A Research Report on

IMPACT OF CLIMATE CHANGE ON GLOBAL ECONOMIC SCENARIO

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CERTIFICATE

This is to certify that our group has successfully completed the project titled "**Impact of Climate Change on Global Economic Scenario**" submitted in partial fulfilment of the requirements for the Degree of Bachelors of Arts (Honors) in Economics at Sri Guru Gobind Singh College of Commerce, University of Delhi. It is further certified that the submitted report is based on original research work carried out by the group, and the data obtained from secondary sources has been duly acknowledged.

Dr. J.B. Singh
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Ms. Divya Seth Guliani
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ACKNOWLEDGEMENT

This project has offered us great insights while researching on our topic. We have enriched our knowledge about climate change, economies and their policies about climate change. We would like to extend our heartfelt thanks to the people who have helped us throughout our research.

We would like to thank our professor, **Ms. Divya Seth Guliani**, for providing guidance in conducting our research and carrying out this project. Her command on the subject and her dedication towards providing constructive feedback helped us make our project better. She provided us regular online sessions and meets in order to help us do our project smoothly without any hassle, and effectively complete the project on time.

We would like to further thank our principal sir, **Dr. J.B. Singh**, for providing us the opportunity to study this subject and conduct this research. We are really thankful to sir for providing us with the webinars and discussions to take guidance from our professors for our project.

Lastly, we would like to thank all the people who directly and indirectly helped us throughout our project.

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CHAPTER 1: INTRODUCTION

1.1 BACKGROUND OF THE TOPIC

In 2017, climate change contributed to extreme weather events causing at least $100 billion in damages. In 2020 the World Economic Forum ranked climate change as the biggest risk to the world economy and society. A survey of independent economists looking at the effects of climate change found that future damage estimates range from 2% to 10% or more of global GDP per year. The Stern Review for the British Government also predicted that world GDP would be reduced by several percent due to climate-related costs; among the factors they considered were increased extreme weather events and stresses to low-lying areas due to sea-level rise. Increasing temperature will lead to accelerating economic losses. More recent studies suggest that economic damages due to climate change have been underestimated, and may be severe, with the probability of disastrous tail-risk events being nontrivial.

Climate change presents a major threat to long-term growth and prosperity, and it has a direct impact on the economic wellbeing of all countries. Between 2030 and 2050, climate change is expected to cause approximately 250000 additional deaths per year, from malnutrition, malaria, diarrhoea, and heat stress alone. The direct damage costs to health are estimated to be between USD 2-4 billion per year by 2030 and losses in productivity reaching 2.2% of all the working hours, every year. This is equivalent to 80 million full-time jobs, or 2,400 billion dollars. The sector expected to be most affected is agriculture, which is projected to account for 60% of this loss. The construction sector is also projected to be severely impacted and accounts for 19% of projected losses.

It is observed that climate change would increase income inequalities between and within countries as developing countries would bear the damages primarily because they are located in the low latitudes and are already too hot. Also, the absence of capital and

technology will give them fewer adaptation options. A small increase in global mean temperature (up to 2 °C, measured against 1990 levels) would result in a net negative market sector in many developing countries. Developed countries would be able to adapt to the climatic changes and protect their resources in the short run but in the long run, all the countries will be hit hard by harsh climatic changes.

Global pollution creates a "public bad" affecting everyone—a negative externality with a wide impact. CO2 and other greenhouse gases continuously accumulate in the atmosphere, stabilizing or "freezing" emissions will not solve the problem. Greenhouse gases persist in the atmosphere for decades or even centuries, continuing to affect the climate of the entire planet long after they are emitted. Future projections of climate change depend on the path of future emissions. Even if all emissions of greenhouse gases end today, the world would continue to warm for many decades, and effects such as sea-level rise would continue for centuries. Climate change can thus be viewed as a public good issue, requiring collaborative action to develop adequate policies. In the case of climate change, such action needs to involve all stakeholders, including governments and public institutions as well as private corporations and individual citizens.

1.2 NEED FOR THE STUDY

Since ancient times, humans have been using Earth's resources for their evolution from caves to metropolises and have developed mind-boggling technologies. But with this advancement, we have paid a price - negative impact on the planet in the form of depletion of Earth's resources, global warming, ozone depletion, and climate change. The industrialization and urbanization of countries have impacted the environment leading to melting of ice caps, warming up of the oceans, seasonal imbalance, delayed monsoon, and other climatic changes. We have hence seen a great change in the climate

due to the development of the economies. But does this change in the climate also affect the economies of the world? Of course, it does. Climate change affects important factors like precipitation, temperature, weather, and wind pattern, which in turn affect the economy's agriculture, manufacturing, and service sectors. A slight change in these sectors can affect the economy to a large extent. Hence, there is an urgent need to study the effects of climate change on the global economies in order to sustain them while improving the health of the planet, and taking up sustainable development.

1.3 OBJECTIVES OF THE STUDY

1. To study the Impact of Climate Change on the GDP of selected Developed and Developing Countries.
2. To study the policy responses of the Government of India.

1.4 RATIONALE OF THE PROJECT

For the last two decades, Climate change has been the centripetal force of every economic discussion. A lot of debates are held on "*the impact of economic growth on climate change*". However, a few economists argue about the unlikely impact of climate change on economies around the globe. Our paper discusses the impact of climate change on global economic scenario through the lens of 10 developed and developing economies with a special focus on the Indian Economy. In his paper *'Is Climate Change Hindering Economic Growth of Asian Economies?'* Naeem Akram highlights how temperature and precipitation have negative impacts on agriculture, manufacturing and service sectors in Asian countries. Jonathan M. Harris and Maximilian Auffhammer with the help of methods like 'Integrated Assessment Models and Social Cost of Carbon', and 'Econometric Methods' argue how the impact of climate change will vary depending on the geographical location of a country and the objective analysis of

mitigation strategies - 'carbon taxes' and 'tradable permits'. The International Monetary Fund (IMF) in their working paper *"Long Term Macroeconomic Effects of Climate Change: A Cross Country Analysis"* predicted the percentage loss in GDP per capita of different countries by the beginning of the 22nd century.

For our paper, we analysed temperature (in Degrees Celsius), rainfall (in mm) and GDP (in US Billion Dollars) for 10 years of the these Developed (United States of America, United Kingdom, Japan, Germany, Denmark) and Developing Countries (India, Bangladesh, Philippines, Brazil, South Africa).

