN will have decreased. Brunei's GDP in the non-agriculture sector will be the most affected by climate change, accounting for 31.847% of the effect of B2 emissions, as shown in Table 22.

Table 22 Impact of climate change on GDP in non-agriculture sector in the ASEAN region in 2099

Countries	BN	KH	SG	ID	LA	MM	VT	TH	MY	PH
Elastic-Temp	-1.03	-1.03	-1.03	-1.03	-1.03	-1.03	-1.03	-1.03	-1.03	-1.03
Elastic-Rain	-3.83	-3.83	-3.83	-3.83	-3.83	-3.83	-3.83	-3.83	-3.83	-3.83
Baseline Temp	26.72	27.19	27.70	26.09	24.44	23.54	24.43	24.62	25.51	25.36
Baseline Rain	3,111.85	1,964.75	2,475.10	2,903.46	1,628.89	2,108.08	1,889.43	1,530.37	3,179.85	2,539.61
TEMP A2(%Δ)	4.661	7.265	5.007	5.112	10.571	9.283	9.138	7.847	5.714	6.025
RAIN A2(%Δ)	-8.468	13.543	6.298	-15.923	-7.285	2.216	-3.130	15.451	1.818	-3.688
TEMP B2(%Δ)	5.688	5.992	5.237	5.451	7.601	7.515	7.361	6.065	5.836	5.481
RAIN B2(%Δ)	6.786	4.565	6.712	4.186	5.580	5.512	4.141	6.180	6.288	5.399
Effect Temp(A)	-4.800	-7.483	-5.157	-5.265	-10.888	-9.562	-9.412	8.083	-5.886	-6.206
Effect Rain(A2)	32.434	-51.869	-24.121	60.985	27.903	-8.488	11.989	-59.178	-6.963	14.125
Effect Temp(B)	-5.858	-6.172	-5.394	-5.615	-7.829	-7.740	-7.581	-6.247	-6.012	-5.645
Effect Rain(B2)	-25.989	-17.486	-25.706	16.033	-21.373	-21.110	-15.862	-23.668	-24.082	20.678
Effect CC(A2)	27.634	**-59.352**	-29.278	55.720	17.015	-18.050	2.577	-51.085	-12.849	7.919
Effect CC(B2)	**-31.847**	-23.658	-31.100	10.418	-29.202	-28.850	-23.443	-29.915	-30.094	15.033

Source: Climate change knowledge portal for development practitioners and policy makers

4.2.9 Simulation of impacts of climate change on total Gross Domestic Product in the ASEAN region in 2039

In the year 2039, the average has changed in ten ASEAN countries, and there will be a total GDP decline in the region as a result of climate change. Most in Lao PDR at 0.431% of the effect of A2 emissions. It was calculated that the effects of simulating projected images of climate change in 2039 in 10 countries of the ASEAN will have a decrease in total Gross Domestic Product. Which Lao PDR will be the most affected by climate change at 0.353% for the effect of B2 emissions, as provided in Table 23.

Table 23 Impact of climate change on the total Gross Domestic Product in the ASEAN region in 2039

Countries	BN	KH	SG	ID	LA	MM	VT	TH	MY	PH
Elastic-Temp	-0.10	-0.10	-0.10	-0.10	-0.10	-0.10	-0.10	-0.10	-0.10	-0.10
Elastic-Rain	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03
Baseline Temp	26.72	27.19	27.70	26.09	24.44	23.54	24.43	24.62	25.51	25.36
Baseline Rain	3,111.85	1,964.75	2,475.10	2,903.46	1,628.89	2,108.08	1,889.43	1,530.37	3,179.85	2,539.61
TEMP A2(%Δ)	3.096	3.537	3.327	3.270	4.457	4.325	4.219	3.669	3.508	3.345
RAIN A2(%Δ)	5.459	3.542	3.446	5.033	3.699	3.304	1.515	6.979	3.103	12.242
TEMP B2(%Δ)	2.626	2.869	2.644	2.788	3.679	3.596	3.4176	2.830	2.887	2.671
RAIN B2(%Δ)	4.108	2.021	2.511	1.887	0.502	0.865	0.954	1.093	2.894	3.636
Effect Temp(A2)	-0.310	-0.354	-0.332	-0.327	-0.446	-0.433	-0.422	-0.367	-0.351	-0.334
Effect Rain(A2)	0.164	0.106	0.103	0.151	0.111	0.099	0.045	0.209	0.093	0.367
Effect Temp(B2)	-0.263	-0.287	-0.264	-0.279	-0.368	-0.360	-0.342	-0.283	-0.289	-0.267
Effect Rain(B2)	0.123	0.061	0.075	0.057	0.015	0.026	0.028	0.033	0.087	0.109
Effect CC(A2)	-0.164	-0.248	-0.229	-0.176	**-0.431**	-0.334	-0.377	-0.158	-0.258	0.003
Effect CC(B2)	-0.140	-0.226	-0.189	-0.222	**-0.353**	-0.334	-0.314	-0.250	-0.202	-0.158

