Impact of COVID 19 on Bangladesh's Environment and Climate Change Trajectory and SDGs Goals

By

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Declaration:

It is herewith declared that,

1. The thesis I am submitting which is a requirement to complete MDS degree, is my authentic work.

2. I have acknowledged the main source of knowledge is every step of the paper.

3. Apart from properly cited through comprehensive and correct referencing, the thesis does not accommodate any information already published or written by a third party.

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Approval

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Ethics Statement

I have carefully considered the ethics of conducting secondary research or data gathering in the arenas of environment and economy and incorporated my assessments of these data and the lacking. I have followed the ethical instructions of the ESRC Ethics Framework as well as the Association of Internet Researchers.

All the data I have collected mostly came from secondary sources from journals, newspapers, internet articles, websites, etc. Thanks to my Supervisor, Dr. Rohini Kamal helped to gather data from well-known and authorized sources with recent information.

I have cited all the sources used in the paper as well as refeed in the bibliography section properly. Further, I have avoided plagiarism and the contents of the paper have not been published in any other media or platform.

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Executive Summary

Human activities have long impacted the earth's environment and climate. Whereas environmental impacts have been a part of policy concern for some decades, climate change (CC) concerns are a more recent phenomenon and have in recent years become the defining issue for humanity. The recent pandemic of COVID 19 has clarified how fragile the world is right now in terms of the environment and economy. This paper tries to tackle the burning question of how has COVID 19 impacted Bangladesh's environmental and climate change trajectory, especially in terms of our SDG goals. In the past two years, another crisis in the form of Covid 19 has dominated our news.

For developing countries like Bangladesh, how has Covid 19 impacted the country's environmental and climate change trajectory? In this thesis, I attempt to first assess what are the pathways through which Covid 19 pandemic can impact the environment and climate change. What do theories tell us about the possible direction of impacts? Then I assess if there has been an impact of Covid 19 on Bangladesh's environment and climate change trajectory. Furthermore, more importantly, how can Bangladesh properly prepare for a twin crisis? Given that we are facing a dual disaster of Climate change and the Covid pandemic, which is the most serious issue of our time. In doing so I wish to identify recommendations for the future to better prepare for the dual crisis of Covid 19 and climate change.

To answer the questions, the paper looks into the data pool of environment and CC of the country to assess the impact, build a bridge with the economy or assess the available pathway of the impacts of CC and economy with the pandemic. Therefore, the paper first analyzes the 20-year data of the environment and CC with the performance of the economy. Environmental pollution is usually an added pollutant to the natural environment, whereas climate change is a shift in climatic pattern and so has a more complicated and less visible set of contributing causes. We understand that COVID is a financial shock for developing countries. As Bangladesh is still the least developing country (LDC) it needs more time to get back on its feet compared to most countries.

Thus, I look into anthropogenic impacts massive on the environment. The pollution has caused disruptions in the general reformation state of the earth and caused more heat by several harmful gases. These gases have damaged the ozone layer, severe damage in health for the animals and humans as well as the scarcity of resources by eliminating the natural producers. We see that a few key factors are impacting Bangladesh's environment and climate change trajectory. The first is

economic activity. Without any policies such as taxation of polluting industries, or regulation, increased economic activity is associated with increased production of pollutants.

The lead theories include- Environmental Kuznets Curve (EKC), depicting the inverse relationship of economic activities and environment, and the theory of Externality, talking about the social benefit of one polluter's actions. An economic theory such as the EKC posits this to be true for developing countries such as Bangladesh. EKC theory predicts that as a country develops further and per capita income rises beyond a certain level that the extra income will then go into improving the environment. Thus, after a certain level of development pollution will go down. For Bangladesh though, given the level of development, the prediction is that pollution will increase with economic activity. With the interruption in economic activities brought about by the pandemic we see less pollution is some of the indicators, but more pollution in others from medical waste.

Looking globally, while we see this is the relation predicted by EKC to be true for some pollutants and some countries, for climate change the polluting factors are greenhouse gas emissions, which are highest for developed countries. Moreover, a reduction in pollution in developed countries has also come about through moving the polluting industry overseas, usually to developing nations. The findings indicate there is no simple relation, but rather point to the importance of policy. Then the paper looks into the available major agreements of the country on the global platform and the local laws regarding CC and the environment. The hypothesis of the paper consists of a visible relationship of the pandemic with the economy and climate change.

I look into the variables of Air Pollution, Water Pollution, Green House Gases, and Resource Constraints. Among these variables, the thesis selects a few sub-variables that are suitable for the study. Then the hypothesis is tested by establishing the trend in environment and CC in Bangladesh. The paper finds the hypothesis is partially true for the country as there are mixed results. Some sub-variables have no change, some positive and some negative. The paper next explains why there are mixed results. In explaining why there are mixed results, we hope to illustrate what we can do in the future.

The first chapter introduces the environmental impacts I am assessing in the thesis, with a particular background on the new challenge of climate change. The second chapter looks at the pathways through which Covid 19 pandemic could impact a country’s environment and climate

change trajectory. Covid 19 had brought about a halt in economic activities in Bangladesh. Therefore, the main pathway of impact has been through the interruption of economic activities. I thus review theories linking economic activities and the environment, including climate change. I then look at the impact of environmental policies particularly with the advent of the Sustainable Development Goals. In the next chapter, I present the variables that capture Bangladesh's environment and climate change trajectory. Then I present the findings of how this trajectory has been impacted by the pandemic and different policies.

I find that the pandemic impacted the country's trajectory in environment and climate change through firstly the economic slowdown, secondly increased medical waste, thirdly lack of funds and human resources to tackle issues such as increased medical waste. Moreover, proper regulation around waste and emissions, along with implementation plays a big role. I conclude with a discussion on the findings and put forth future recommendations, highlighting available mechanisms through which to do so, as included in economic theory and international policies.

Moreover, the paper discusses the SDG achievements in terms of CC and environment with gaps and ways of filling these gaps. The paper concludes by examining the nature of the two issues of CC or environment and COVID, physical resources, and policy reformations. By reviewing the laws and agreements the paper dictates the impact of COVID on the resources of the country as the country lacks human resources. Sudden health crisis made the country vulnerable to any shock and thus the country ended up in a big pit of poverty with an ever-growing environmental crisis. Going forward the paper ends with solutions that are based on development economic framework such as polluters pay principle, internalizing externalities, increasing funds for local eco-friendly products, and investments in research for eco-friendly innovations.

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List of Acronyms

AC	**Air Conditioning**
ADB	Asian Development Bank
ADP	Annual Development Programs
AOSIS	Alliance of Small Island States
AQI	Air Quality Index
BNAAQS	Bangladesh National Ambient Air Quality Standard
BBS	Bangladesh Bureau of Statistics
BCCRF	Bangladesh Climate Change Resilience Fund
BCCSAP	Bangladesh Climate Change Strategies and Action Plan
BCCTF	Bangladesh Climate Change Trust Fund
BSEF	Bangladesh Environmental Statistics Framework
BFDES	Bangladesh Framework for Development Environment Statistics
BGMEA	Bangladesh Garment Manufacturers and Exporters Association
BPA	Bisphenol A
CC	Climate Change
CFC	Chloro-Fluoro-Carbons
CIMMYT	International Maize and Wheat Improvement Center
CO	Carbon Monoxide
COP	Conference of Parties
COVID 19	Coronavirus disease 2019
CTC	Carbon tetrachloride
DG	Director General
DNCC	Dhaka North City Corporation
DOE	Department of Environment
DSCC	Dhaka South City Corporation
ECA	Environment Conservation Act

ECDS	Emergency Care Data Set
ECNEC	Executive Committee of the National Economic Council
EEA	European Environmental Agency
EIA	Environmental Impact Assessment
EKC	Environmental Kuznetz Curve
ESDO	Environment and Social Development Organization
ESRC	Economic and Social Research Council
FAO	Food and Agriculture Organization
FYP	Five Year Plan
GDP	Gross Domestic Product
GED	General economic Division
GHG	Green House Gas
GNI	Gross National Income
HCFC	Hydrochlorofluorocarbons
HFC	Hydrofluorocarbon
IMF	International Monetary Fund
IPCC	Intergovernmental Panel on Climate Change
MOEF	Ministry of Environment, Forest and Climate Change
MT	Metric Ton
NAP	National Action Plan
NAPA	National Action Plan on Adaptation
NASA	National Aeronautics and Space Administration
NCC	Narayanganj City Corporation
NDC	Nationally Determined Contributions
NO	Nitric Oxide

NSDS	National Sustainable Development Strategy
ODP	Ozone Depletion Potential
ODS	Ozone Depleting Substances
PFC	Perfluorocarbons
PM	Particle Matter
PMF	Positive Matrix Factorization
POP	Persistent Organic Pollutants
PPE	Personal Protective Equipment
PPP	Polluters Pay Policy
PRDI	Partnership for Responsible Drug Information
PVC	Polyvinyl chloride
SDG	Sustainable Development Goals
SLCP	Short-Lived Climate Pollutants
UN	United Nations
UNDP	United Nations Development Programme
UNEP	United Nations Environment Programme
UNFCCC	United Nations Framework Convention on Climate Change
UNGA	United Nations General Assembly
USD	United States dollar
USEPA	United States Environmental Protection Agency
USGBC	U.S. Green Building Council
VGF	Vulnerable Group Feeding
WB	World Bank
WHO	World Health Organization
WRI	World Resources Institute

Chapter 1:

Introduction

Industrialization has led to impacts on the environment and climate change. Environmental impacts are usually thought to include the localized and more immediate impact on the environment through an additive pollutant. This could be noxious fumes from cars and factories in the air or pesticide runoff to water bodies. Climate change on the other hand is a change in the climate patterns impacting the entire plant, due to emissions of certain gasses known as a greenhouse gas which can remain in the atmosphere for centuries.

The climate is generally described as the average weather in a certain location, considering a few factors such as temperature, humidity, precipitation, and windiness. Climate is the average condition and variability of these features throughout time. Thus, it is always varying from time to time in the specific region. Other aspects of Earth, such as oceans, ice masses (including sea ice and glaciers), land surfaces, and flora, influence and are linked to the atmosphere (Jackson, 2021). They form an interconnected Earth system, in which all components interact and impact one another in a variety of ways. When the climate changes these components also change in a complex measured way although in a natural way. However, when human-made reasons intervene in the climate these components or the earth system get disrupted and cause non-preferring situations for the environment as well as the climate to change again.

Climate change (CC) has become the most recent crisis of the entire world as the consequences of it are being faced severely thought out the entire world. It is the result of global warming and human-made high emissions due to industrialization. The world is getting warmer day by day as the average temperature is increasing around 2°F in the last decades. Although the change seems very little it has greater impacts on our environment. Losing ice sheets leading towards water level rise in the seas in some places, and lengthy with intense heat waves are some of the massive outcomes that experts anticipated would occur as a result of global climate change (NASA, 2021). Many scientists are assertive that human activities are responsible for the increase in GHG emissions which is the major contributor to global temperature rise and it is going to climb more. As the glaciers are melting in Switzerland in Mount Titlis, the scientists are saying it will give rise to several diseases which might be dangerous than COVID 19.

These melting glaciers are creating a vast flow of water which will result in floods in many countries as well as the ecology will be damaged. By the 2080s, Bangladesh's southern area is expected to lose 40% of its productive land due to a 65cm rise in sea level (Islam, n.d.). Further, flood regions might expand by more than 29% if the temperature rises by 2.5°C. If a one-meter sea-level rise, Bangladesh might lose approximately 15% of its land area to the sea, and about 30 million people residing in Bangladesh's coastal districts could be displaced. CC will have an impact on a variety of sectors in Bangladesh, including groundwater, human health, agricultural production, food security, coastal zones, ecosystems, and biodiversity. Climate change will exacerbate many environmental and developmental issues.