CHAPTER 2: LITERATURE REVIEW

The team read 10 research papers for a better understanding of the topic. The research papers have been summarized as under:

1. *'Is Climate Change Hindering Economic Growth of Asian Economies?' by Naeem Akram, Asia-Pacific Development Journal, Vol. 19, No. 2, December 2012* highlights the relationship between changes in the weather patterns and economic growth of Asian countries. The results show that temperature and precipitation have negative and significant relationships with GDP growth as well as with productivity in the agriculture, manufacturing, and services sectors. The study also focuses on the fact that if climate change is not controlled, the economic growth of these Asian countries will be reduced considerably. Lastly, the study mentions that Asian developing countries have very little control over climate change and its reduction in comparison to developed countries, hence suggesting that international policy should be made for poverty alleviation and economic growth of these Asian Countries.

2. *'The Economic Effects of Climate Change' by Richard S. J. Tol, Journal of Economic Perspectives, April 2009* focuses on the fact that climate change has both negative and positive impacts on the economies, depending on the nature of the impact. Throwing light on carbon emissions and taxes, the study highlights the role of governments and politicians. The author also mentions the contribution of high-income countries and low-income countries in climate change and its effects and role of these countries in overcoming it for developing their economies.

3. Jonathan M.Harris et al., in their study "The Economics of Global Climate Change" describe the issue of Climate Change with economic, scientific, political and technological dimensions. The research paper outlines the adaptive and mitigative policies like 'Carbon Taxes' and 'Tradable permits' using cost-benefit analysis. The authors highlight the billions of dollars of damage caused by climate changes every now and then, the need to control the accumulation of greenhouse gases and the role of forests and soils in accumulating these gases and preserving the environment. Climatic Change can thus be viewed as a public good issue, requiring collaborative action to develop adequate policies.

4. Robert Mendelsohn et al., in their study "The Distributional Impact of Climate Change on Rich and Poor Countries," examine the impact of climate change on rich and poor countries across the globe with the help of 2 indices: impact per capita and impact per GDP. It is observed with the help of various models and tests that developing

countries will bear the brunt of climate change damages primarily because they are located in the low latitudes and are already too hot. Also, the absence of capital and technology will give them fewer adaptation options.

5. Keith Wade and Marcus Jennings, in their study *"The impact of climate change on the Global Economy,"* examine the exogenous impact of climate change on world GDP, with a special emphasis on developing economies. The study establishes, with the help of various models, climate change functions and focuses in the end on the policy response for mitigating the risk.

6. Maximilian Auffhammer in his study *"The(Economic) Impacts of Climate Change: Some Implications for Asian Economies"* discussed the steps from physical impact to human and natural impact. There are two major inter-connected ways in which economists have tried to estimate the economic effects of climate change: 'Integrated Assessment Models and Social Cost of Carbon', and 'Econometric Methods', along with variation in weather and climate to estimate damages from climate change. He points out that in equilibrium all firms should produce at a point where marginal abatement costs are identical across firms, and if the permit price is chosen correctly, it will equate to the external cost of emissions.

7. International Monetary Fund (IMF) in their working paper *"Long Term Macroeconomic Effects of Climate Change: A Cross Country Analysis"* written by some of the renowned environmental economists studied the long-term impact of climate change on economic activities of countries across the globe using different mathematical tools. They also predicted the percentage loss in GDP per capita of different countries by the beginning of the 22nd century.

8. Reflections on the Economics of Climate Change by William D. Nordhaus discussed how variables like wages, unionization, labour-force skills, and political factors swamp climatic considerations. The study discusses how different sectors of various countries are affected by climate change. The study then focused on the "Balancing Act" in climate change policies. The author stated that from an economic point of view, efficient policies are ones in which the marginal costs are balanced with the marginal benefits of emissions reductions. Lastly, it mentioned the DICE model i.e., the Dynamic Integrated Model of Climate and the Economy which is a global dynamic optimization model for estimating the optimal path of reductions of greenhouse gas emissions.

9. *"The costs of Climate Change in India" by Angela PicciarielloID, Sarah Colenbrander ID, Amir Bazaz, and Rathin Roy* covers the economic and social costs due to climate-related risks. The authors state that the costs will not be borne equally within India. Climate change threatens India's development aspirations through so-called 'nonlinear events', where an ecosystem fundamentally shifts after passing a specific environmental threshold. GDP to be reduced by 2100 due to global warming affecting agricultural productivity, sea-level rise, increased health expenditure, temperature, and precipitation changes. Lastly, it talked about securing a 'triple win' from low carbon development by carefully crafting policies and investments to navigate potential trade-offs and maximise benefits.

10. "Occasional Paper Series - Climate change and the Macro economy" by Malin Andersson et al., examines the macroeconomic impact of climate change on the European Union (EU) and spotlights the success of coordinated adaptive and mitigation policies among EU members - carbon pricing, carbon tax. It also suggests how monetary institutions can play a vital role in managing the risk - along with short-term and long-term impacts on society and the economy.

CHAPTER 3: RESEARCH METHODOLOGY

3.1 Sample Size and Data Collection

For this research, we have taken the sample size of 10 years (n=10). The research uses secondary data collected through reputed and trusted websites. For the first objective, that is, to study the impact of climate change on the GDP of selected Developed and Developing countries, the data has been collected from The Climate Knowledge Portal of the *World Bank*: https://climateknowledgeportal.worldbank.org/ and World Bank Data Portal: https://data.worldbank.org/indicator/NY.GDP.MKTP.CD. For the second objective, the data has been collected from https://dst.gov.in/climate-change-programme and https://www.ideasforindia.in/topics/environment/india-s-progress-in-meeting-its-climate-goals.html to study the policy responses of the Government of India. We have taken the data of 10 countries (Developed : US, UK, Germany, Japan, Denmark; Developing : India, South Africa, Bangladesh, Philippines, Brazil). We have taken 10-year data, from 2011 to 2020. We have 3 variables: GDP, Rainfall, Temperature.

3.2 Research Methods

The study will use descriptive analysis as well as inferential analysis. The study will use descriptive analysis with the help of bar graphs, line charts (time series), and tables, the goal of which is to organize and describe data collected from the websites. This will provide a simple summary about the sample. The paper will also use inferential analysis for the first objective. A P-Value Test will be done on the data. This will help us test the hypothesis and examine whether the climate change has a significant impact on the GDP of a country or not. For the second objective, we have analysed the Policy responses of Government of India for curbing the effects of climate change on GDP of the country.