Source: Climate change knowledge portal for development practitioners and policy makers

4.2.10 Simulation of impacts of climate change on total Gross Domestic Product in the ASEAN region in 2059

The average has changed in the year 2059 in 10 countries of the ASEAN region. There will be a total Gross Domestic Product decline in the region which will be affected by climate change. Most in Lao PDR at 0.991% of the effect of A2 emissions. It was calculated that the effects of simulating projected images of climate change in 2059 in 10 countries of the ASEAN will have a decrease in total Gross Domestic Product. Which Lao PDR will be the most affected by climate change at 0.554% for the effect of B2 emissions, as provided in Table 24.

Table 24 Impact of climate change on the total Gross Domestic Product in the ASEAN region in 2059

Countries	BN	KH	SG	ID	LA	MM	VT	TH	MY	PH
Elastic-Temp	-0.10	-0.10	-0.10	-0.10	-0.10	-0.10	-0.10	-0.10	-0.10	-0.10
Elastic-Rain	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03
Baseline Temp	26.72	27.19	27.70	26.09	24.44	23.54	24.43	24.62	25.51	25.36
Baseline Rain	3,111.85	1,964.75	2,475.10	2,903.46	1,628.89	2,108.08	1,889.43	1,530.37	3,179.85	2,539.61
TEMP A2(%Δ)	5.641	7.270	6.013	5.959	9.695	8.651	8.752	7.701	6.660	6.371
RAIN A2(%Δ)	-0.236	9.497	4.702	-4.430	-0.744	6.084	-1.029	13.823	1.723	7.915
TEMP B2(%Δ)	4.122	4.426	3.922	4.088	5.824	5.387	5.481	4.460	4.383	4.012
RAIN B2(%Δ)	4.963	2.598	2.896	3.072	0.944	2.571	1.735	1.718	4.127	3.512
Effect Temp(A2)	-0.564	-0.727	-0.601	-0.596	-0.969	-0.865	-0.875	-0.770	-0.666	-0.637
Effect Rain(A2)	-0.007	0.285	0.141	-0.133	-0.022	0.183	-0.031	0.415	0.052	0.237
Effect Temp(B2)	-0.412	0.443	-0.392	-0.409	-0.582	-0.539	-0.548	-0.446	-0.438	-0.401
Effect Rain(B2)	0.149	0.078	0.087	0.092	0.028	0.077	0.052	0.052	0.124	0.105
Effect CC(A2)	-0.634	-0.442	-0.460	-0.729	**-0.991**	-0.628	-0.906	-0.355	-0.661	-0.400
Effect CC(B2)	-0.263	0.521	-0.305	-0.317	**-0.554**	-0.462	-0.496	-0.394	-0.314	-0.296

Source: Climate change knowledge portal for development practitioners and policy makers

4.2.11 Simulation of impacts of climate change on total Gross Domestic Product in the ASEAN region in 2079

In the year 2079, the average has changed in ten ASEAN countries, and there will be a total GDP decline in the region as a result of climate change. Most in Vietnam at 1.269% of the effect of A2 emissions. It was calculated that the effects of simulating projected images of climate change in 2079 in 10 countries of the ASEAN will have a decrease in total Gross Domestic Product. Which Lao PDR will be the most affected by climate change at 0.573% for the effect of B2 emissions, as expressed in Table 25.