Since the beginning of the industrial revolution, gas emissions that influence climate change have increased. Emission levels have come to a point where climate-related tangible repercussions will be seen on a broad case soon (Alves et al 2017). As a result of the disruptions, it can strangle development and progress as well as become a major source of issues for organizations and food security and cause damage to essential infrastructures. Due to high air pollution, the average age of India has been reduced to 9 years, found in a recent study (Somoy tv, 2021).

To explain climate change, the theory of Milanovic and Climate Balance models are used as natural causes, however, for this study the human-made causes or anthropogenic causes are significant. The theory of Externality and Environment Kuznets Curve (EKC) show how human activities are connected to climate change through economic growth. Although these theories are applicable for many countries for Bangladesh the natural theories are much more applicable as the amount of emission and pollution is very low while the country faces climate problems due to the developed nations and their exploitation of developing countries.

Recently the world leaders have realized the urgency of a greener economy and sustainability as the environment is getting worse, as well as the natural resources, are being depleted. Sustainable Development and Climate Laws and Agreements are the remedies of climate change. According to Brundtland (1987), Sustainable Development refers to, “Our Common Future as ‘development that meets the needs of the present without compromising the ability of future generations to meet their own needs”. Sustainable development is crucial for Bangladesh as it promises to reduce poverty, better the environment, and provide a peaceful and livable atmosphere for every country.

SDG has 17 goals focusing on five p- people, place, planet, prosperity, and peace. For this paper SDG goals 9, 11, 12, 13, 14, 15 are significant as these are related to CC and the environment.

The hypothesis of this study touches on the impact of COVID 19 on CC and the economic development of Bangladesh through examining the available data. This paper tries to compute the impact on the economic development through CC in Bangladesh by analyzing the trajectory of 20 years. Further, I examine the climate agreement and laws made by the country as they can play a crucial role in the trajectory, and suggest future direction. Bangladesh ratified many environmental agreements and among UNFCCC (1992), the Montreal Protocol in 1990 and Copenhagen Amendment was signed in 1996 after the London Amendment was adopted in 1994 and Kyoto Protocol to the UNFCCC in 1997 (United Nations Commission on Sustainable Development, 1997). The last United Nations Conference of the Parties (COP-21) in Paris demonstrated global leaders' cooperative movement to set objectives to cut CO2 emissions to tackle climate change (Huq & Ayres, 2008). This has the ability to have an impact on organizational strategy and practice.

However, the agreements have been signed but the activities and promises are not implemented much in the country. While the existing local laws such as Bangladesh Climate Change Strategies and Action Plan (BCCSAP), Bangladesh National Action Plan (NAP) for Reducing Short-Lived Climate Pollutants (SLCPs), and The Environment Court Act are prominent. Secondary sources are the main source of data for the paper where the paper tries to conduct the study through both quantitative and qualitative methods. The paper also tries to analyze the Sustainable Development Goals (SDG) success with the national climate laws while incorporating other policies such as Polluters Pay Policy (PPP) and Low Emissions Analysis Platform (LEAP). Besides, the study tries to look into the available pool of studies while describing the significance of it- investigation of climate shifts, development or alteration of laws, and learnings from developed countries.

Bangladesh has to take necessary actions to approach the effects of CC as well as prevent it with the application of many policies and conservation methods related to the SDG goals and their indicators while keeping the impacts of COVID 19 ahead as it may be the most significant reason of present climate change. The shocks of COVID 19 are very complex as it is taking a toll on human life but in some places flourishing the environment. It has put a halt in daily life for humans by restricting economic activities- causing low emissions and pollution. Although, in some parts

of the world the activities have risen to overcome economic shocks and heavy pollution like China. Thus, the impact of this pandemic is ambiguous and the study tries to reveal the situation of Bangladesh through available data. There is a higher possibility that such outbreaks might also occur in the future due to environmental exploitation and damage to human life in a broader measure. The country must be able to integrate all spectrums of CC into its provision and implementation of necessary measures to the citizens and ecosystems if it is to accomplish its aim of graduating from a poor country by 2021 and a rich country by 2041. This would be a progressive and significant step forward for Bangladesh in achieving its SDG goals in an emerging SDG world.

1.1: Purpose

A core purpose of the study is to scrutinize the trajectory of CC with the positive and negative impact of COVID 19 in terms of sustainable growth actions. Then, the study tries to fill up the gaps in understanding the climate policies and will align the policies with the SDG goals (SDG goals related to climate). Lastly, to identify the possible solutions or indicate improvement areas in connection with the conservation of the environment and environmental policies to stimulate the overall development happening in the country.

1.2: Objectives

- To aggregate the data of CC in Bangladesh (last 20 years)
- Describing the economic impact on climate change
- Finding the pros and cons of COVID 19 on CC and the impact on economic development
- Through compare and evaluation, pinpoint the actual climate achievements of Bangladesh in SDG
- Gathering and comparing data to establish the hypothesis
- Opening new opportunities for a sustainable environment: implementation of Polluters Pay Policy (PPP), Low Emissions Analysis Platform (LEAP), Green growth, BCCSAP, Clean Air ACT, etc.

1.3: Significance

The study tries to build a bridge between the economic growth of Bangladesh with climate change trajectory, the impact of COVID 19, and the alignment of SDG achievement through the

implication of better policies. Although, the study tries to expand knowledge through the interlinkages between theories but aims to look into available resources to evaluate their significance so that new policies must take place with the inclusion in the constitution and establishment and execution of sustainable environmental policies from the experience of developed countries.

Chapter 2:

Literature Review

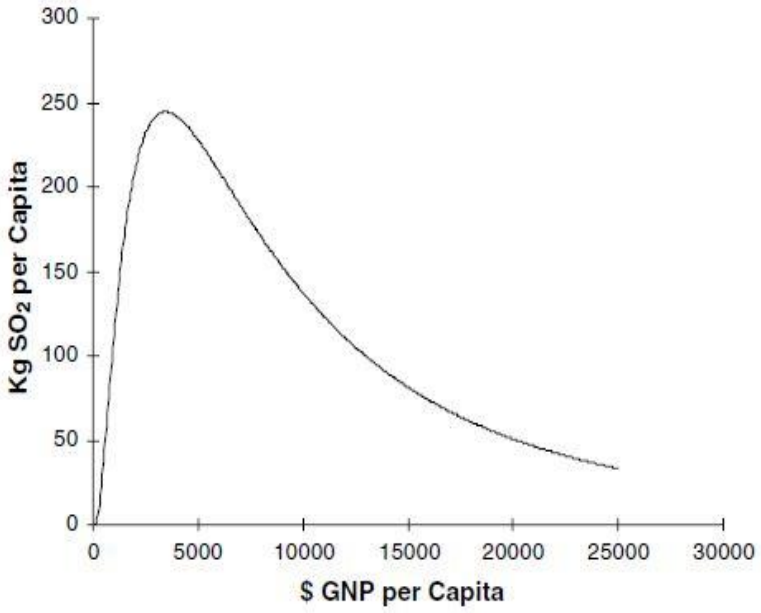
This section of the paper is divided into four parts- theories, major climate agreements, climate laws, and the impact of COVID 19 with possible future shocks. First, the theories which help to explain the climate change phenomena is explained- it is explained in terms of the anthropogenic or human-made phenomenon. In the later part of the literature review, the conceptions of environment and economy are explained to establish a linkage within the chosen variables such as pollution and emission to explain climate change in detail. Some of the prominent climate agreements and laws are discussed then to analyze the position of Bangladesh in climate change where the recent impacts of COVID 19 are also explored. Finally, the section ends with possible predictions or hints of similar shocks which might not only hamper human life but also the environment.

2.1 Theories:

The first CC theory refers to the degradation of the environment which is studied as the Environmental Kuznets curve (EKC). After the Industrial Revolution, people started to produce in a robust way and to maximize their profit utilized natural resources and created huge industries. As result, the environment got heavily damaged as John Ruskin indicated the result as a "counterpart of development" (Jean-Marie & Patrick, 2020). However, many other economists and scholars such as Adam Smith excluded the exploitation of the environment from the context of economic development rather focused on labor productivity. Later, Thomas Robert Malthus provided his famous theory of the "arithmetic progression" of the population with relation to resources.

So, coming back to the environment and economic growth to explain climate change, we need to understand EKC. Kuznets curve is based on the measurement of inequality and income per capita, the EKC is the modified version for the environment. The EKC is a presumed link among several environmental indices and per capita income (Stern, 2004). In the early stages of economic expansion Pollution and atrophy rise, however, when income per capita reaches the peak (varies depending on the factor(s)) the disposition reverses, and economic growth accompanies environmental healing. Thus, it indicates that the measurement of environmental effect is an inverted U-shaped factor of per capita income. according to the theory, as income increases or industrialization progresses the environment would be damaged (Fig 2) and after reaching a certain point the deterioration process would decrease by itself with the growing economy with the help of technological advancements or other external interventions.

Fig 1: EKC for Sulphur Emissions



Source: Stern 2004 pp 1420

From fig 2 it can be seen, that the pollution of Sulphur infused emissions decreases after a point as the technological advancement of industries take place although the economy grows with the higher number of GNI per capita. For example, despite the fact that the number of cars on the road in the United States remained constant or rose, Sulphur dioxide levels fell as a result of increased monitoring (Halton, 2021).

The theory of Externality by Pigou is another environmental theory that is connected to climate change. It links policies to the environment such as through taxation or command and control regulations. The theory of externality is a non-monetary influence that can be an economic representative (polluters) has on the interests of other economic representatives, with the impact capable to convert into a benefit (Positive Externality) or harm and annoyance (Negative Externality) (Jean-Marie & Patrick, 2020). These impacts, by altering the value on which each representative makes a choice, are the cause of inefficient social activity allotment and, as a result, incompetence in the economy. For example, when the profitability of a forest operation is calculated without taking into account the forest's regulatory effects on climate, the profitability is overestimated, and the forest is overexploited.

Rationalizing externalities, having the polluter pay for the pollution they cause, is one way to avoid such malfunctions, which is known as the Polluter Pays Principle. With this principle, the Pigouvian Tax was developed by calculating the cost-benefit of marginal social damage to reduce polluting activities. This tax takes social and environmental components into account when it comes to collective wellbeing and sustainable development. However, this is not applicable in real scenarios most of the time due to monetary compensation is far more difficult to be applied as power and politics play a massive role.

2.2 Major Climate Agreements and Position of Bangladesh

Climate agreements are a bridge for developing nations by helping the least developed countries through financial or resource help from the rich countries. Further, these agreements play a big role in containing emission rates as the monitoring or governing bodies are very active of world organizations and these keep track of all climate information as well as provide remedies for climate problems. In this paper, the major agreements and laws are described to look into the knowledge pool. In the table below (Table 1) the major climate agreements of Bangladesh are provided with ratified years.

Table 1: Major Climate Agreements of Bangladesh

Agreements	Ratified Year
Vienna Convention for the Protection of the Ozone Layer	1985

Basel Convention on the Control of Transboundary Movements of Hazardous Wastes and Their Disposal, Basel	1993
Convention on Persistent Organic Pollutants, Stockholm	2001
Kyoto Protocol	2002
Montreal Protocol on Substances that Deplete the Ozone Layer, Copenhagen	2009
United Nations Framework Convention on Climate Change, Paris	2015

Source: Ministry of Environment and Forest 2014

Vienna Convention for the Protection of the Ozone Layer accord was signed in 1985 which is still in work. The goal of the Convention was to foster international cooperation by sharing information about the impacts of human actions on the ozone layer (UNEP, 2021). The framers of the Convention believed that by doing so, policymakers would take action to tackle the behaviors that cause ozone depletion.