CHAPTER 4: PRESENTATION AND ANALYSIS OF DATA

4.1 PRESENTATION AND ANALYSIS OF OBJECTIVE 1

DESCRIPTIVE ANALYSIS

For our analysis of first objective – studying the impact of climate change on global economic scenario, given below is the table of data collected.

DEVELOPED COUNTRIES

S.NO.	COUNTRIES	2011			2012			2013			2014			2015		
		GDP (in billion dollars)	RAINFALL (in mm)	TEMPERATURE (in degree celsius)	GDP (in billion dollars)	RAINFALL (in mm)	TEMPERATURE (in degree celsius)	GDP (in billion dollars)	RAINFALL (in mm)	TEMPERATURE (in degree celsius)	GDP (in billion dollars)	RAINFALL (in mm)	TEMPERATURE (in degree celsius)	GDP (in billion dollars)	RAINFALL (in mm)	TEMPERATURE (in degree celsius)
1	US	15542.6	707.37	9.37	16197	658.57	10.11	16784.9	745.48	9.09	17527.3	720.92	9.42	18238.3	806.4	10.21
2	UK	2659.88	1133.51	9.45	2704.01	1373.45	8.79	2783.25	1128.29	8.74	3065.52	1369.8	9.82	2932.78	1264.58	9.06
3	Germany	3748.66	656.39	9.6	3529.38	708.65	9.1	3733.86	727.05	8.7	3890.1	692.05	10.3	3357.93	640.68	9.9
4	Japan	6167	1746.65	11.22	6203.21	1724.84	11.02	5156	1711.96	11.41	4850.41	1734.92	11.18	4389	1789.53	11.7
5	Denmark	344	767.59	8.61	327.149	774.85	8.7	343.584	780.57	8.82	352.994	784.19	8.96	302.673	785.12	9.11

DEVELOPED COUNTRIES

S.NO.	COUNTRIES	2016			2017			2018			2019			2020		
		GDP (in billion dollars)	RAINFALL (in mm)	TEMPERATURE (in degree celsius)	GDP (in billion dollars)	RAINFALL (in mm)	TEMPERATURE (in degree celsius)	GDP (in billion dollars)	RAINFALL (in mm)	TEMPERATURE (in degree celsius)	GDP (in billion dollars)	RAINFALL (in mm)	TEMPERATURE (in degree celsius)	GDP (in billion dollars)	RAINFALL (in mm)	TEMPERATURE (in degree celsius)
1	US	18745.1	728.29	10.68	19543	755.19	10.24	20611.9	804.4	9.89	21433.2	814.96	9.74	20934.9	717.58	10.05
2	UK	2693.24	1172.89	9.24	2662.48	1163.11	9.51	2857.31	1117.45	9.36	2830.81	1270.59	9.44	2707.74	1322.56	9.58
3	Germany	3468.9	697.63	9.5	3681.3	794.34	9.6	3965.57	586.3	10.4	3449.05	735	10.2	3803.01	643.53	10.4
4	Japan	5003.68	1834.74	11.78	4930.84	1525.13	11.17	5036.89	1760	11.73	5148.78	1600	11.91	5048.69	1799.6	11.96
5	Denmark	313.116	783.11	9.25	332.121	778.66	9.38	356.88	772.38	9.51	350.1	764.87	9.63	355.184	756.76	9.75

DEVELOPING COUNTRIES

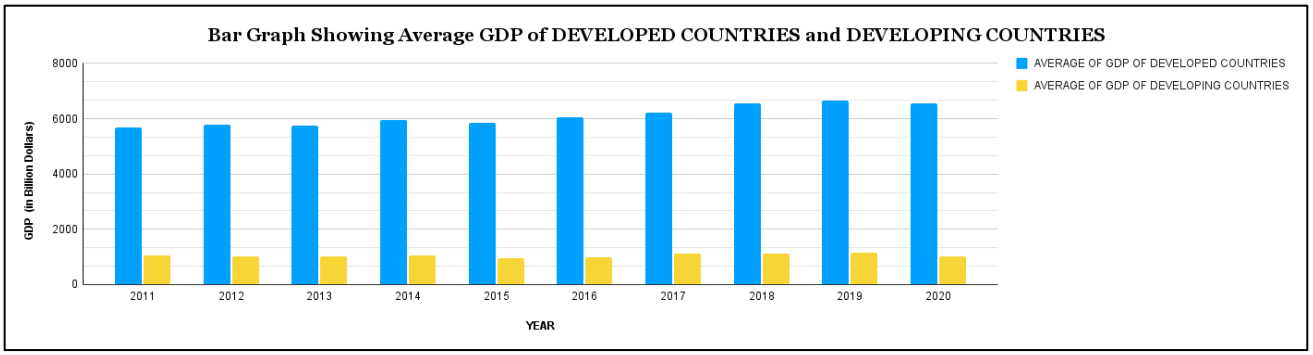
S.NO.	COUNTRIES	2011			2012			2013			2014			2015		
		GDP (in billion dollars)	RAINFALL (in mm)	TEMPERATURE (in degree celsius)	GDP (in billion dollars)	RAINFALL (in mm)	TEMPERATURE (in degree celsius)	GDP (in billion dollars)	RAINFALL (in mm)	TEMPERATURE (in degree celsius)	GDP (in billion dollars)	RAINFALL (in mm)	TEMPERATURE (in degree celsius)	GDP (in billion dollars)	RAINFALL (in mm)	TEMPERATURE (in degree celsius)
1	India	1823.04	1089.24	24.82	1827.63	1018.89	24.77	1856.72	1196.86	24.64	2039.12	999.89	24.77	2103.58	1085.1	24.89
2	South Africa	416.41	541.72	17.98	396.33	462.35	18.21	366.82	420.93	18.3	350.9	450.06	18.51	317.62	368	18.96
3	Bangladesh	128.61	1971.04	25.69	133.3	1992.35	25.2	150.03	2023.31	25.12	172.89	1801.96	25.4	195.15	2543.25	25.25
4	Philippines	234.22	3128.48	25.63	261.92	2764.45	25.93	283.9	2533.23	25.94	297.48	2345.38	25.78	306.45	2249.93	26.02
5	Brazil	2616	1800.59	25.63	2465	1765.94	25.69	2473	1727.72	25.76	2456	1692.62	25.82	1802	1667.3	25.88