Table 25 Impact of climate change on the total Gross Domestic Product in the ASEAN region in 2079

Countries	BN	KH	SG	ID	LA	MM	VT	TH	MY	PH
Elastic-Temp	-0.10	-0.10	-0.10	-0.10	-0.10	-0.10	-0.10	-0.10	-0.10	-0.10
Elastic-Rain	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03
Baseline Temp	26.72	27.19	27.70	26.09	24.44	23.54	24.43	24.62	25.51	25.36
Baseline Rain	3,111.85	1,964.75	2,475.10	2,903.46	1,628.89	2,108.08	1,889.43	1,530.37	3,179.85	2,539.61
TEMP A2(%Δ)	7.362	10.351	7.865	7.645	13.541	11.996	12.269	10.823	8.596	8.408
RAIN A2(%Δ)	3.913	10.778	8.979	-5.690	6.442	8.593	-1.389	22.958	5.530	8.474
TEMP B2(%Δ)	5.061	5.330	4.831	5.033	7.049	6.832	6.508	5.552	5.356	4.991
RAIN B2(%Δ)	4.766	4.209	4.279	3.473	4.413	4.415	3.331	6.120	4.801	5.884
Effect Temp(A2)	-0.736	-1.035	-0.787	-0.765	-1.354	-1.200	-1.227	-1.082	-0.860	-0.841
Effect Rain(A2)	0.117	0.323	0.269	-0.171	0.193	0.258	-0.042	0.689	0.166	0.254
Effect Temp(B2)	-0.506	-0.533	-0.483	-0.503	-0.705	-0.683	-0.651	-0.555	-0.536	-0.499
Effect Rain(B2)	0.143	0.126	0.128	0.104	0.132	0.132	0.100	0.184	0.144	0.177
Effect CC(A2)	-0.619	-0.712	-0.518	-0.936	-1.161	-0.942	**-1.269**	-0.393	-0.694	-0.587
Effect CC(B2)	-0.363	-0.407	-0.355	-0.399	**-0.573**	-0.551	-0.551	-0.371	-0.392	-0.322

Source: Climate change knowledge portal for development practitioners and policy makers

4.2.12 Simulation of impacts of climate change on total Gross Domestic Product in the ASEAN region in 2099

In the year 2099, the average has changed in ten ASEAN countries, and there will be a total GDP decline in the region as a result of climate change. Most in Lao PDR at 1.276% of the effect of A2 emissions. It was calculated that the effects of simulating projected images of climate change in 2099 in 10 countries of the ASEAN will have a decrease in total Gross Domestic Product which Vietnam will be the most affected by climate change at 0.612% for the effect of B2 emissions, as shown in Table 26.

Table 26 Impact of climate change on the total Gross Domestic Product in the ASEAN region in 2099

Countries	BN	KH	SG	ID	LA	MM	VT	TH	MY	PH
Elastic-Temp	-0.10	-0.10	-0.10	-0.10	-0.10	-0.10	-0.10	-0.10	-0.10	-0.10
Elastic-Rain	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03
Baseline Temp	26.72	27.19	27.70	26.09	24.44	23.54	24.43	24.62	25.51	25.36
Baseline Rain	3,111.85	1,964.75	2,475.10	2,903.46	1,628.89	2,108.08	1,889.43	1,530.37	3,179.85	2,539.61
TEMP A2(%Δ)	4.661	7.265	5.007	5.112	10.571	9.283	9.138	7.847	5.714	6.025
RAIN A2(%Δ)	-8.468	13.543	6.298	-15.923	-7.285	2.216	-3.130	15.451	1.818	-3.688
TEMP B2(%Δ)	5.688	5.992	5.237	5.451	7.601	7.515	7.361	6.065	5.836	5.481
RAIN B2(%Δ)	6.786	4.565	6.712	4.186	5.580	5.512	4.141	6.180	6.288	5.399
Effect Temp(A2)	-0.466	-0.727	-0.501	-0.511	-1.057	-0.928	-0.914	-0.785	-0.571	-0.603
Effect Rain(A2)	-0.254	0.406	0.189	-0.478	-0.219	0.066	-0.094	0.464	0.055	-0.111
Effect Temp(B2)	-0.569	-0.599	-0.524	-0.545	-0.760	-0.751	-0.736	-0.607	-0.584	-0.548
Effect Rain(B2)	0.204	0.137	0.201	0.126	0.167	0.165	0.124	0.185	0.189	0.126
Effect CC(A2)	-0.720	-0.321	-0.312	-0.990	**-1.276**	-0.862	-1.008	-0.321	-0.516	-0.714
Effect CC(B2)	-0.365	-0.462	-0.323	-0.419	-0.593	-0.586	**-0.612**	-0.422	-0.395	-0.422

Source: Climate change knowledge portal for development practitioners and policy makers

Trends of impacts from climate change are affecting the GDP of the Agricultural Sector in the ASEAN region.