Basel Convention on the Control of Transboundary Movements of Hazardous Wastes and Their Disposal was corroborated in 1993 by Bangladesh. This agreement was based on the discarding of bio-hazard wastes from industrial production to a safe place where the environment would not be disrupted while the parties or states involved in it should carry out necessary regulations to minimize the hazardous impacts. Bangladesh developed the 'Regulatory Framework on Import of Hazardous and Toxic Materials' in 1996 as part of an ADB-funded initiative (MoE, 2007). Medical Waste Management Handling Rules have also been succeeded by the MoEF. Further, Bangladesh has developed Implementation of the Basel Convention to 2010 with different partnership programs and Integrated Life Cycle Approach.

The Stockholm Convention on Persistent Organic Pollutants (POP) was formalized by Bangladesh's government on May 23, 2001. As a signatory to the Convention, the government must take steps to raise public awareness about the dangers of POPs and their eventual removal (ESDO, 2005). The Ministry of the Environment has compiled a list of POPs and created numerous public awareness campaigns. Many action plans are being designed with the NDCs with proper allocation of financial resources as well as inter-sectoral partnerships.

The Kyoto Protocol is an international agreement below the UNFCCC that befit for governments to uphold was on May 9, 1992, during UNCED, which is also recognized as the Earth Summit. The Kyoto Protocol is a contractual arrangement that regulates CO_2 as well as five additional

Greenhouse Gases (GHGs): Methane (CH_4), Per-fluorocarbons (PFCs), Nitrous Oxide (N_2O), Sulphur-hexafluoride (SF_6), and Hex-Fluorocarbons (HFCs) (PRDI, n. d.). These emissions are mostly caused by energy generation and consumption, manufacturing production, urban waste, and inland pollution like destroying forests. Even though this protocol was the first step towards cleaning the environment the withdrawal of many rich countries including the US, Russia, Japan, Canada, and Australia and the inconsistency of development actions with the environment made the protocol a failure.

Montreal Protocol on Substances that Deplete the Ozone Layer is another consensus that was upheld in 2009 to maintain the Earth's ozone layer by cutting out ozone-depleting chemicals. The production and consumption of ozone-depleting chemicals are both included in this step process plan. This Protocol is a monumental one as many countries have participated successfully with shared ideas and this agreement is still in its place. The Protocol's union unites at one time every year to make resolutions regarding the treaty's effective operation, re-arrange or altering the Protocol, and it was done 6 times since birth. The Multilateral Fund has sanctioned $6,339,765 within the Executive Committee to delegate Bangladesh to comply with Article 10 of the Protocol (UNEP, 2021).

The fund is provided to reduce chlorofluorocarbon consumption and to license the imports or exports and import quotas of substances that deplete the ozone layer (ODSs). However, the fund comes with a few clauses such as reducing chlorofluorocarbons (CFC) consumption to 140 ODP tonnes in 2009 and 0 in 2010. Bangladesh reported 154.9 ODP-tonnes consumption of chlorofluorocarbons for 2007, thus, qualifying for the fund allocation. Bangladesh provided a plan to reduce this consumption by HCFC Phase-out Management Plan (Stage-I& II). Bangladesh triumphantly gradually disposes of main ODSs such as halons, CFCs, methyl-bromide and CTC, from industrial use in 2010 (UNDP, 2018). Under the Public-Private Partnership (PPP) model and the allocated fund, CFCs were taken out in the manufacturing of metered dosage inhalers and HCFC-141b (hydrochlorofluorocarbons) was disposed of the industrialization of refrigerator’s spume as the spume blowing agent (2012).

HCFC Phase-out Management Plan (Stage-I) was successful due to proper implementation by country. On the eve of the Montreal Protocol's 25th anniversary, the United Nations Environment Programme (UNEP) recognized Bangladesh for its fulfillment in the elimination of core ODSs. In

stage-II, the country is further aiming to erase ODS to protect the ozone layer and sustainable growth, which was planned in 2018. However, the ODS is still used in the country despite such success. Because HFCs are recently found in fridges, inhalers and automobile ACs, the Department of Environment has launched a $3 million mission to eliminate their use. Another $6 million initiative is underway to phase out the usage of HCFCs by 2023. As an alternative to HCFCs, R-290 (propane gas), a chemical with negligible Ozone Depletion Potential (ODP) and minimal climate emergency potential, would be employed too.

Bangladesh ratified the United UNFCCC in 2015, also acknowledged as the Paris agreement led by the CoP21 (Conference of Parties in the twenty-first century). This protocol is the result of two major failures- the Kyoto Protocol and CoP15 where most of the states could not come to a census conclusion. The United States and the umbrella group China, India, Russia, Alliance of Small Island States (AOSIS), the G-77 Forum, the Least Developed Country (LDCs) group, and the Africa group all are aboard with this protocol (Hasan, 2019). The Paris Agreement was supposed to be malleable, as it requires a simple set of a collective goal of protecting global temperature expanding to beneath 2℃, and member countries were given the freedom to select their own share of global commitment.

Despite three years of intense talks, the parties eventually succeeded in introducing the "Rulebook" on the Paris Agreement in December 2018 in Katowice, Poland, with all the precise details. Poverty reduction, universal access to sustainable energy for developing nations, and increased participation of all stakeholders were among the topics covered in other sections (Rahman, 2016). Bangladesh is among the foremost countries to develop and put forward its 'Nationally Determined Contributions (NDC)' to the UNFCCC in 2015 (Hasan, 2019). Bangladesh agreed to reduce its GHG effusion just by 5% underneath "business-as-usual" levels before 2030 using just household materials, however, this downward level might be increased up to 15% if adequate outward funds are granted, according to the NDC's climate mitigation plan.

Regrettably, the current trend of constructing more carbon incentive infrastructures, such as the Rampal power source, as well as the inadequate plain and explicit regulatory substructure, does not bode well for moving toward a greener economy for Bangladesh. The development of mass projects and population growth with unplanned urbanization is hurting the agreements as the ecosystems of specific areas are being swiped. Further, the Trump government has quit the

agreement, and it made a severe hole in the agreement as other leftist parties are also following the same footsteps thus the agreement is in jeopardy.

2.3 Major Climate and Environmental Laws and Action Plans

Climate laws are significant for any country as these laws try to minimize the number of emissions and balance out the impacts of CC. The effects of CC are not felt by all- inequality and poverty makes the situation worse for the poor, the oppressed, or minority groups. Thus, climate laws are mandatory for Bangladesh as poverty rates are high. Although, the country has many climate laws here some of the significant laws are explained.

Bangladesh Environmental Statistics Framework (BESF) is the most significant document which collects and monitors the data collected all over the country and suggests applicable policies so that the country can take valid steps for the environment. Further, the General Economics Division (GED) and Bangladesh Bureau of Statistics (BBS) with the accordance of UNDP helps to gather information as well as the legal execution. Bangladesh falls below concerning developing countries for both having a legislative framework and putting it into practice when it comes to CC mitigation. Major climate policies are-

Table 2: Major Environment and Climate Policies of Bangladesh

Policies and Acts	**Year**
Environment Policy	1992
Environment Conservation Act (ECA)	1995
Environmental Conservation Rules	1997
Bangladesh Climate Changes Strategy and Action Plan (BCCSAP)	2008-2018
The Environment Court Act	2010
National Sustainable Development Strategy (NSDS)	2010-2021
The Brick Manufacturing and Brick Kilns Establishment (Control) Act	2013
Bangladesh National Action Plan (NAP) for Reducing Short-Lived Climate Pollutants (SLCPs)	2014
Clean Air Act	2020

Source: Author's compilation for the internet

The Environment Policy was formulated by GoB in 1992 with the notion of safeguarding and improving the environment to ensure ecological balance and general development. The policy

includes several actors involved, internal actors were local NGOs, MOEF, DOE, related ministries, civil society, and planning commission, the external actors were UNGA, donor agencies, and international organizations (Assignment Point, 2021). This policy covered major sectors of the country including agricultural, health and sanitation, industries, energy, fuel, land forest, etc. The strategy stated the applicability of ecologically sound development based on appropriate impact on the production management and relationships in the agriculture sector to ensure environmental improvement and long-term resource usage.

Furthermore, the policy called for a thorough evaluation of Environmental Impact Assessment (EIA) on private and public sector companies, additionally the integration of environmental issues into the National Health Policy. This policy is monumental for Bangladesh as it has introduced many salient components for environmental monitoring such as the precautionary approach and EIA. Bangladesh's Environment Policy of 1992 acknowledged the need for a more efficient and detailed approach to environmental challenges. The Bangladesh Environment Conservation Act (ECA) 1995 is the sole piece of legislation that exclusively addresses environmental issues. The Act was passed to protect and improve environmental standards, as well as to control and mitigate environmental pollution.

To conserve, enhance environmental standards, and management of impurity in Bangladesh's environment through mitigation, the Environmental Conservation Act was established in 1995 (Oikya, 2017). The overall environment and the natural resources have been put under the greater ambit of this Act to take prompt and required steps. It prompts an environmental certificate for each industry and identification of environmental pollutants. Later through this Act use of polythene bags was banned in 2002 with a review of it. The Act sets up the Environmental Conservation Rules (1997), which describes the criteria for water, air, and other environmental segments. The Act has been chastised for giving the DG far-reaching powers, failing to specify the technical qualifications of concerned authorities, providing insufficient penalties, and creating vulnerabilities (Lubaba, 2019).

Bangladesh Climate Changes Strategy and Action Plan (BCCSAP) was published in 2008, later reviewed in 2009 to increase the country's capacity and durability in the face of CC. The major goal is to develop a governing mechanism for managing CC and its effects in Bangladesh, culminating in a program action plan that addresses the need for real interventions with a clear

schedule for execution (FAO, 2021). This plan encompasses Vision 2021 and emphasizes the goal of eradicating poverty by 2021. Based on six pillars, the BCCSAP describes 44 immediate, intermediate, mid, and long-term programs. The pillars are- comprehensive disaster management, food safety and health, social safeguarding and infrastructure, diminutions and decreased carbon growth, knowledge and research governing, and facilitation and institutional strengthening (MoFA, New Zealand, 2018). The action plan was revised in 2009 and incorporated new stakeholders- the Bangladesh Agricultural Research Council and Water Resource Planning Organizations. This action plan is very significant for Bangladesh as it is incorporated in the 7th FYP as it is concerned with Annual Development Programs (ADP) while keeping the environment clean and maintaining sustainable development.

Bangladesh joined National Strategy for Development of Statistics in 2010 in accordance with BBS to collect all the environmental statistics. Many of the statistics designed to control climate change and the environment, as well as design suitable policies, are now unavailable. Increased knowledge of the relevance and availability of timely and trustworthy official data, as well as their more efficient usage, will be an important aspect of the plan. Generating Bangladesh Framework for BFDES in accordance with UNFDES, developing statistics to track climate change impacts, and establishing a new Environment and Resource Statistics Office, as well as establishing a new Environment and Resource Statistics Section in BBS to lead in this field are some of the plan's strategy actions (ECDS, 2017).

The Environment Court Act was established in 2010. The Act tries to hasten the resolution of cases with environmental damage. As people cannot directly approach the court, the competencies of the act are not fulfilled, therefore, the DG of the DoE must delegate an investigator who must develop a report before the charge can be undertaken. The Act's goal of establishing an environment court within every district has mostly been realized. The inability to obtain that the dignitaries of the environment court are adequately educated on the required expertise has been an obstacle on the route to climate protection (Lubaba, 2019).