DEVELOPING COUNTRIES

S.NO.	COUNTRIES	2016			2017			2018			2019			2020		
		GDP (in billion dollars)	RAINFALL (in mm)	TEMPERATURE (in degree celsius)	GDP (in billion dollars)	RAINFALL (in mm)	TEMPERATURE (in degree celsius)	GDP (in billion dollars)	RAINFALL (in mm)	TEMPERATURE (in degree celsius)	GDP (in billion dollars)	RAINFALL (in mm)	TEMPERATURE (in degree celsius)	GDP (in billion dollars)	RAINFALL (in mm)	TEMPERATURE (in degree celsius)
1	India	2294.79	1065.11	25.27	2651.47	1108.3	25.15	2701.11	974.76	25	2870.5	1244.56	24.94	2622.98	1168.82	24.8
2	South Africa	296.35	425.62	19.07	349.55	426.02	18.61	368.29	384.54	18.74	351.43	383.92	19.36	301.92	462.23	18.55
3	Bangladesh	221.4	2119.78	25.73	249.7	2743.86	25.49	274.04	1823.15	25.1	353	2029.11	25.44	323.06	2476.53	25.23
4	Philippines	318.63	2362.35	26.36	328.48	2928.63	25.91	346.842	2596.05	26.11	376.823	2286.55	26.18	362.24	2332.73	26.3
5	Brazil	1796	1655.86	25.92	2064	1656.27	25.95	1917	1764.38	25.72	1878	1662.23	26.01	1445	1698.89	25.99

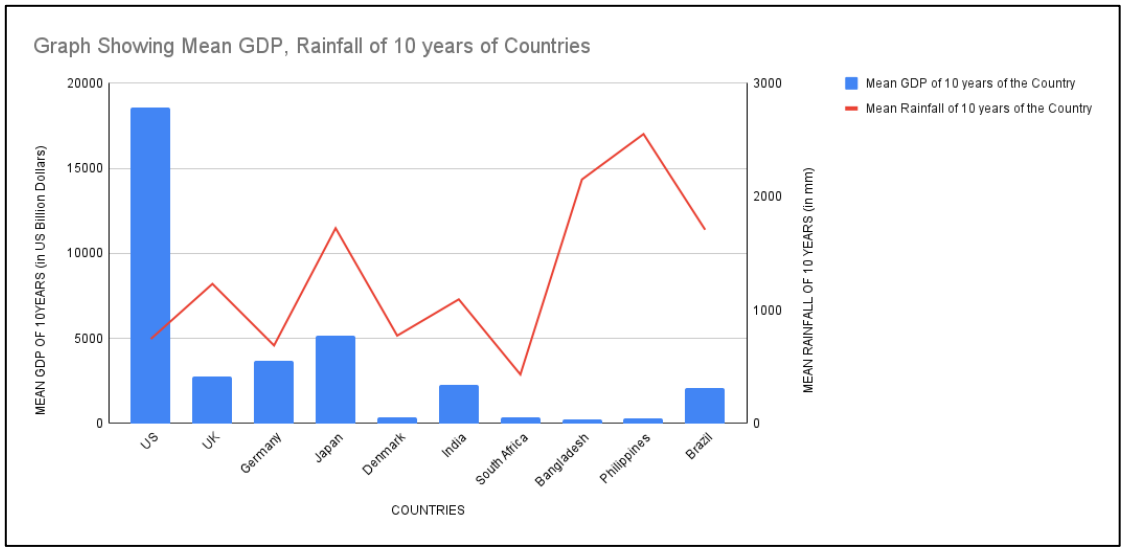
Table 1*

Furthermore, given are few graphs for the analysis of the data.



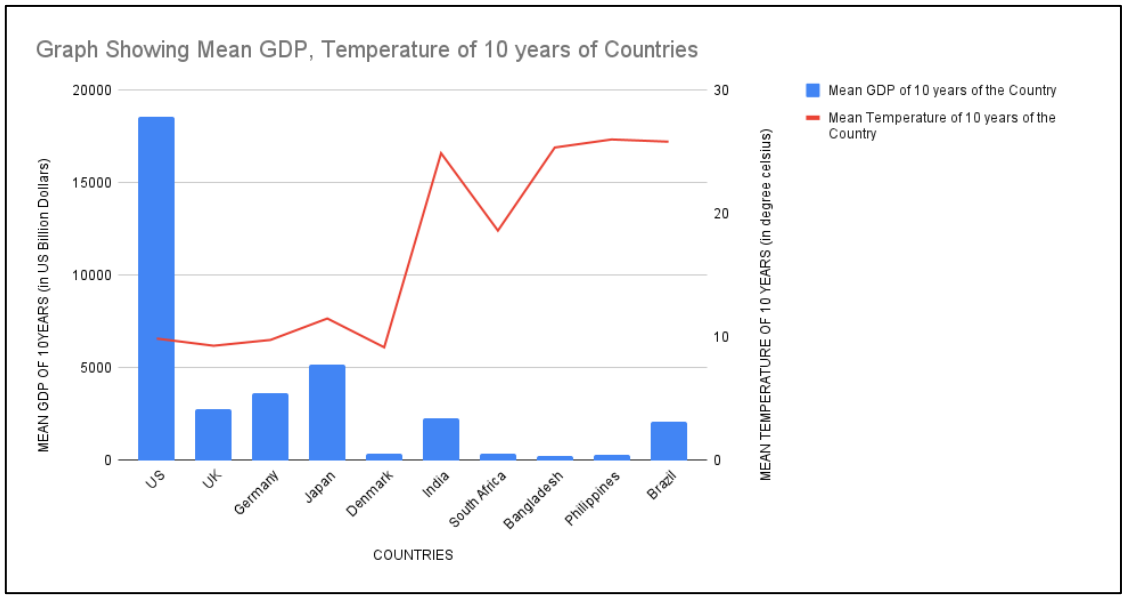
Graph 1

Given above graph shows the visual representation through bar graph of mean GDP of Developed and Developing Countries over a period of 10 years.



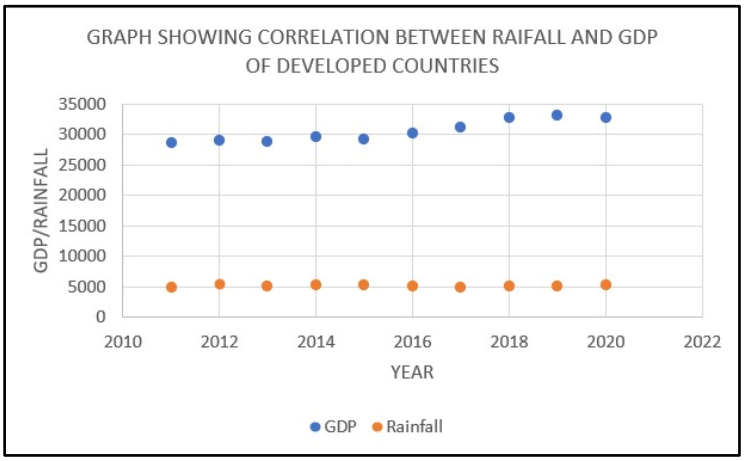
Graph 2

Given above graph shows the visual representation through bars and line of mean GDP and mean Rainfall of Developed and Developing Countries for a period of 10 years.