From Table 27, it was found that the effects of climate change on the gross domestic product in the agriculture sector in the ASEAN region in the future under the A2 situation, which is the future of the world is diverse, self-reliant in the region. There is also local identity preservation. The population is increasing throughout the region-dependent economic development. Economic growth, however, has slower technological changes and localized distribution in each country in the ASEAN region. Section B2's situation will focus on resolving local problems, economic, social, and environmental sustainability, as the population continues to grow. (But increases less than situation A2) emphasis on environmental protection at the local level, the region has moderate economic development. Technology has changed in many ways with environmental protection and equality. A society with an emphasis on local and regional levels with a projection of future weather changes of the ASEAN region is the average in each region of the ASEAN from the research of the trend of impact which will take place in the future.

Effects under the A2 emission scenario were found in 2039, 2059, 2079, and in 2099, the gross domestic product of the agricultural sector in the ASEAN region has been affected. Lao PDR will be affected by climate change at 2.221 percent and 4.473 percent by the years 2039 and 2059, respectively. In addition, in the years 2079 and 2099, Lao PDR will be impacted by climate change at 6.699 percent, and 5.106 percent, respectively.

Effects under the B2 emission scenario were found in 2039, 2059, 2079, and in 2099, the gross domestic product of the agricultural sector in the ASEAN region has been affected. By the years 2039 and 2059, Lao PDR will be affected by climate change at 1.808 percent and 2.863 percent, respectively. Furthermore, climate change will have a 3.478 percent and 3.781 percent impact on Lao PDR in the years 2079 and 2099, respectively.

From forecasting the impact of climate change on the gross product domestic product in the agricultural sector of the ASEAN region in the future. It was discovered that the gross domestic product in the agricultural sector, which had the greatest impact of climate change effects in Lao PDR, has a greater chance of being affected by changes in the weather on the land than other parts of the ASEAN region.

Table 27 Summary of trends on climate change on GDP in the agriculture sector in the year of 2039, 2059, 2079, and 2099, in the ASEAN region, situation A2 and B2

	Year	BN	KH	SG	ID	LA	MM	VT	TH	MY	PH
Effect CC(A2)	2039	-1.572	-1.768	-1.664	-1.652	**-2.221**	-2.152	-2.082	-1.868	-1.750	-1.761
	2059	-2.766	-3.658	-2.993	-2.876	**-4.743**	-4.261	-4.279	-3.911	-3.280	-3.201
	2075	-3.647	-5.180	-3.944	-3.803	**-6.699**	-5.964	-6.026	-5.534	-4.267	-4.205
	2099	-2.198	-3.695	-2.516	-2.346	**-5.106**	-4.571	-4.446	-4.000	-2.818	2.915
Effect CC(B2)	2039	-1.327	-1.426	-1.320	-1.355	**-1.808**	-1.771	-1.684	-1.398	-1.443	-1.345
	2059	-2.070	-2.195	-1.951	-2.034	**-2.863**	-2.666	-2.703	-2.202	-2.189	-2.001
	2079	-2.518	-2.654	-2.410	-2.501	**-3.478**	-3.391	-3.222	-2.782	-2.673	-2.505
	2099	-2.855	-2.982	-2.633	-2.713	**-3.781**	-3.737	-3.648	-3.034	-2.923	-2.740

Source: Climate change knowledge portal for development practitioners and policy makers

Trends of impacts from climate change are affecting the GDP in the non-agriculture sector in the ASEAN region.

From Table 28, it was found that the effects of climate change on the gross domestic product in the non-agriculture sector in the ASEAN region in the future under the A2 situation, which is the future of the world is diverse, self-reliant in the region. There is also local identity preservation. The population is increasing throughout the region-dependent economic development. Economic growth, however, has slower technological changes and localized distribution in each country in the ASEAN region.

Section B2's situation will focus on resolving local problems, economic, social, and environmental sustainability, as the population continues to grow. (But increases less than situation A2) emphasis on environmental protection at the local level, the region has moderate economic development. Technology has changed in many ways with environmental protection and equality. A society with an emphasis on local and regional levels with a projection of future weather changes of the ASEAN region is the average in each region of the ASEAN from the research of the trend of impact which will take place in the future.