The National Sustainable Development Strategy (NSDS) was created to address the country's daunting environmental issues on the road to development, a 10-year-old plan (2010-2021). The issues start when the country's development attempts are done without sufficient consideration of the environmental consequences, resulting in a deteriorated agro-ecosystem, coastal and urban

environments, desertification, deforestation, and groundwater deterioration and depletion (MoF, 2021). Aside from local concerns, the NSDS demonstrates Bangladesh's determination to the international community to establish and adopt a sustainable development framework that meets environmental concerns. The NSDS recognizes five key priority areas and three inter sectors as being vital to Bangladesh's long-term viability and they are- Sustained economic growth; Social security and safeguarding; Urban habitat; Environment, natural materials, and disaster overseeing; and Development of priority sectors. Further, climate change is mentioned in the environment guiding principle, emphasizing the necessity to increase catastrophe risk reduction financing to establish a viable atmosphere for the country's economic and social enhancement in the context of CC.

The Brick Manufacturing and Brick Kilns Establishment (Control) Act of 2013 is a law that regulates the manufacturing of bricks and the establishment of the brick kiln. This Act was intended to regulate the brick manufacturing process. The Act imposes several limits on the locations where brick kilns should be built, which is criticized as being overly pushy and, to some dimensions, unworkable. Furthermore, specifies bans on the consumption of the natural materials derived from a hillock, agricultural land, and use of wood as an oil source. However, reality shows that these requirements are rarely followed.

Bangladesh's National Action Plan on Short-Lived Climate Pollutants (SLCPs) was established in 2014 and later was reviewed in 2018. The major action of this plan is to identify 11 prominent mitigation areas in SLCPs which include cutting back on carbon emission. This plan has the potential to meet the climate commitments under the Paris Agreement, by cutting down CH_4 emissions to 17% and black carbon emissions to 40% (DoE, 2020). The strategy, if completely executed, will result in immediate benefits from better air quality, along with a prediction of 9000 early deaths prevented. Further, the plan aims to design and enact a fruitful MNE procedure for SLCP related operations and mitigation, as well as the level of execution of the plan's suggested measures.

Clean Air Act has been drafted in recent times and is yet to be applicable for Bangladesh. The government has identified a few critical areas if the air quality drops after a certain level and immediate remedy for the situation. The draft suggests forming a 29-member advisory board made up of officials from several ministries and departments to monitor the plan's implementation and

provide recommendations (Nabi, 2019). It also advocates enacting the highest fine of ten years in prison, a fine, or both as consequences for breaking the legislation.

2.4 COVID 19 Impact and Future Shocks

COVID 19 has brought several issues and benefits in front of the world as it is benefitting the environment through reduction of pollution by killing and banning people to go out. However, in some regions, land pollution has sky rocketed due to the dumping of sanitary products or biomedical products and high rates of plastic consumption. Global CO_2 emissions decreased by 6.4% (2.3 billion tonnes), in 2020, after steadily increasing for decades, COVID 19 has worked as a blessing for the world (Tollefson, 2021). As factories, commutation, and production or manufacturing have closed, GHG emissions have dropped vastly. Vehicles and airplanes are the pivotal producers of emissions, accounting for around 72% and 11% of the commutation sector's GHG emissions. Water pollution has shrunk in Bangladesh, Malaysia, Maldives', Indonesia, and Thailand’s coastal regions.

Due to the shortfall of manufacturing contamination during India's and Bangladesh's lockout, the rivers Ganga and Yamuna have achieved a significant level of quality. This means SO_2 and NO_2 levels were reduced by 43 and 40%, sequentially, meanwhile tropospheric O_3 levels climbed by a maximum of 7 % from February 2019 to May 2020 (Islam et al 2020). Dhaka, Gazipur, Chattogram, and Narayanganj were identified to be the cities most affected by the emissions restrictions. NO_2 and SO_2 concentrations in Dhaka were reduced by about 69% and 67 %. However, COVID-19 generates almost 206 million tonnes of biohazard through hospitals per day in Dhaka (Rume & Islam, 2020). Further wastewater treatment methods are required, which is difficult in underdeveloped nations such as Bangladesh, where urban wastewater is discharged directly in the neighboring rivers and water bodies with no purification.

Different variations or mutations of COVID 19 have made life more difficult all over the world as it has linked itself with plenty of other diseases as an aftereffect. The development of vaccines appropriate to kill this virus has become the main object of many countries to reduce mortality and as a result, developed country like the USA has resulted in a reduction of an average of 2 years in life expectancy. Flood, cyclones, and drought are getting connected to the disease and making living quite impossible in Bangladesh as people are dying at a rapid speed. Nevertheless, this kind

of disease will come frequently in the world due to negligence and exploitation of nature. It was found that only reforestation, reduction of displaced animals, and banning animal trafficking are the solutions to such outbreaks. Reforestation is the only option for Bangladesh to keep the country afloat and fight against future outbreaks.

Chapter 3:

Methodology

This section of the paper talks about the methodological approaches of the study through which data sets would be collected and explained. Further, the hypothesis of the study is clearly stated in this section to guide the study and find specific results so that the main motive of the study would be fulfilled.

3.1: Type of Study

Based on the literature review of national data sources, the following research methods are found appropriate and effective for the study:

Quantitative Research Approach

The quantitative method is significant for this study as the trajectory is formed through the statistics or data, which comes from secondary sources. Depending on the variables in the hypothesis data is generated from government documents, organizational reports, journal articles, and newspapers. From these sources, document screening is also performed to validate data from the sources and lastly, the hypothesis is tested to see the outcome.

Qualitative Research Approach

For the quantitative purpose, this paper looks at the theoretical framework where the SDGs responsible for climate change will be analyzed. SDG 8.4, 11, 12, 13, 14, 15 (mostly focusing on 12 and 13) will be addressed and how to develop a probable solution for the country through these goals. Furthermore, the progress of Bangladesh would also be scrutinized to figure out the progress of the country. To do this the study is highly dependent on the document analysis method, where the information is gathered through again secondary sources. The impact of COVID shock would be explored to see if it has both positive and negative influences on the environment. In the last

part of the study, preventative methods to tackle future shocks like COVID would be explained through policy recommendations and suggestions.

3.2: Research Questions

The study has developed an initial three specific research questions to fulfill the objectives of the study and navigate to the desired outcome-

- Is COVID 19 a blessing or a curse for climate change and the environment for Bangladesh?
- Is there any significant alteration in the economic growth due to climate change?
- How can Bangladesh perform better in SDG achievement in terms of environmental sustainability (inspecting the success/achievements history of the country)?

3.3: Hypothesis

The hypothesis of the study is, climate change (dependent variable) has a set of multiple independent variables which leads to a distinctive trajectory, however, the impact of COVID 19 may have caused few changes in recent years in the trajectory of Bangladesh. To figure out the latest changes in the trajectory the null and alternative hypotheses are-

H_0: Climate Change has no relation to COVID 19

H_1: Environment and Climate Change are positively linked to Covid 19 pandemic.

This is based on EKC which states for a developing country like Bangladesh, economic growth will have an inverse or negative relationship with the environment. As Covid 19 pandemic through an economic interruption will lead to the slowdown of growth and thus an improvement in the environment. The sign of the relation between economic activities and the environment is negative. The relation between the pandemic and the environment is thus positive. In presence of a pandemic, the environment will improve.

Therefore, these equations are made from the alternative hypothesis,

$$EG_1 = GDP_t(C) \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots (1)$$

Here, EG_1= economic growth of Bangladesh, t= time (1 to 20 years), and C= impact of Covid 19. Thus, through this equation, I am analyzing the impact of Covid 19 on the economic Growth via

GDP in the last 2 years (2020 and 2021). Further, for the environment and economic growth, another equation is formed,

$$EG_2 = E(GHG) + AP + WP + RC \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots(2)$$

Here, EG_2= economic growth of Bangladesh with relation to the environment, E(GHG)= emissions of Green House Gas, AP= air pollution, WP= water pollution, and RC= resource constraints. To measure the emissions for Bangladesh the levels of CO_2, CH_4, N_2O, and HFC, are considered. O_3, NO_x, CO, PM_x, and SO_2 are the main air pollutants in Bangladesh and to examine the hypothesis these would be measured in terms of their availability or existence level in the air. The same process would also be followed for measuring water pollution through measuring the existence of solid waste and plastic pollution. Resource constraint is measured through the allocation of resources to improve air and water quality. Although, this variable is not directly responsible for climate change but is crucial for the environment as it has the ability to better the environment.

$$EG = \sum_{i=2}^{t=20} E(GHG) + \sum_{i=2}^{t=20} AP + \sum_{i=2}^{t=20} WP + \sum_{i=2}^{t=20} RC \ldots\ldots\ldots\ldots(3)$$

Finally, $EG = EG_1 + EG_2 \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots(4)$

The time considered in this paper is the maximum time for the study is 20 years and the lower time frame is 2 years as COVID 19 shock is going to be counted for 2 years. As all the variables are going to be analyzed the summation symbol is used to indicate the aggregate values of the variables.

Chapter 4:

Data Analysis

This chapter of the paper depicts data for supporting the assumptions of the study. However, the data is collected from secondary sources such as journal papers, newspapers, news portals, websites, and pdfs. The paper aims to collect as much possible for recent data, nonetheless in most cases it ends up collecting data up to 2021. In the first part of the section, data is tabulated then data is visualized in the data elastration section with explanations. In the last, the hypothesis is tested to answer the research questions of the study to validate the data.

4.1: Data Tabulation

This section is dedicated to the data of each variable to be tabulated. Each component of the variables is stated and some of them are compared with different countries. The impact of COVID 19 is tabulated comparing both Bangladesh and the rest of the world without the numbers as this sector is less explored by scholars.

Air Pollution

Air pollution is mainly measured through the existence of O_3, SO_2, CO, PMx, and NOx. Air Quality Index is the method of measuring the quality of air and air pollution through a scale of 0 (good) to 500 (bad). The scales are explained through the use of various colors to categorize health impacts with an explanation.

Table 3: AQI Method of Measuring the Air Pollution

AQI	Air Pollution Level	Health Implications
0 - 50	Good	Air quality is considered satisfactory, and air pollution poses little or no risk
51 -100	Moderate	Air quality is acceptable; however, for some pollutants, there may be a moderate health concern for a very small number of people who are unusually sensitive to air pollution.
101-150	Unhealthy for Sensitive Groups	Members of sensitive groups may experience health effects. The general public is not likely to be affected.
151-200	Unhealthy	Everyone may begin to experience health effects; members of sensitive groups may experience more serious health effects
201-300	Very Unhealthy	Health warnings of emergency conditions. The entire population is more likely to be affected.
300+	Hazardous	Health alert: everyone may experience more serious health effects

Source: AQICN 2021

The data for PM_{10} and $PM_{2.5}$ were reported in Table 4, it discovered that $PM_{2.5}$ concentrations are greater than the BNAAQS (Begum et al 2013). The mean values for $PM_{2.5}$ are significantly higher than the 2006 USEPA level BNAAQS. Compared to WHO standard the annual numbers are much bigger which is very alarming for Bangladesh. The table also shows the parameters of PM_{10} and $PM_{2.5}$ where the SD shows a high significance of spreading of PM which is very dangerous for health. The maximum values also cross the WHO standards in high numbers.