Graph 3

Given above graph shows the visual representation through bars and line of mean GDP and mean Temperature of Developed and Developing Countries for a period of 10 years.

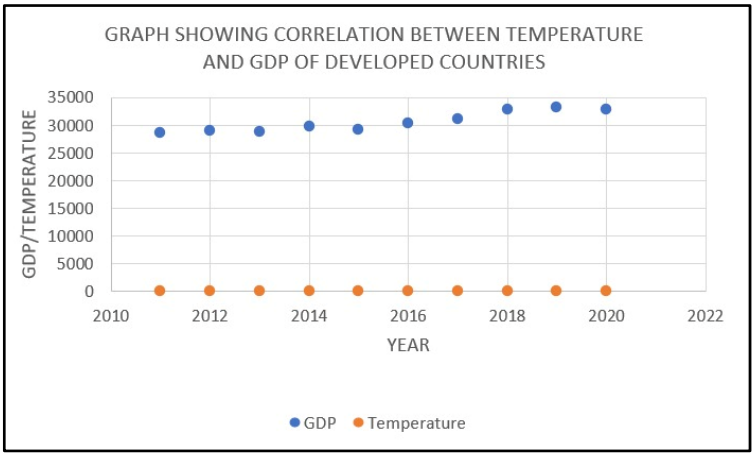


CORRELATION

	GDP	*Rainfall*
GDP	1	
Rainfall	-0.07796	1

Graph 4

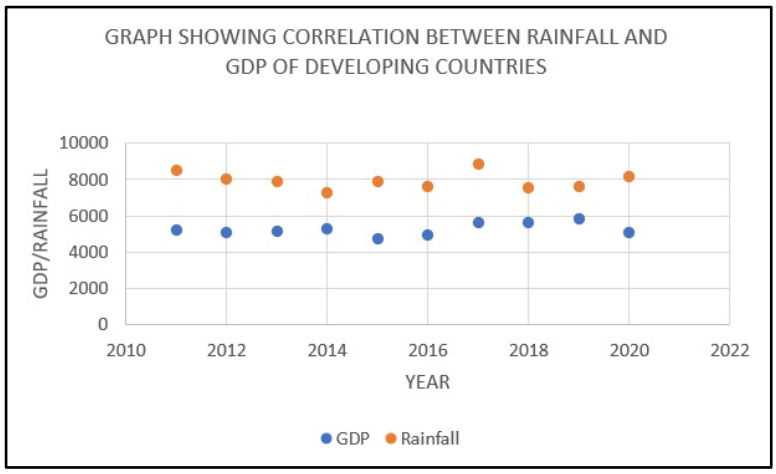
The above scatter plot graph shows correlation between Rainfall and GDP of Developed countries for a period of 10 years.



CORRELATION		
	GDP	*emperature*
GDP	1	
Temperatu	0.822818	1

Graph 5

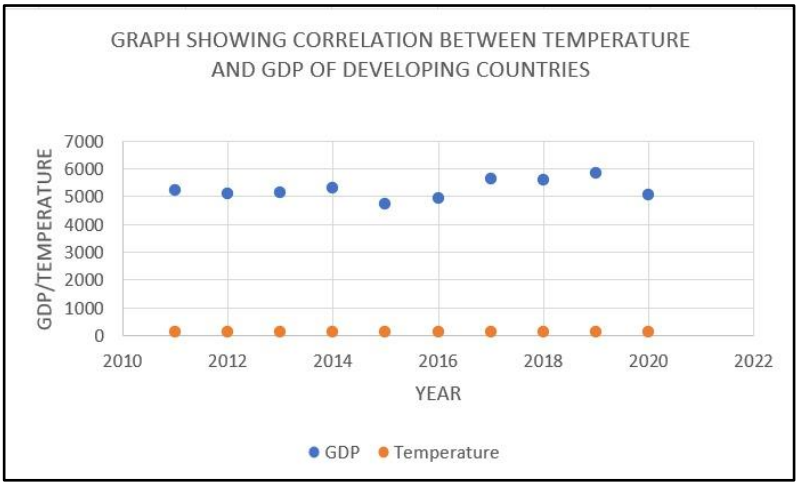
The above scatter plot graph shows correlation between Temperature and GDP of Developed countries for a period of 10 years.



CORRELATION		
	GDP	*Rainfall*
GDP	1	
Rainfall	0.023669294	1

Graph 6

The above scatter plot graph shows correlation between Rainfall and GDP of Developing countries for a period of 10 years.



CORRELATION		
	GDP	*Temperature*
GDP	1	
Temperature	0.143314475	1

Graph 7

The above scatter plot graph shows correlation between Temperature and GDP of Developing countries for a period of 10 years.

Now let's look at the mean, standard deviation and variance of the data.

Table showing data on GDP (in US Billion Dollars) of Developed and Developing Countries for a period of 10 years

	DEVELOPED COUNTRIES	DEVELOPING COUNTRIES
MEAN	6107.90562	1050.7345
STANDARD DEVIATION	6550.021931	969.6750725
VARIANCE (squared)	42902787.29	940269.7463

Source of data on GDP: https://data.worldbank.org/indicator/NY.GDP.MKTP.CD

Table 2a

Table showing data on Rainfall (in mm) of Developed and Developing Countries for a period of 10 years		
	DEVELOPED COUNTRIES	**DEVELOPING COUNTRIES**
MEAN	1032.6496	1588.4168
STANDARD DEVIATION	405.5064384	786.0724779
VARIANCE (squared)	164435.4716	617909.9405
Source of data on GDP: https://climateknowledgeportal.worldbank.org/		

Table 2b

Table showing data on Temperature (in Degrees Celsius) of Developed and Developing Countries for a period of 10 years		
	DEVELOPED COUNTRIES	**DEVELOPING COUNTRIES**
MEAN	9.9258	24.1504
STANDARD DEVIATION	0.942811882	2.826747579
VARIANCE (squared)	0.888894245	7.990501878
Source of data on GDP: https://climateknowledgeportal.worldbank.org/		

Table 2c

INFERENTIAL ANALYSIS

For the inferential analysis of the first objective, we conducted the P-Value Test on the three variables, i.e., GDP, Rainfall and Temperature.