Effects under the A2 emission scenario were found in 2039, 2059, 2079, and in 2099, the gross domestic product in the non-agricultural sector in the ASEAN region has been affected. Future climate change by the year 2039, the Philippines will be the most affected by climate change at 50.334 percent. In the year 2057, Cambodia will be the most affected by climate change at 43.864 percent. Furthermore, in the years 2079 and 2099, Cambodia will also be the most impacted by climate change at 51.942 percent, and 59.342 percent, respectively.

Effects under the B2 emission scenario were found in 2039, 2059, 2079, and in 2099, the gross domestic product in the non-agricultural sector in the ASEAN region has been affected. Future climate change by the years 2039 and 2059, Brunei will be the most affected by climate change at 18.438 percent and 23.253 percent, sequentially. Moreover, in the year 2079, Thailand will be the most affected at 29.159 percent, and in the year 2099, Brunei will be the most impacted by climate change at 31.847 percent.

From forecasting the impact of climate change on the gross product domestic product in the non-agricultural sector of the ASEAN region in the future. It was discovered that the gross domestic product in the non-agricultural sector had the greatest impact of climate change effects in Brunei, Cambodia, Thailand, and the Philippines, which have a greater chance of being affected by changes in the weather on the land than other parts of the ASEAN region.

Table 28 Summary of trends on climate change on GDP in the non-agriculture sector in the year of 2039, 2059, 2079, and 2099, in the ASEAN region, situation A2 and B2.

	Year	BN	KH	SG	ID	LA	MM	VT	TH	MY	PH
Effect CC(A2)	2039	-24.097	-17.211	-16.626	-22.646	-18.758	-17.111	-10.147	30.507	15.499	**-50.334**
	2059	-6.714	**-43.864**	-24.200	10.830	-7.140	-32.214	-5.072	-37.885	-13.458	-36.878
	2079	-22.539	**-51.942**	-42.490	13.919	-38.622	-45.265	-7.284	-45.457	-30.033	-41.115
	2099	27.634	**-59.352**	-29.278	55.720	17.015	-18.050	2.577	-51.085	-12.849	7.919
Effect CC(B2)	2039	**-18.438**	-10.694	-12.339	-10.099	-5.711	-7.016	-7.140	-7.099	-14.059	-16.677
	2059	**-23.253**	-14.506	-15.133	7.557	-9.615	-15.394	-12.293	-11.174	-20.322	9.319
	2079	-23.465	-21.611	-21.363	8.119	-24.193	-23.946	-19.459	**-29.159**	-23.907	17.395
	2099	**-31.847**	-23.658	-31.100	10.418	-29.202	-28.850	-23.443	-29.915	-30.094	15.033

Source: Climate change knowledge portal for development practitioners and policy makers

Trends of impacts from climate change are affecting the total of GDP in the ASEAN region.

From Table 29, it was found that the effects of climate change on the total gross domestic product in the ASEAN region in the future under the A2 situation, which is the future of the world is diverse, self-reliant in the region. There is also local identity preservation. The population is increasing throughout the region-dependent economic development. Economic growth, however, has slower technological changes and localized distribution in each country in the ASEAN region.

Section B2's situation will focus on resolving local problems, economic, social, and environmental sustainability, as the population continues to grow. (But increases less than situation A2) emphasis on environmental protection at the local level, the region has moderate economic development. Technology has changed in many ways

with environmental protection and equality. A society with an emphasis on local and regional levels with a projection of future weather changes of the ASEAN region is the average in each region of the ASEAN from the research of the trend of impact which will take place in the future.

Effects under the A2 emission scenario were found in 2039, 2059, 2079, and in 2099, the total of gross domestic product in the ASEAN region has been affected. Lao PDR will be the most affected by climate change in the years 2039 and 2059, with 0.431 percent and 0.991 percent, respectively. Moreover, in the year 2079, Vietnam will be the most affected by climate change at 1.269 percent. In addition, in the year 2099, the Lao PDR will also be the most impacted by climate change at 1.276 percent.

Effects under the B2 emission scenario were found in 2039, 2059, 2079, and in 2099, the total of gross domestic product in the ASEAN region has been affected. Future climate change by the years 2039, 2059, and 2079 which Lao PDR will be the most affected by climate change at 0.353 percent, 0.554 percent, and 0.573 percent, sequentially. In addition, in the year 2099, Vietnam will be the most affected by climate change at 0.612 percent.