Table 4: The Air Quality Standards

Pollutant	**Averaging time**	**Bangladesh Standard**	**WHO Standard**
$PM_{2.5}$ (µg/m^3)	Annual	15	10
	24 hour	65	25
PM_{10} (µg/m^3)	Annual	50	20
	24 hour	150	50

Source: Begum et al 2013

Table 5: The Annual Summaries of PM_{10}, $PM_{2.5}$, and the Ratios of $PM_{2.5}/PM_{10}$ in Dhaka (December 1996 to December 2011)

Parameter	**PM_{10} (µg/m^3)**	**$PM_{2.5}$ (µg/m^3)**	**$PM_{2.5}/PM_{10}$**
Mean	97.7	36.7	0.41
Median	76.6	29.6	0.40
Standard deviation	68.6	25.5	0.14
Maximum	491	240	0.95
Minimum	10.1	5.26	0.10

Source: Begum et al 2013

Next comes the rate of change from 2013 to 2017 where only SO_2 and CO have been increasing due to the economic activities that Bangladesh has, which produces these harmful gases. However, $PM_{2.5}$ and PM_{10} have been reduced drastically as the country reduced producing such products

which produce these chemicals. As Bangladesh is a carbon importing country, the chemicals related to carbon would rise in the future.

Table 6: Trend of Air Pollutants at Dhaka City (from 2013–2017)

Pollutants	Rate of change (per year)
$PM_{2.5}$ (µg/m^3)	−4.6
PM_{10} (µg/m^3)	−2.7
SO_2 (ppb)	1.4
NO_2 (ppb)	−0.32
CO (ppm)	0.17
O_3 (ppb)	−0.24

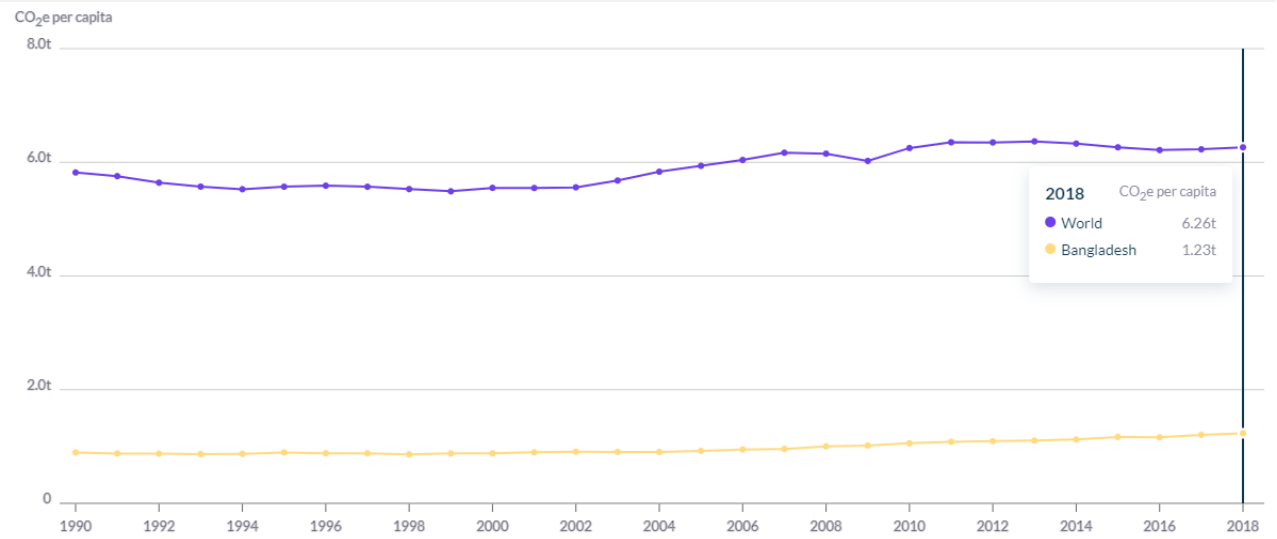
Source: Rahman et al 2019

GHG Pollution

GHG is measured through the amount of available CO_2, CH_4, N_2O, HFC, PFC and SF_6. For Bangladesh, the level of SF6 has always been 0 since the 1990s. Carbon dioxide (CO_2) is responsible for 74% of all greenhouse gas emissions. The use of fossil fuels is responsible for the majority of CO_2 emissions (93%), particularly for heat and power generation, commuting, industry, and consumerism (WRI, 2021). Another 3.3 % of anthropogenic CO_2 emissions come from land use, land-use change, and forestry, primarily owing to deforestation.

Fig 2 depicts the position of Bangladesh, as the country is a low CO_2 producer, the country lays in a good state compared to most countries. Furthermore, the country is recently emerging as a key market player, still holding the title of "Least Developing Countries" and would hold the title for long to enjoy the benefits further. As the country is mostly dependent on agriculture, it can be hoped that the rates of CO_2 would be lower for a long time. The country only bares 0.12% of total CO_2 production in the world.

Fig 2: World VS Bangladesh CO_2 Per Capita



Source: World Resource Institute 2021

Table 7 is for the other GHG and the rate of change. It can be seen that the rate of change is both increasing and decreasing, it is because of the production pattern of the country. Further, due to frequent natural disasters and changing economic policies the country has reduced a few harmful GHG productions. As mentioned before the country has achieved tremendous results in reducing GHG and has been awarded by the UN.

Table 7: Total GHG Emission (Kilotons of CO_2 Equivalent)

Year	**Kilotons of CO_2 Equivalent (all emissions)**	**CO_2**	**CH_4**	**HFC**	**N_2O**	**Annual % Change (except CO_2)**
2000	112,240	21,650	68,940	-	21,360	2.13
2001	116,870	25,780	68,930	-	21,820	4.12
2002	120,430	27,430	70,230	-	22,400	3.05
2003	122,030	28,630	71,050	-	21,930	1.33
2004	123,760	30,530	70,730	-	22,060	1.42
2005	128.390	32,710	72,360	-	22,830	3.74

2006	133,590	35,900	73,270	-	23,860	4.05
2007	136,520	37,990	73,940	-	23,950	2.19
2008	144,740	41,580	76,420	15.00	26,030	6.02
2009	148.380	44,750	77,310	15.82	25,530	2.51
2010	155,970	50,580	78,460	16.70	26,060	5.12
2011	161,700	54,420	79,160	17.82	27,070	3.67
2012	165,250	57,990	79,550	19.29	26,470	2.20
2013	168,630	60,580	79,980	21.12	26,650	2.05
2014	173,510	63,800	80,550	23.60	27,550	2.89
2015	182,600	71,690	80,900	26.42	28,210	5.24
2016	183,500	73,740	80,240	29.48	27,270	0.49
2017	192,420	78,710	82,590	32.71	28,400	4.86
2018	198,970	82,780	83,790	36.05	29,240	3.40
2019	-	110,200	-	39.46	-	-
2020	-	-	-	42.91	-	-

Source: Macrotrends 2021, World Bank 2021, Konema 2021

Table 8 shows the data sets of CH_4, N_2O, and HFC and the other gases were not relevant for the study. CH_4 has been increasing due to the increasing rate of livestock and fishing. During the early 2000s goat and cattle farming became very popular among the poor rural population and many financial institutions were introducing such economic activities. These were designed to empower women through financial inclusion in society. Although, the country claims that HFC almost vanishes from the country but it is increasing, due to higher temperature and increased living standards in the country. An increase in car number, purchasing more AC and high production of aerosols are directly responsible for HFC increase.

Table 8: GHG Emission by Sectors (2000-2018)

Year	**Agriculture (MT)**	**Energy (MT)**	**Land use change and forestry (MT)**	**Waste (MT)**	**Industrial process (MT)**
2000	72.43	23.83	29.29	14.99	1.01

2001	72.66	27.82	22.85	15.11	1.27
2002	73.95	29.58	22.60	15.65	1.26
2003	73.72	30.88	22.62	16.19	1.25
2004	72.92	32.88	22.48	16.72	1.23
2005	74.74	35.15	22.52	17.26	1.24
2006	76.34	38.48	23.83	17.51	1.26
2007	76.77	40.67	22.54	17.76	1.32
2008	80.98	44.33	22.62	18.01	1.42
2009	81.05	47.58	22.67	18.26	1.49
2010	82.39	53.51	22.53	18.51	1.55
2011	83.76	57.41	22.06	18.78	1.75
2012	83.22	61.07	22.08	19.05	1.91
2013	83.49	63.65	22.22	19.31	2.17
2014	84.63	66.93	22.11	19.58	2.36
2015	85.31	74.85	21.92	19.84	2.59
2016	83.47	76.87	21.76	20.11	3.05
2017	86.72	81.81	21.75	20.38	3.51
2018	88.53	85.84	21.78	20.64	3.97

Source: World Resource Institute 2021

Water Pollution

Core sources of water pollution found in Bangladesh are – industrial wastewater, fecal discharge or sewerage waste, solid waste, river encroachment, oil spills, bilge water, and sedimentation or siltation. Chemicals are used extensively in textile production processes for cleaning and dyeing. As a consequence, textile effluents include significant levels of harmful contaminants, particularly heavy metals. This is why this sector is the most polluting (3.35) with high rates of water-borne diseases compared with other sectors. Next are the leather and sugar sector being extremely high polluting sectors with high amounts of pollution products and the least polluting sector is the transport.

Table 9: Industrial Water Pollution Sources

Industry	Pollution Level	Pollution Product
Textile	High	3.35
Leather	Extremely high	1.88
Sugar	Extremely high	1.72
Agriculture	Moderate	1.08
Paper	Very High	0.67
Construction	Low	0.14
Transport	Low	0.02

Source: Restiani n.d. p14

Resource Constraints

Bangladesh allocated environmental funds in the national budget; however, the amount is mostly not utilized due to scarcity and ignorance of the government. India let alone spends Rs 2,217 (2021) crore for air pollution whereas Bangladesh allocated 318,664.79 crores for overall development. The majority of the budget is spent on land development and building dams to protect citizens from natural calamities. Less significance is given to air and water pollution, more and more brickfields and unplanned industries are being built each year.

Table 10: The Climate Relevance Trend in Budgets for 25 Ministry and Division

Year (revised)	Climate Programs Total (crore)	Total GoB Budget / Expenditure (crore)	Percentage of GDP	Percentage of Annual Budget
2009/10	26,749.60	1,13,310	1.1	6.6
2010/11	34,337.82	1,33,204	1.2	7.2
2011/12 (original)	31,094.28	1,66,799	3.46	18.64
2015/16	11,620.4	166443.2	0.7	-
2017/18	17,569.8	233,702.21	-	7.52
2018/19	21,253.2	267904.9	-	7.9
2019/20	22,713.35	301,919.33	0.8	7.52

2020/21	22,939.45	318,664.79	-	7.20
2021/22 (original)	25,124.98	346,106.40	-	7.26

Source: MoF 2019, MoF 2021, GED 2012

COVID 19 Impact

The impact can be categorized in terms of Bangladesh and the rest of the world so that the main purpose of the study remains on the path.

Table 11: Impact of COVID 19 in Bangladesh and Worldwide

	Bangladesh	**Worldwide**
Air Pollution	Reduced vehicular emission	Reduced five major air pollutants
	Increases high rates of fatality	Increases high rates of fatality
	Reduced N2O and $PM_{2.5}$	Reduced N2O but $PM_{2.5}$ reduced before the pandemic
GHG	Carbon emissions fell by 24%	Carbon emissions fell by 26%
	-	High plastic material production (i.e. PPE)
	Increased isopropanol/ethanol, triclocarban, and triclosan	The rapid increase in Sodium hypochlorite, hypochlorous acids, chlorine, isopropanol/ethanol, triclocarban, and triclosan
Water Pollution	High plastic (micro) pollution	Low water transportation
	High use of soap and detergents	High use of soap, detergents, pesticides, wastewater, water consumption
	High solid waste pollution	Nitric dioxide reduced up to 40%
	Reduced recycling	Natural resource exploitation
Wildlife	Increased Dolphins, turtles, crabs, birds, etc	Increased endangered species

	High medical waste disposal hampering bio-diversity	Low road kills
Economy	A moderate increase in GDP	Low GDP
	Increased poverty rate	Food insecurity
	Increased unemployment rate	Increased unemployment rate
	Migration	Reduced trade
	Extension of existing socio-economic problems	Reduced oil price and demand

Economic Growth

Bangladesh has a high rate of GDP growth rate due to the abundance of population. The country has been enjoying demographic dividends for a long time with growing different industries. The overall development is quite mysterious as there is no direct indication of how the country is emerging as one of the best players in Southeast Asia. Furthermore, during the pandemic, the country did not face much GDP degradation compared to other countries such as Sri Lanka (-3.57%), India (-7.96%), and Pakistan (0.53%) (Macro Trends, 2021).