(A)

SUMMARY OUTPUT

Regression Statistics	
Multiple R	0.077964591
R Square	0.006078478
Adjusted R Square	-0.118161713
Standard Error	1923.069077
Observations	10

ANOVA

	df	*SS*	*MS*	*F*	*Significance F*
Regression	1	180934.9545	180934.9545	0.048925	0.83048535
Residual	8	29585557.39	3698194.674		
Total	9	29766492.35			

	Coefficients	Standard Error	t Stat	P-value	Lower 95%	Upper 95%	Lower 95.0%	Upper 95.0%
Intercept	37060.1673	29404.6627	1.260350023	0.243061	-30747.10648	104867.4411	-30747.10648	104867.4411
Rainfall	-1.259408651	5.693775231	-0.22119044	0.830485	-14.38927788	11.87046058	-14.38927788	11.87046058

Null Hypothesis (H_0): There is no significance of Rainfall on GDP of Developed Countries.
Alternate Hypothesis (H_A): There is significance of Rainfall on GDP of Developed Countries.

Hypothesis Testing by P-value Approach:

- We have selected a sample of n = 10, 5% level of significance (i.e., $\alpha = 0.05$) and 95% level of Confidence.
- P-Value is calculated as 0.8304 which means that 83.04% is the minimum value of level of significance at which Null Hypothesis can be rejected.
- According to our research, the level of significance (5%) is **less** than 83.04%. So, we **do not reject** the Null Hypothesis(H_0) and reject the Alternative Hypothesis (H_A).
- We can conclude that our data **does not provide** compelling evidence for concluding that there is significance of Rainfall on GDP of Developed Countries.

(B)

SUMMARY OUTPUT

Regression Statistics	
Multiple R	0.822817932
R Square	0.677029349
Adjusted R Square	0.636658017
Standard Error	1096.226677
Observations	10

ANOVA

	df	*SS*	*MS*	*F*	*Significance F*
Regression	1	20152788.93	20152788.93	16.77005254	0.003460988
Residual	8	9613703.418	1201712.927		
Total	9	29766492.35			

	Coefficients	*Standard Error*	*t Stat*	*P-value*	*Lower 95%*	*Upper 95%*	*Lower 95.0%*	*Upper 95.0%*
Intercept	-16554.66407	11509.67799	-1.438325562	0.188287749	-43096.02912	9986.700977	-43096.02912	9986.700977
Temperature	949.2875571	231.8091512	4.095125461	0.003460988	414.7346959	1483.840418	414.7346959	1483.840418

Null Hypothesis (H_0): There is no significance of Temperature on GDP of Developed Countries.
Alternate Hypothesis (H_A): There is significance of Temperature on GDP of Developed Countries.

Hypothesis Testing by P-value Approach:

- We have selected a sample of n = 10, 5% level of significance (i.e., $\alpha = 0.05$) and 95% level of Confidence.
- P-Value is calculated as 0.0034 which means that 0.34% is the minimum value of level of significance at which Null Hypothesis can be rejected.
- According to our research, the level of significance (5%) is **more** than 0.34%. So, we have to **reject** the Null Hypothesis(H_0) and do not reject the Alternative Hypothesis (H_A).
- We can conclude that our data **does provide** compelling evidence for concluding that there is significance of Temperature on GDP of Developed Countries.

(C)

SUMMARY OUTPUT

Regression Statistics	
Multiple R	0.023669294
R Square	0.000560235
Adjusted R Square	-0.124369735
Standard Error	504.3181376
Observations	10

ANOVA

	df	*SS*	*MS*	*F*	*Significance F*
Regression	1	1140.546927	1140.547	0.004484396	0.948252416
Residual	8	2034694.271	254336.8		
Total	9	2035834.818			

	Coefficients	*Standard Error*	*t Stat*	*P-value*	*Lower 95%*	*Upper 95%*	*Lower 95.0%*	*Upper 95.0%*
Intercept	7771.625633	2550.451321	3.047157	0.015889518	1890.274339	13652.97693	1890.274339	13652.97693
Rainfall	0.032445564	0.484510659	0.066966	0.948252416	-1.084838019	1.149729147	-1.084838019	1.149729147

Null Hypothesis (H_0): There is no significance of Rainfall on GDP of Developing Countries.
Alternate Hypothesis (H_A): There is significance of Rainfall on GDP of Developing Countries.

Hypothesis Testing by P-value Approach:

- We have selected a sample of n = 10, 5% level of significance (i.e., $\alpha = 0.05$) and 95% level of Confidence.
- P-Value is calculated as 0.9482 which means that 94.82% is the minimum value of level of significance at which Null Hypothesis can be rejected.
- According to our research, the level of significance (5%) is **less** than 94.82%. So, we **do not reject** the Null Hypothesis(H_0) and reject the Alternative Hypothesis (H_A).
- We can conclude that our data **does not provide** compelling evidence for concluding that there is significance of Rainfall on GDP of Developing Countries.

(D)

SUMMARY OUTPUT

Regression Statistics	
Multiple R	0.143314475
R Square	0.020539039
Adjusted R Square	-0.101893581
Standard Error	0.943362779
Observations	10

ANOVA

	df	*SS*	*MS*	*F*	*Significance F*
Regression	1	0.149293343	0.149293343	0.167757896	0.69285962
Residual	8	7.119466657	0.889933332		
Total	9	7.26876			

	Coefficients	*Standard Error*	*t Stat*	*P-value*	*Lower 95%*	*Upper 95%*	*Lower 95.0%*	*Upper 95.0%*
Intercept	118.8017874	4.770799751	24.90185997	7.23303E-09	107.8003034	129.8032713	107.8003034	129.8032713
Temperature	0.000371209	0.000906311	0.409582588	0.69285962	-0.001718749	0.002461167	-0.001718749	0.002461167

Null Hypothesis (H_0): There is no significance of Temperature on GDP of Developing Countries.

Alternate Hypothesis (H_A): There is significance of Temperature on GDP of Developing Countries.