From forecasting the impact of climate change on the total of gross product domestic product in the ASEAN region in the future. It was discovered that the total of gross domestic product, which had the most impact of climate change was Lao PDR, and Vietnam, respectively, has a greater chance of being affected by changes in the weather on the land than other parts of the ASEAN region.

Table 29 Summary of trends on climate change on total Gross Domestic Product in the year of 2039, 2059, 2079, and 2099, in the ASEAN region, situation A2 and B2.

	Year	Brunei	Cambodia	Singapore	Indonesia	Lao	Myanmar	Vietnam	Thailand	Malaysia	Philippines
	2039	-0.164	-0.248	-0.229	-0.176	**-0.431**	-0.334	-0.377	-0.158	-0.258	0.003
Effect	2059	-0.634	-0.442	-0.460	-0.729	**-0.991**	-0.628	-0.906	-0.355	-0.661	-0.400
	2079	-0.619	-0.712	-0.518	-0.936	-1.161	-0.942	**-1.269**	-0.393	-0.694	-0.587
CC(A2)	2099	-0.720	-0.321	-0.312	-0.990	**-1.276**	-0.862	-1.008	-0.321	-0.516	-0.714
	2039	-0.140	-0.226	-0.189	-0.222	**-0.353**	-0.334	-0.314	-0.250	-0.202	-0.158
Effect	2059	-0.263	0.521	-0.305	-0.317	**-0.554**	-0.462	-0.496	-0.394	-0.314	-0.296
	2079	-0.363	-0.407	-0.355	-0.399	**-0.573**	-0.551	-0.551	-0.371	-0.392	-0.322
CC(B2)	2099	-0.365	-0.462	-0.323	-0.419	-0.593	-0.586	**-0.612**	-0.422	-0.395	-0.422

Source: Climate change knowledge portal for development practitioners and policy makers

UNIT 5

SUMMARY OF THE STUDY RESULTS

5.1 Summary of study results

5.1.1 The study result of climate change on gross domestic product in the ASEAN region

The descriptive results of the total gross domestic product in the ASEAN region from 1995-2018, the mean calculated is 149,000 million US$ with a standard deviation of 196,000 million US$ while minimum and maximum value seemed is 1,280 million US$ and 1,040,000 million US$ respectively. Total precipitation resulted in a mean of 2,333.14 mm with a standard deviation of 599.54 mm. The minimum and maximum total precipitation in the research area note down 1,530.37 mm and 3,179.85 mm respectively. The calculated mean of variance-precipitation noted is 11.019.83 mm with a maximum value of 28,403.44 mm and the minimum is 2,580.82 mm whereas the standard deviation premeditated is 8,341.07 mm. The mean of an average temperature is 25.86℃ with a minimum and maximum of 23.54℃ and 27.70℃ respectively while the standard of deviation is 1.44℃. The mean of variance temperature calculated is 2.71℃ with the standard deviation of 2.99℃ while the minimum and maximum of 0.07℃ and 7.15℃ correspondingly. There are 4 non-climate variables that brought into the model, the mean of current account balance calculated is 11.77 percent with a standard deviation of 11.58 percent while the minimum and maximum values are shown as 0.03 percent and 48.21 percent, sequentially. The mean of the labor force approximated is 27 million people with the standard deviation of 31 million people while the minimum and maximum value appeared 0.131 million people and 133 million people correspondingly. The inflation rate resulted in a mean of 7.36 percent with the standard deviation of 13.33 percent the minimum, and maximum in this research area are noted is 0.02 percent and 125.27 percent sequentially. The calculated mean of total investment noted is 5.60 percent with a minimum and maximum of 0.06 percent and 28.89 percent respectively while the standard deviation is 5.59 percent.