Table 12: Economic Growth of Bangladesh (2000-2020)

Year	GDP Growth Rate (%)	Annual GDP Change (%)	GDP Per Capita ($)
2000	5.2933	0.62	418.069
2001	5.0773	-0.22	415.034
2002	3.8331	-1.24	413.080
2003	4.7396	0.91	446.311
2004	5.2395	0.5	475.292
2005	6.5359	1.3	499.462
2006	6.6719	0.14	509.640
2007	7.0586	0.39	558.058
2008	6.0138	-1.04	634.987
2009	5.0451	-0.97	702.264

2010	5.5718	0.53	781.158
2011	6.4644	0.89	861.762
2012	6.5215	0.06	883.117
2013	6.0136	-0.51	981.186
2014	6.0611	0.05	1118.874
2015	6.5526	0.49	1248.453
2016	7.1135	0.56	1401.565
2017	7.2842	0.17	1563.786
2018	7.8637	0.58	1698.132
2019	8.1527	0.29	155.692
2020	2.3755	-5.78	1968.792

Source: Macrotrends 2021, World Bank 2021

In recent 20-30 years, there seemed to occur no balance of payment blows in the country. One of its reasons seems to have been macroeconomic steadiness, it has been upheld in the prolongation of the development procedure and the preservation of exchange rate constancy compared to the Indian rupee. Between 3.5 and 4.5 %, the fiscal deficit is well under check. Furthermore, supported through strong outward sectoral developments, such as exports, which performed exceptionally well in the past for the last 30 years (Ethraj, 2020).

4.2: Data Illustration

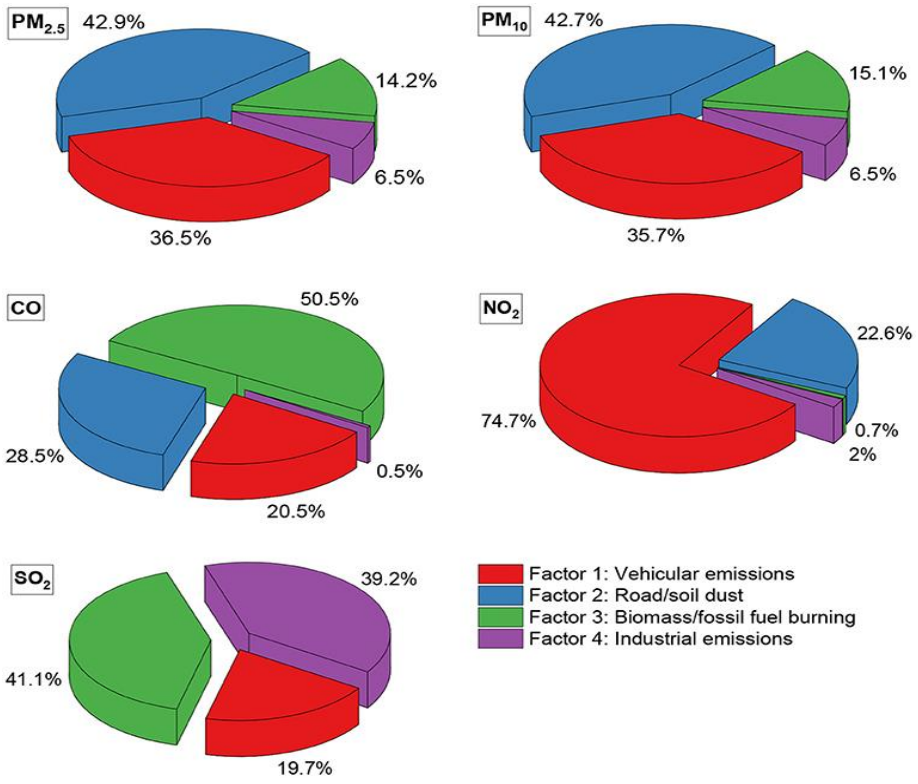
This section of the study visualizes the impacts and rates of pollution happening in the country. First, the air pollution is explained through a four-factor approach then the trends of different variables are provided. Next, GHG emission is visualized through sectoral approaches and comparisons with different components such as per capita emission and sources are provided. In the water pollution sector, solid waste is the most significant part of the impact of COVID 19 part of the study thus it has been given utmost priority.

Air Pollution

Air pollution can be understood with the Positive Matrix Factorization (PMF) Model and it has four factors. The primary factor has the biggest contribution of 74.7 % to NO_2, (fig 3) next by contributions of 35.7, 36.5, 19.7, and 20.5% in-favor of PM_{10}, $PM_{2.5}$, SO_2, and CO,

correspondingly (Pavel et al 2021). Since those contaminants were substantially associated, suggesting comparable sources, factor 1 is concluded to represent automotive emissions. The second factor seemed to have the largest PM loadings of 42.7 and 42.9 % for PM_{10} and $PM_{2.5}$, with presenting of 22.5 and 28.5 % for NO_2 and CO, implying that the above part is likely to represent a road or soil dust. The third factor has a major contribution to CO of 50.5%, as well as considerable contributions to SO_2. This component has an impact on PMs as well, with pilings of 15.1% and 14.2% for PM10 and $PM_{2.5}$, accordingly. Because of the large CO loading, the third factor should be attributed to fossil fuel or biomass use. The last factor can be interpreted as industrial emissions because it produces the majority of SO_2 (39.2%), with traces of NO_2 (2%) and PM_{10} and CO (0.5%). $PM_{2.5}$ is also linked to a 6.5% increase in lung cancer risk.

Fig 3: Factors of Air Pollution in Bangladesh

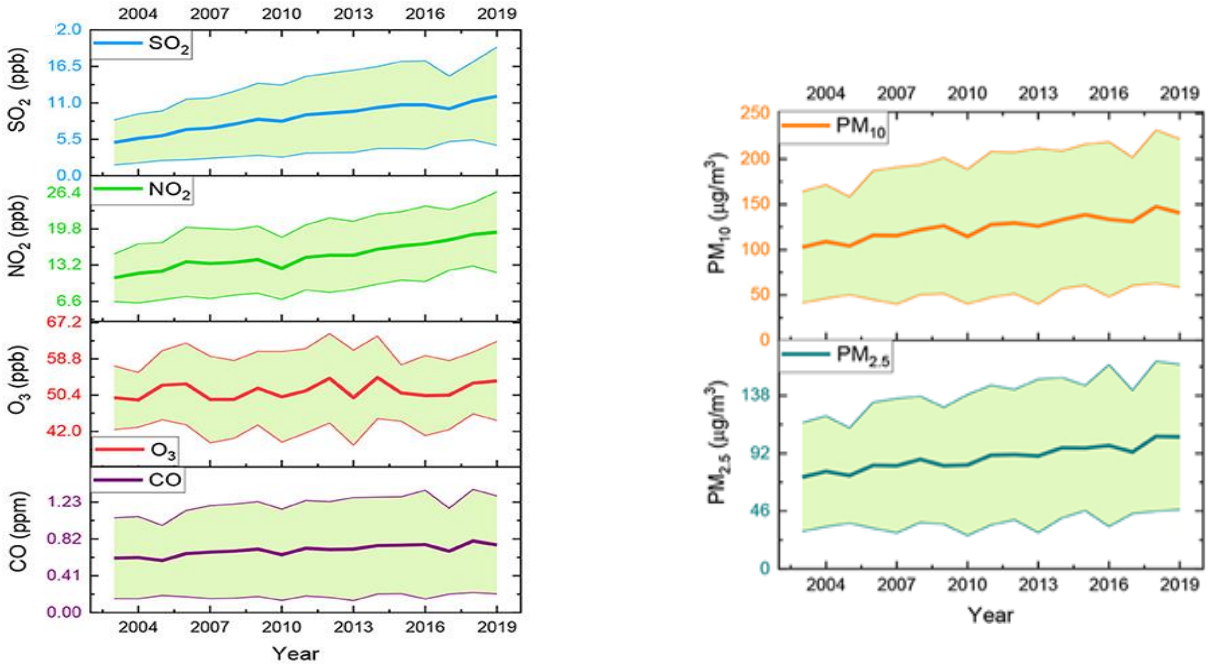


Source: Pavel et al 2021

For the years 2003–2019, O_3, NO_2, CO, and SO_2 had annual values of 51.42-1.82 ppb, 14.87-2.45 ppb, 0.69- 0.06 ppm, and 8.76-2.07 ppb, accordingly. Throughout the study period, all trace gases had a normal distribution although, NO_2 and SO_2 levels were well below the Department of

Energy's yearly national guideline levels. For the examined period, annual trends of O_3, NO_2, CO, and SO_2 showed slopes of 0.13-0.09 ppb/year, 0.47-0.03 ppb/year, 0.01-0.002 ppm/year, and 0.40-0.02 ppb/year, respectively. CO, NO_2, and SO_2 levels maintained a nearly identical pattern throughout the year, having the largest value during the winter season (starting from November to February) while the smallest during the monsoon season (starting from June to August). On the flip side, O_3 levels were highest during the March to May period and poorest during July to September period. Ozone's periodic tendencies in Dhaka were dissimilar to other pollutants, thus showing notable periodic fluctuations having a spike during winter and a fall during monsoon.

Fig 4: Yearly Trends of SO_2, NO_2, O_3, and CO (2004-2019)



Source: Pavel et al 2021

PM_{10} and $PM_{2.5}$ levels breached national air quality guidelines by almost 2.5 and 6.0 times, correspondingly, alongside topping WHO standards through 6.0 and 9.0 times (Pavel et al 2021). To examine the variations and statistical significance of PM_{10} and $PM_{2.5}$, a linear regression analysis was used where PM_{10} and $PM_{2.5}$ have both shown rising trends over time, having slopes of 0.15, 1.83, and 0.24, 2.35 g/m^3/year, sequentially (fig 4).