Hypothesis Testing by P-value Approach:

- We have selected a sample of n = 10, 5% level of significance (i.e., $\alpha = 0.05$) and 95% level of Confidence.
- P-Value is calculated as 0.6928 which means that 69.28% is the minimum value of level of significance at which Null Hypothesis can be rejected.
- According to our research, the level of significance (5%) is **less** than 69.28%. So, we **do not reject** the Null Hypothesis(H_0) and reject the Alternative Hypothesis (H_A).
- We can conclude that our data **does not provide** compelling evidence for concluding that there is significance of Temperature on GDP of Developing Countries.

4.2 ANALYSIS OF OBJECTIVE 2

OBJECTIVE 2: TO STUDY THE POLICY RESPONSES OF THE GOVERNMENT OF INDIA

The growing concern for Climate Change made it mandatory for the Government of India to take measures to manage the issue. The Government launched the National Action Plan for Climate Change NAPCC in 2008 to combat climate change. The plan aims at achieving economic growth by taking the emission intensity of its economy into account. There are 8 sub-missions under NAPCC. These are:

- National Solar Mission
- National Mission for Enhanced Energy Efficiency
- National Mission on Sustainable Habitat
- National Water Mission
- National Mission for Sustaining Himalayan Ecosystem
- Green India Mission
- National Mission for Sustainable Agriculture
- National Mission on Strategic Knowledge for Climate Change

NATIONAL SOLAR MISSION

The National Solar Mission was launched as Jawaharlal Nehru National Solar Mission in 2010. Although the mission was launched with a target of producing 20,000 Megawatts of solar power in three phases, the target was revised in 2015 to 100,000 Megawatts to be achieved by 2022. The Ministry of New and Renewable Energy set up targets of producing solar power through 'Rooftop Solar Power Projects' and other large and medium-scale grid-connected solar power projects.

To undertake projects, the Government planned to leverage the funding from bilateral donors like Green Climate Fund under United Nations Framework

Convention on Climate Change (UNFCCC), as the solar power production could reduce greenhouse gas emissions from coal-based power plants. In 2019, at the United Nations Secretary General's Climate Action Summit, Prime Minister Narendra Modi announced the target of 175 GW renewable energy production to be extended beyond its ceiling to reach an ambitious target of 450 GW by 2022. To fulfil the targets set up under the mission, the Government launched several schemes in order to promote solar power and reduce dependency on the traditional power sources. One such scheme called Kisan Urja Suraksha Evam Uthhan Mahabhiyan (KUSUM) was approved by the Cabinet Committee on Economic affairs in 2019. The program aims to install off-grid solar pumps in rural areas and reduce dependence on the grid in grid-connected areas.

NATIONAL MISSION FOR ENHANCED ENERGY EFFICIENCY (NMEEE)

Having 4 main components, namely,

- Perform, Achieve, and Trade
- Energy Efficiency Financing Platform
- Market Transformation for Energy Efficiency (MTEE)
- Framework For Energy Efficiency Economic Development

NMEEE plans sustainable economic growth along with a reduction in energy and carbon intensity of the economy.

Under this scheme, the Government launched Bachat Lamp Yojna to replace incandescent lamps with CFL bulbs. The "Bachat Lamp Yojna" was later replaced by the "Unnat Jyoti Affordable LED for All" (UJALA) scheme in 2015 in which LED bulbs were distributed to replace the comparatively more efficient CFL bulbs. The Government also launched "Super Efficient Equipment Program", supported by the World Bank and implemented by Bureau of Energy Efficiency, aimed at transferring assistance from the World Bank to the energy

equipment manufacturers to enable them to produce products that consume less electricity.

In order to hedge the financial institutions providing loans for the energy efficiency projects against credit risks, the Bureau of Energy Efficiency has also institutionalized two funds - "Partial Risk Guarantee Fund for Energy Efficiency" and "Venture Capital Fund for Energy Efficiency".

NATIONAL MISSION ON SUSTAINABLE HABITAT

The transport sector along with urban buildings are major consumers of energy in India apart from the electricity production sector. The National Mission on Sustainable Habitat is an umbrella programme to reduce energy consumption and hence the risk of climate change due to the urban settlement pattern. The mission envisages a shift to the Energy Conservation Building Code (ECBC) in the design of new commercial buildings as well as waste management. It also covers water resource management and paving the way for a shift to public transport.

NATIONAL WATER MISSION

National Water Mission is a comprehensive programme for equitable distribution of water across the country as well as for enhancing the capacity-building process for the management of overexploited blocs. It is focused upon tackling the issues related to water availability and pollution which is owed to global warming and climate change. The mission promotes research and development, and timely review of National Water Policy. The mission while promoting the traditional water conservation system also promotes the expeditious implementation of multipurpose water projects. It has a target of increasing water use efficiency by 20%. The convergence of various water conservation schemes for a better outcome and implementation of water resource

management programs via the MNREGA route with the participation of the elected representatives of the overexploited water blocs is the central theme of the mission. The National Water Mission also has an identified goal of putting a comprehensive water resource database in the public domain, onus of which lies with the Ministry of Jal Shakti.

NATIONAL MISSION FOR SUSTAINABLE HIMALAYAN ECOSYSTEM

The Himalayas are one of the most important ecosystems of India with millions of people depending upon it. The adverse impact of climate change has remained detrimental to the Himalayan Ecosystem. The National Mission for Sustainable Himalayan Ecosystem has a multi-pronged approach to understanding the impact of climate change on the Himalayan Ecosystem for the Sustainable Development of other parts of the country. One of the primary objectives of the mission is to assess the health of the Himalayan Ecosystem, for which the scheme was released with an outlay of Rs.550 Crores during the 12th "Five Years Plan" period.

GREEN INDIA MISSION

The Green India Mission is aimed at protecting, restoring, and enhancing India's green cover in response to climate change. The mission has a cumulative target of increasing forest cover on 5 million hectares of land while improving the forest cover on additional 5 hectares. The mission also has a target of providing livelihood to 3 million people through forest-based activities and enhancing the provisioning capacity of the Indian forests along with their carbon sequestration capacity. The scheme also has an important goal of fulfilling India's *Nationally Determined Contribution (NDC)* target of sequestering 2.5 billion tonnes of "Carbon emissions" by 2020-30, which is submitted to UNFCCC. Massive plantation drives have taken place in Uttar Pradesh, Madhya Pradesh, and

Maharashtra, but due to ineffective execution, these drives haven't been much successful, but officials and institutions are coming with new ideas like the "One Tree My Duty" by Ek Kadam Sansthan for this mission.