For the total gross domestic product, the effects of time trend (T) on the total gross domestic product are all positive and statistically significant at 99% confidence level. This indicates that technological progress is significant during the sample period. The effect of total precipitation varies across regions and shows a positive impact and is statistically significant at 90% confidence level, where 1% increase in total precipitation induces an increase in the total gross domestic product by 0.03%. Furthermore, variance-precipitation has a negative impact on total GDP and is statistically significant at the 95% confidence level, with a 1% increase in variance-precipitation decreasing total GDP by 0.02%.The findings also confirmed that the average temperature contribution to total GDP is statistically significant at the 99% confidence level, with a 1% increase in average temperature decreasing total GDP by 0.10%.The fallout further declared variance-temperature statistically significant at a degree of 5% with a positive coefficient that means the variance-temperature has a positive impact on the total gross domestic product where a 1% increase in the variance-temperature will boost total gross domestic product by 0.02%. The effect of the labor force shows a negative impact and is statistically significant at 99% confidence level, where a 1% increase in the labor force induces a decrease of 0.57% in the total gross domestic product. The results also show that an increase of 1% in current account balance could induce a decrease of 0.003% in the total gross domestic product in the ASEAN region and is statistically significant at 99% confidence level. The results showed that a 1% increase in the percentage of inflation rate reduces total gross domestic product by 0.04%, indicating that the inflation rate has a positive impact on total gross domestic product and is statistically significant at the 99% confidence level. In addition, the total investment in percent change has a significant and positive impact on total gross domestic product where a 1% increase in total investment in percent change will boost total gross domestic product by 0.01%. The findings show a significant and insignificant relationship between climate change and non-climate change variables and total GDP.

5.1.2 Simulating the effects of climate change on the total gross domestic product of the ASEAN region in the future

Section B2's situation will focus on resolving local problems, economic, social, and environmental sustainability, as the population continues to grow. (But increases less than situation A2) emphasis on environmental protection at the local level, the region has moderate economic development. Technology has changed in many ways with environmental protection and equality. A society with an emphasis on local and regional levels with a projection of future weather changes of the ASEAN region is the average in each region of the ASEAN from the research of the trend of impact which will take place in the future. Effects under the A2 emission scenario were found in 2039, 2059, 2079, and in 2099, the total of gross domestic product in the ASEAN region has been affected. Lao PDR will be the most affected by climate change in the years 2039 and 2059, with 0.431 percent and 0.991 percent, respectively. Moreover, in the year 2079, Vietnam will be the most affected by climate change at 1.269 percent. In addition, in the year 2099, the Lao PDR will also be the most impacted by climate change at 1.276 percent. Effects under the B2 emission scenario were found in 2039, 2059, 2079, and in 2099, the total of gross domestic product in the ASEAN region has been affected. Future climate change by the years 2039, 2059, and 2079 which Lao PDR will be the most affected by climate change at 0.353 percent, 0.554 percent, and 0.573 percent, sequentially. In addition, in the year 2099, Vietnam will be the most affected by climate change at 0.612 percent.

5.2 Discuss the results of the study

The purpose of this study is to look into the potential effects of climate change on GDP using panel data from 1995 to 2018.The variables used for fixed effect model estimation were climatic and non-climatic variables. The empirical results indicate that climate change influences gross domestic product through the effects of both temperature and precipitation. The results found that the rise in temperature reduces gross domestic product, in accordance with the study of Abidoyend Odusola: 2015 explained that a 1°C increase in temperature reduces the region's economy by approximately 0.27 percentage points, and also related the

study of Dell et al (2008), which found that an increase in temperature has wide-ranging effects on poor countries, reducing agricultural output, industrial output, aggregate investment, and political instability. Besides this, the study also found that rising temperatures significantly reduce economic growth in poor countries. Such an effect is insignificant in developed countries. Furthermore, Dell et al (2008) suggested that the effect of climate change at the aggregate level depends on a country's level of development, with the negative effect damped as the country moves up on the development ladder. In addition, Du et al (2017) found that the change of temperature was significantly oppositely correlated with economic growth. The study of Alagidede et al (2016) found that an approximation of the flexible found temperature has a positive effect on economic growth in Sub-Saharan Africa. Similarly, an increase in variance-temperature would also reduce gross domestic product. We also estimated the effect of precipitation level increases and found that an increase in precipitation will boost gross domestic product, and it is different from the study of Lanzafame: 2014 found that falling precipitation reduces the capacity to utilize irrigation to grow crops and to support export-based agriculture and light industry. Furthermore, we found that an increase in variance-precipitation induces a decrease in gross domestic product.