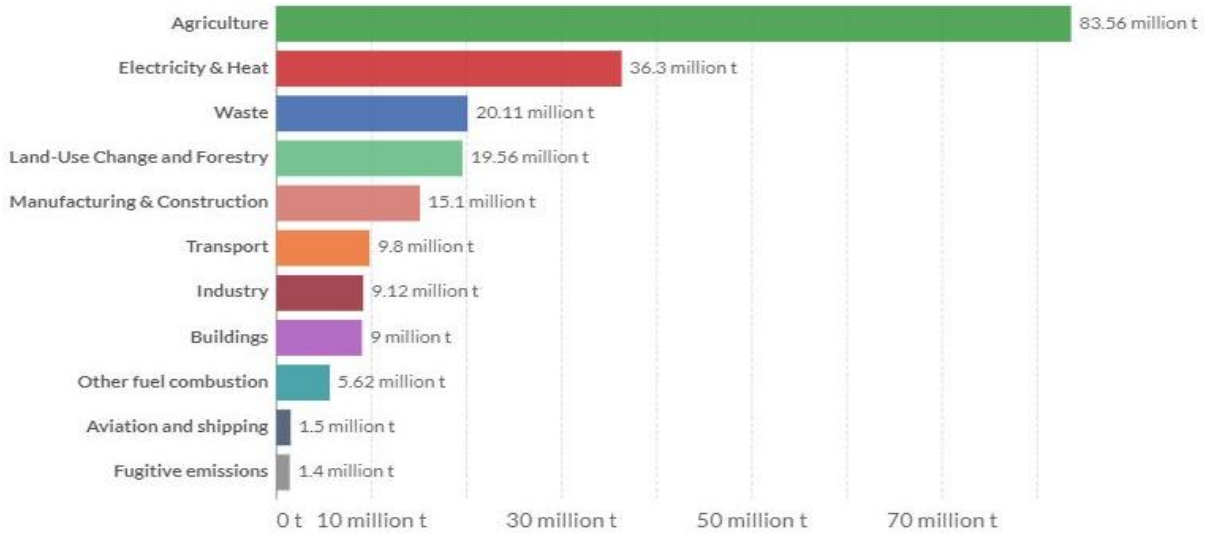
Air pollution is directly linked with the increase of death tolls of COVID 19 as many studies suggest that it impacts in three ways- increased transmission, increased vulnerability, and increased infection severity (Narain, 2020). The virus is thought to be transmitted through the

airborne dispersion of fluids of an infected individual, particularly through coughing and sneezing. Because coughing is the main effect of air pollution, it is possible that air pollution will increase transmission. Individuals with also before chronic conditions (such as cardiac, kidney diseases, non-asthmatic chronic pulmonary disease, and diabetes) account for the bulk of those diagnosed for COVID-19, according to new research. All of these diseases are linked to air pollution, which contributes to the intensity of the disease.

GHG Emissions

When it comes to the production of GHG, the agricultural sector is the major contributor through crop cultivation and livestock farming. Rearing cows, cattle, goats, etc produce huge of GHG with the use of various types of fertilizers which limits soil development. Bangladesh's total agricultural emissions are predicted to reach 86.87 Mt CO_2 by 2030, and 100.44 Mt CO_2 by 2050, if current trends continue (CIMMYT, 2021). Next, is the electricity and heat sector being the second major GHG producer, which is the result of the power sector of the country. As the world is getting more digitalized, it demands more electricity consumption thus, the GHG is rising along with high rates of waste generation. However, industrial GHG production places seventh position as Bangladesh produces certain types of goods which produce less GHG but the rates are alarming.

Fig 5: GHG by Sector in Bangladesh (2016)



Source: Ritchie & Roser 2020

In Fig 6 the variables have been connected to form the GHG timeline for a better understanding of the trends of increase with respect to economic growth. The timeline is crucial for the study as it is lined with per capita growth through the economic activities available in the country.

Fig 6: GHG Timeline of Bangladesh in Kilo Tonnes

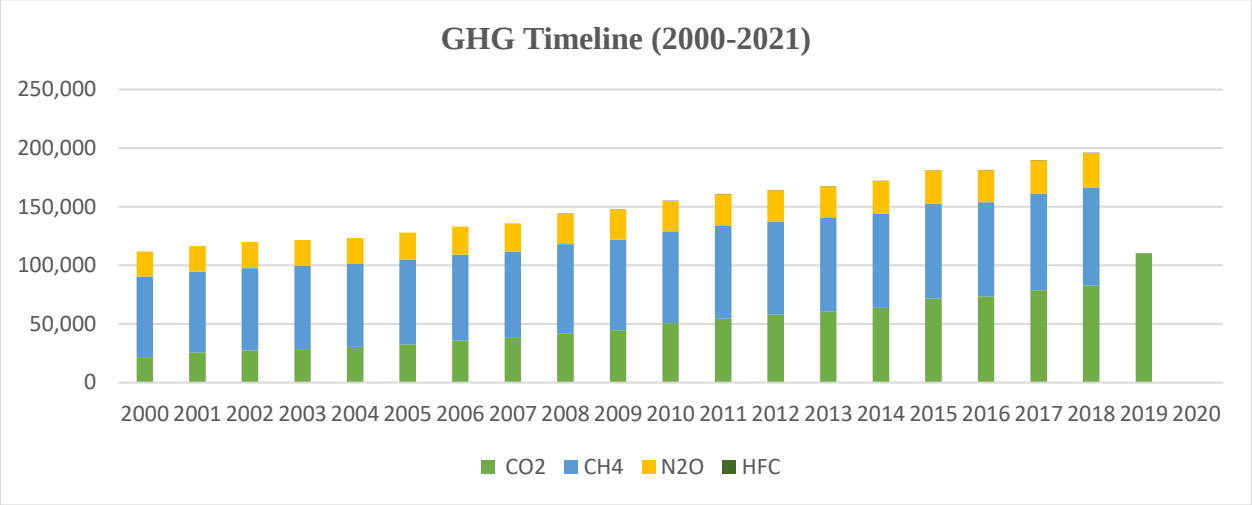
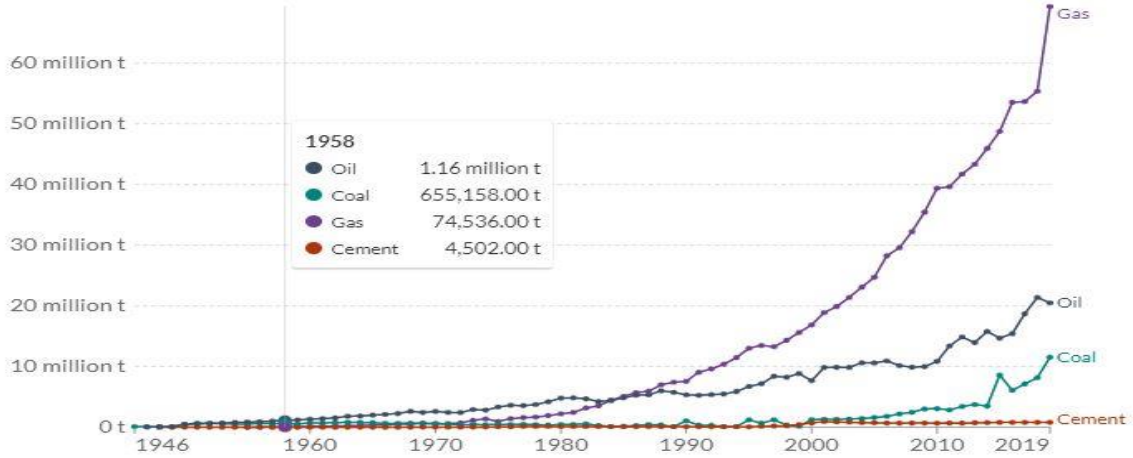


Figure 7 below shows the breakdown of CO_2 emissions by the type of fuel consumption. Fuel gas is the highest CO_2 producer, fossil fuel or oil ranks second the coal and lastly cement. Unplanned use of fossil fuels and generation makes high production of CO_2. As most of the industries, businesses, and households rely on gas, (as it is cheaper) the amount of it is expected to rise in the future unless the use of solar energy or renewable energy becomes popular in the country.

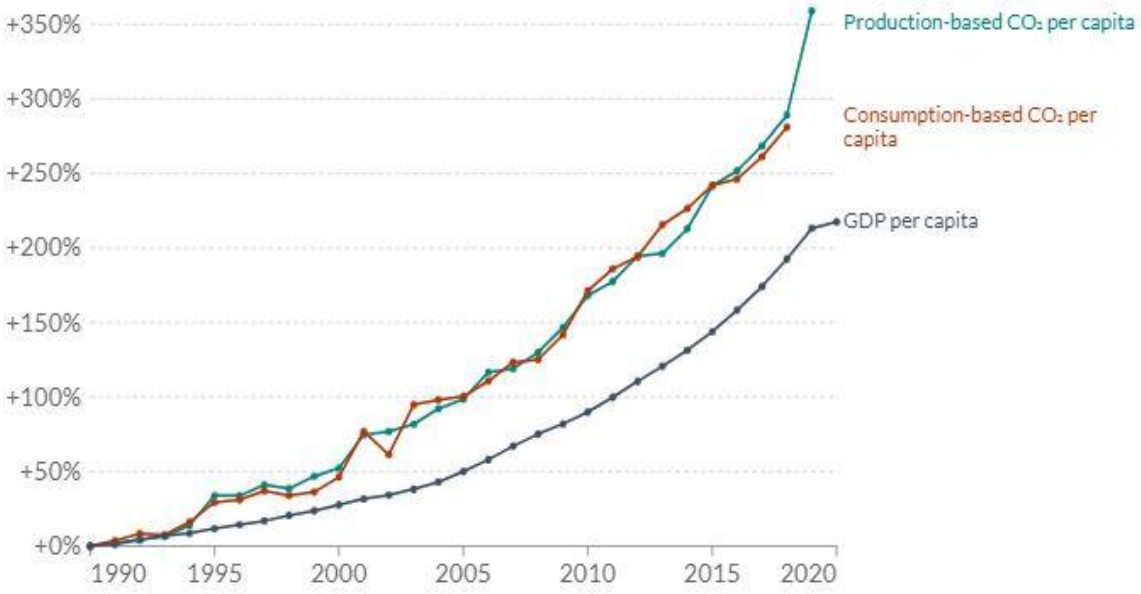
Fig 7: CO_2 Emission by Fuel Type



Source: Ritchie & Roser 2020

Economic growth and prosperity come with high rates of CO_2 production but eventually, it may cripple productivity. Figure 8 below shows the high rates of CO_2 per capita although the consumption-based CO_2 is lower than it. This means Bangladesh is an emission importer country-imports goods with CO_2 embedded. It is the outcome of trade policies and practices that should be revised to reduce the amount of CO_2 per capita in the country.

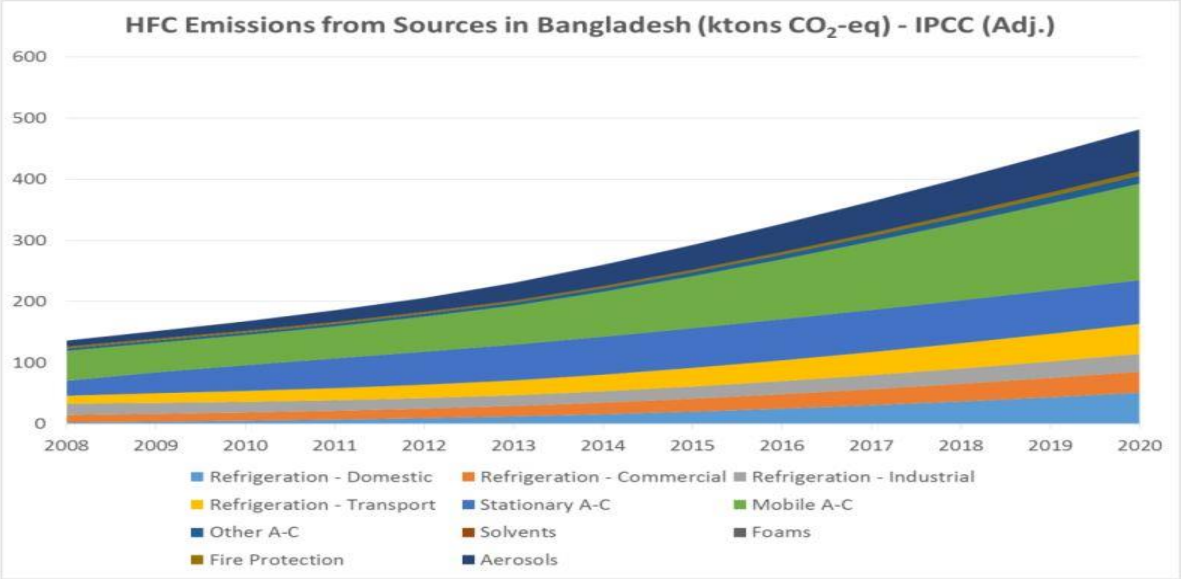
Fig 8: CO_2 Emissions and GDP (2020)



Source: Ritchie & Roser 2020

The main source of HFC is the mobile A-C as it is less expensive and easy to consume for the local people. Stationary A-C ranks second as the demand for it is rising in recent times due to the comfortable use of indoor occupants. As the climate is getting hotter each year the demand for it is rising rapidly and it has become the most rapidly growing sector of HFC use in the world. According to the government regulation the HFC production in refrigerators has been reduced, almost diminished it ranks low but illegal production continues. Other responsible producers rank low as Bangladesh has less diversified goods but among these Aerosol consumption is high due to high rates of mosquito diseases.