NATIONAL MISSION FOR SUSTAINABLE AGRICULTURE (NMSA)

The National Mission for Sustainable Agriculture includes multiple programmes for the sustainable growth of agriculture sector. It includes interventions like Soil Health Card Scheme, Paramparagat Krishi Vikas Yojana, Mission organic value chain development for North-East region, Rainfed Area Development program, National Bamboo Mission, and Sub Mission on Agroforestry. These programs along with others like "Pradhan Mantri Krishi Sinchai Yojana" are aiming to promote the judicious use of natural resources.

NATIONAL MISSION ON STRATEGIC KNOWLEDGE FOR CLIMATE CHANGE

This sub-mission involves the formation of knowledge networks among the existing knowledge institutions involved in research and development relating to climate science and facilitating data sharing and exchange through a suitable policy framework and institutional support.

Not only the above schemes, but the Government, both National and State, take measures to aid in controlling damage to the environment. Battery powered rickshaws, odd-even schemes, awareness campaigns, reusable and recyclable products, are few examples of such measures launched by the Government.

Not only these, checking up on a few details and facts,

India's greenhouse gas (GHG) emission intensity target is to reduce its GHG emissions intensity by 33-35% in 2030, based on 2005 levels (United Nations Framework Convention on Climate Change (UNFCCC), 2009). Hence, one indicator of India's progress in meeting the goal is the reduction in GHG emissions intensity achieved since 2005. According to estimates from country-reported data India achieved a 21% reduction in GHG emissions intensity in 2014 compared to 2005.

Meanwhile, Indian officials say they will meet two major pledges under the Paris agreement on climate change ahead of schedule. India has promised to ensure that 40 percent of its electricity-generation capacity comes from non-fossil fuel sources by 2030. It will also reduce its “emissions intensity” — a ratio of total emissions to gross domestic product — by at least one-third compared with 2005 levels. India has increased its solar-energy capacity more than twelvefold since 2014 and launched initiatives to save electricity.

Hence, we can conclude by saying that the Indian Government is taking a lot of measures to combat Climate Change alongside maintaining its economic growth. But these measures are not enough unless and until the goals are achieved as planned and the measures are continued to be taken by the government and the people.

CHAPTER 5: CONCLUSIONS, RECOMMENDATIONS AND LIMITATIONS

5.1 KEY FINDINGS OF THE RESEARCH

- In all the cases, the null hypothesis (H_o) is assumed that a particular parameter does not have a significance on the GDP of the country.

  In case of developed countries, the rainfall data shows that the P-value which is calculated as 0.83(83%) is more than the level of significance which we have kept as 5%. Therefore, by the rule of P-value test we do not reject the null hypothesis because the result came out to be insignificant. But if we consider the case of temperature variable under developed countries, the data shows that the P-value which is calculated as 0.0034 (0.34%) is less than the level of significance which we have kept as 5%. Therefore, we can reject the null hypothesis in this case and can clearly state that Temperature has a significant impact on the GDP of Developed Countries.

  In case of developing countries, the rainfall data shows that the P-value which is calculated as 0.94 (94%) is more than the level of significance which we have kept as 5% in our research. Therefore, by P-value test, we do not reject the null hypothesis because the result came out to be insignificant. Similarly, in case of temperature variable under developing countries, the data shows that the P-value is calculated as 0.69 (69%) which is clearly more than our level of significance of 5%. Therefore, we do not reject the null hypothesis in this case as well.

- We have described our data set through the graphs and charts and tables under descriptive analysis. Table 1 shows the data of the three variables- GDP, Rainfall and Temperature, and the data on the given developed and developed countries from 2011 to 2020.

  Graph 1 shows a comparison of average GDPs of Developed and Developing Countries from 2011 to 2020. Graph 2 shows the trend of mean GDP and

Rainfall in these countries from 2011 to 2020. Similarly, Graph 3 shows the trend of mean GDP and Temperature in these countries from 2011 to 2020. Graphs 4, 5, 6, and 7 shows the correlation between GDP, and Rainfall and Temperature of Developed and Developing countries in these 10 years. The strong correlation values show that Temperature has a significant impact on GDP of Developed Countries. Whereas, we observe a weak correlation between Rainfall and GDP and hence, it shows that Rainfall does not have significant impact on GDP in 10 years. Also, we see a weak correlation between Temperature and GDP of Developing Countries, which shows that there is no significant impact of Temperature on GDP for Developing Countries.

Tables 2a, 2b, and 2c shows the statistics about mean, standard deviation and variance of these countries over 10 years. We observe that Mean GDP of Developed Countries is greater than Developing Countries. Through these tables, we observe that GDP of Developed and Developing countries have high variance which indicates that GDP values are very spread out from their mean and from one another. We also observe that Rainfall of Developed and Developing countries have high variance which indicates that Rainfall values are very spread out from their mean and from one another. Further, we observe that Temperature of Developed and Developing countries have a small variance which indicate that the temperature values tend to be very close to their mean and to each other.

- Under the objective 2 analysis, as mentioned before under the head, we observe that although the government took many steps to curb climate change, it still remains a threat to the economy. The government need to take further steps and ensure their proper implementation and citizens of India need to take steps at their end to preserve the climate and the economy.

5.2 LIMITATIONS OF RESEARCH

There are certain limitations to our research study. They are as follows:

1. The research is limited to only 5 developed and 5 developing countries. This limits our data and restricts our findings to these 10 countries only.
2. The research has been conducted for a period of 10 years from 2011-2020. Climate Change occurs over centuries, hence due to lack of data availability, the research is restricted to 10 years only.
3. The other factor that could be taken into consideration is the paucity of time to conduct the research.
4. The 2nd objective has only been restricted to India. The other countries have not been included due to the unavailability of data from a few countries.
5. We have taken 5% level of significance in all the four cases while conducting the P-Value Test for Inferential Analysis. There might have been different conclusions if we take level of significance according to the P-Values in all the cases.

5.3 RECOMMENDATIONS

- Recommendations for Researchers:

  We would like to recommend to further researchers to conduct on a large data set in order to properly study the impact of climate change on economies of the world. This project is limited to 10 countries, developed and developing, and analyses the data of 10 years which doesn't show the long-term impact of economies over a hundred years.

- Recommendations for the Governments:

  The governments should consider the climate change as a great threat to their economies. They should take proper measures, domestically and

internationally, to control the climate change and hence protect their economies and people. Governments should also encourage their citizens to take climate friendly measures.

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KEYNOTE

Table 1*: The table has been placed vertically due to spatial issues.