The non-climatic variables result of this study expressed that an increase in the labor force will decrease gross domestic product. The study also found that the rise in both current account balance and the inflation rate would also reduce gross domestic product. Over a while, a rise in total investment will increase gross domestic product in the ASEAN region. The other studies are different variables, which the study of Fankhauserand Tol: 2005 discovered that temperature increases slow down the rate of learning and also have a negative impact on the health of the labor force. The cumulative effect of this is to reduce labor productivity and long-run economic growth. An important conclusion from Milliner and Dietz (2011) is that the task of apportioning investment between productive capital and adaption investments is a subtle one. Implicit in this finding then is that as an economy develops over time, it will automatically insulate itself from the perils of climate change. For instance, the structural changes that go with economic development will

mean less dependence on the more sensitive sectors to climate change, such as agriculture. Furthermore, the study of Jonesand Olken: 2010 analyses the trade effects and export performance of developing countries to climate change and concludes that warmer temperatures tend to dampen the export performance of developing countries, predominantly for agriculture and light manufacturing. Aside from that, Milliner and Dietz (2011) discovered that economic development will automatically insulate countries from the perils of climate change, and thus separating adaptation investment from productive capital accumulation will not make much of a difference. With regard to precipitation, Dell et al. (2008) concluded that precipitation does not have any significance in economic growth. This conclusion is independent of a country's level of development. In a related study, Dell et al. (2009) combined theory with empirics to further examine the temperature income relationship. Employing data from 12 countries in America, Dell et al. (2009) established a negative cross-sectional inter-and intra-country relationship between temperature and income. However, as the authors argue, about half of the negative short-run effects of temperature on growth are mitigated through long-run adaptation. The important lesson of Lanzafame (2014) is that African countries have not adapted well to weather shocks, and without proper intervention, mechanisms to arrest the alarming effects of climate change growth may be hampered. Akram:2013 conducted a study on climate change as a barrier to economic growth in Asia. The study found that the economy is statistically significant, the percentage of urban population and human development index the most, but will have the least impact on the industry.

5.3 Study recommendations

In this study, the recommendations from studies on the potential impacts of climate change on the economic indicators in the ASEAN region include:

1. Selecting the greatest number of years of study for available panel data in accordance, be able to understand the results from the past until now to be used in assessing the situation that will arise in the future.

2. Choosing a period of the year will affect the results of the study that may not be consistent with the condition. The reality in education, in addition, choosing a range will make it less obvious to change.

3. Separate the level of countries' economies in order to make a database of developed and developing countries then it will be easy to test the relationship between dependent and independent variables more efficiency.

4. Separate the countries which are near the sea and near the mountainous countries in order to make panel data model analysis test the relationship between dependent and independent variables more efficient.

5. Consequently, further studies could attempt to collect more available panel data for analysis with regard to conventional gross domestic product factors such as import, export, foreign direct investment to result in more persuasive estimates.

5.4 Policy recommendations

Based on estimation results, the research suggests that economic policy should concern with climate change condition actions. Moreover, it could help with more comprehensive risk decision-making, and policy exertions should be concentrated toward impact of climate change on gross domestic product. Besides significantly contributing to the estimates of potential impacts of climate change on the gross domestic product to the existing literature, the study also raises several issues which could be further investigate. Since the main contribution of this study focuses on the impacts of climate condition and gross domestic product, other input factors are not considered. After getting the empirical result, the policymaker can develop and evaluate strategic policy responses with a view to how societies in the ASEAN region might respond to the potential impacts of climate change identified in the previous phase to protect their environmental and natural resource base, their economic vitality, and their prosperity. Improve federal coordination and policy evaluation by establishing clear leadership, responsibilities, and coordination for climate-related decisions, information systems, and services at the federal level. Establish information and reporting systems that allow for regular evaluation and

assessment of the effectiveness of both government and non-gov-ornamental responses to climate change. Assess, evaluate, and learn from the different approaches to climate-related decision-making used by non-federal levels of government and the private sector

5.5 Recommendation for the next study

In this study, the recommendations for the next study that will be related to the title on the potential impacts of climate change on the economic indicators in the ASEAN region including

1. The following study should go over how to select more year datasets for the available panel data model analysis in accordance, as well as be able to understand the results from the past until now to be used in assessing the situation that will arise in the future climate change effect.

2. Next study must imagine how to choose a period of the year that will affect the results of the study that may not be consistent with the condition. The reality in education, in addition, choosing a range will make it less obvious to change.

3. Next, studies have to consider how to separate the level of countries' economies in order to make a database of developed and developing countries. Then the results of research will be easy to analyses the relationship between dependent and independent variables more efficient.

4. The next study may also focus on how to separate countries that are near the sea from countries that are near mountains in order to perform panel data model analysis, which should yield a better result of the relationship between dependent and independent variables with more coefficients.

5. Consequently, further studies should pay more attention to collect more available data for panel data model analysis with regard to conventional gross domestic product factors such as import, export, foreign direct investment to result in more persuasive estimates.

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