Fig 9: HFC Sources in Bangladesh

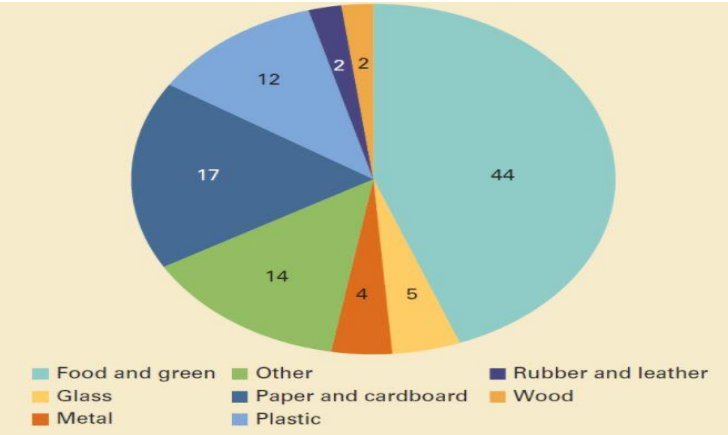


Source: Anthesis-Caleb n.d. pg-5

Water Pollution

The mix of waste varies in line with income level, pointing variety of consumption behavior. Strong countries make lower food and natural waste, accounting for 32 % of trash, and more dry waste which is recyclable, like paper, plastic, metal, cardboard, and glass, responsible for 51% of total garbage (WB, 2021).

Fig 10: Global Solid Waste Composition in Percentage

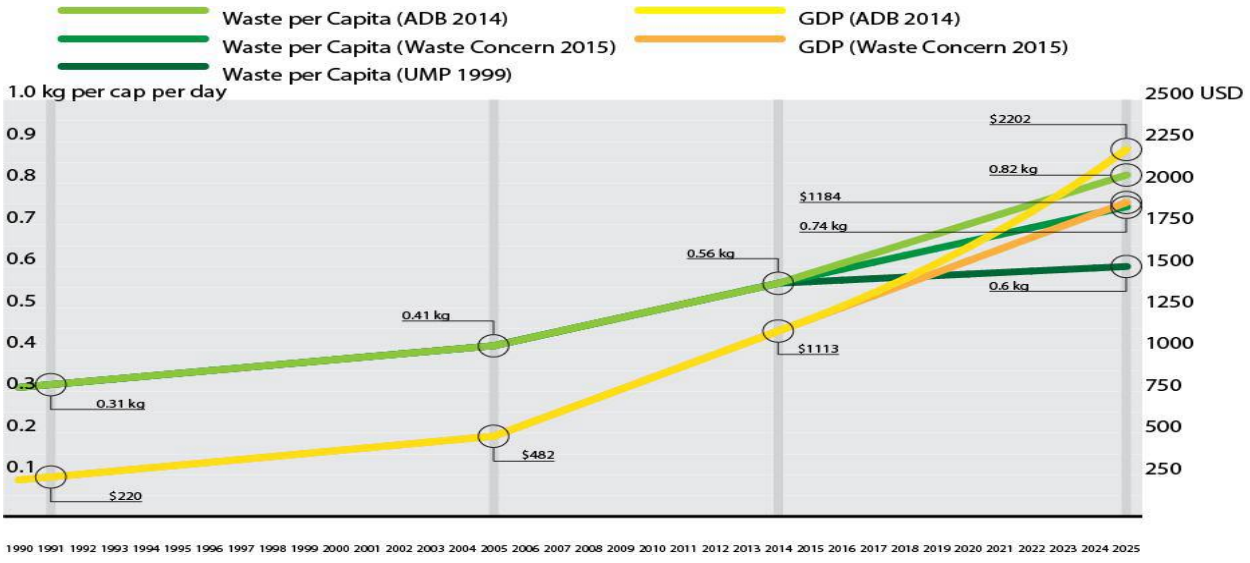


Source: WB 2021

In Bangladesh, 36% of waste is recycled, accommodating 39% landfilled, and the other 25% remains unregulated and routes further into the marine environment (Hossain et al 2020). Furthermore, the per day waste accumulation volume has been rising since 1991. In 1991, Bangladesh's metropolitan regions generated around 6,493 tonnes of MSW per day; in 2005, that number had over doubled to 13,330 tons per day (West Concern 2015). Also, Bangladesh's metropolitan areas were expected to produce 23,688 tons per day in 2014 and 47,000 tonnes in 2025. The everyday waste generation rate per capita in 1991 was reported to be 0.31 kg per capita per day. Further, had risen to 0.41kg per capita per day in 2005, and 0.56kg per capita per day in 2014. Everyday trash generation rate is predicted to reach about 0.60kg per individual per day by 2025, according to forecasts made before the alteration of millennia. According to a more current World Bank projection, daily waste generation will exceed 0.75 kg per capita per day by 2025.

Bangladesh's GDP will reach $1,884 by 2025 under a business, with both the GDP and the per capita trash generation rate is up warding at present rates (West Concern 2015). Along with per capita its waste generation rate would reach 0.74kg per capita per day by the same year. Further, Bangladesh's GDP was thought to rise by 6.4% in the fiscal year 2015, according to Asian Development Bank predictions. Bangladesh's GDP is expected to reach $2,202 by 2025 if the same pace of growth is upheld annually from 2014 to 2025, while currently, the GDP per capita is $1280.

Fig 11: Per Capita Waste Generation Rate vs. GDP



Source: West Concern 2015 p11

4.3: Hypothesis Testing

Keeping 95% confidence interval the data sets have been run in STATA Software for regression analysis. The main motive of conducting regression analysis is to predict the relationship among the Independent Variables (GDP Growth Rate) and Dependent Variables (Components of Air, Water, GHG pollution). Through this, the hypothesis can be tested, and then the results will predict the statistical significance.

First, the regression among GDP Growth Rate and GHG Emission is conducted separately for each variable as the limitation of data is found. From the available data sources, the information for CO_2 is available individually whereas another GHG has been found in clusters. The P-value for CO_2 regression is 0.001 (see appendix 1) which is less than 0.05, which means the null hypothesis is true. The R^2 value is 0.6018 or above 60% tells that the 60% data is fit for the model and there is a moderate link between the variables. Thus, if the GDP growth rate increases it will cause more CO_2 meaning more Emissions.

The P-value for CH_4 regression is 0.0013 (see appendix 2) which is less than 0.05, which means the null hypothesis is true. The R^2 value is above 46%, indicating a poor relationship between CH_4 and GDP Growth Rate. However, as there is an existence of relationship thus it is responsible for causing emission as GDP grows more. The P-value for N_2O regression is 0.0014 (see appendix 3) which is less than 0.05, which means the null hypothesis is true. The R^2 value is above 46%, indicating a poor relationship between N_2O and GDP Growth Rate.

The P-value for HFC regression is 0.9131 (see appendix 4) which is way above 0.05, which means the null hypothesis cannot be accepted. No effect was observed as the p-value exceed the statistical significance. Further, the R^2 value is less than 1% depicting there is no relationship among the dependent and independent variables. Thus, GDP growth has no impact on the HFC increase in Bangladesh.

For air pollution, the variables have been put all together due to low levels of data. P-value for SO_2 is 0.104 (see appendix 5) which is greater than 0.05, so the null hypothesis cannot be accepted. P-value for NO_2 is less than 0.05 (0.035) so the null hypothesis cannot be rejected. P-value for O_3 exceeds 0.05 (0.092) thus null hypothesis cannot be accepted. Lastly, P-values of CO, $PM_{2.5,}$ and

PM_{10} are less than 0.05 (0.030, 0.036, and 0.020 respectively) and the null hypothesis cannot be rejected. The R^2 values are-

Table 13: Hypothesis Testing Results Summary

Tests	P-Value	Statistical Significance	R^2	Correlation	Nature of Relationship
GHG Emission and GDP Growth Rate	0.001	Significant	0.6018	0.8662	Moderate
CO_2 and GDP Growth Rate	0.0013	Significant	0.4636	0.8301	Poor
N_2O and GDP Growth Rate	0.0014	Significant	0.4626	0.8665	Poor
HFC and GDP Growth Rate	0.9131	Insignificant	0.0011	0.8782	Not-available
SO_2 and GDP Growth Rate	0.104	Insignificant	0.5233	0.7234	Moderate
NO_2 and GDP Growth Rate	0.035	Significant	0.7100	0.8426	Strong
O_3 and GDP Growth Rate	0.092	Insignificant	0.5479	0.7402	Moderate
CO and GDP Growth Rate	0.030	Significant	0.7293	0.8540	Strong
$PM_{2.5}$ and GDP Growth Rate	0.036	Significant	0.7053	0.8398	Strong
PM_{10} and GDP Growth Rate	0.020	Significant	0.7798	0.8831	Strong
Solid Waste and GDP Growth Rate	0.238	Insignificant	0.0723	0.2690	Very Poor
Resource Constraints and GDP Growth Rate	0.4607	Insignificant	0.0290	0.5448	Not-available

The P-value for solid waste is above 0.05 (0.238) (see appendix 6) thus it is statistically insignificant. However, the R^2 value is less than 10% (7.2%), indicating a very poor relationship with the GDP growth rate. P-value for resource constraints is above 0.05 (0.4607) (see appendix 7) and this is statistically insignificant. The R^2 value is less than 10% (2.9%), indicating an almost non-existing relationship with the GDP growth rate.

Chapter 5:

Findings

This chapter is the core chapter of this paper as it determines the answers to the hypothesis. In the first part of this chapter, the finding from the hypothesis test is explained with graphs and charts, later the chapter utilizes resources to look into previous chapters to find the actual connection between economic development and the climate situation of Bangladesh. The epitome of this section is crucial for the study as it directs the study to the conclusion.

5.1: Major Findings from Hypothesis Testing

Hypothesis testing results will lead the paper to come to a conclusion about the hypothesis. From the previous tables, it is visible that the results provide a mixed and complex overall result. However, in 5 cases the alternative hypothesis or H_1 is rejected wherein in 7 cases the null hypothesis or H_0 is rejected. In table 14 the overall results are summarized with related variables. According to the p-value rule, the 7 cases are statistically insignificant thus the H_0 is rejected and in 5 cases the H_1 is rejected as the p-values exceed 5% significance. In the cases where H_1 is rejected, the dependent variable (components of pollution) and independent variable (GDP Growth Rate) has moderate or little relationship thus the economic growth does not pose any impact on these variables or simply increase in economic growth do not increase these components. If the GDP growth rate increase HFC, SO_2, O_3, Solid Waste, and Resource Constraint do not increase.

Table 14: Result Decisions

Variables	Hypothesis Result
GHG Emission and GDP Growth Rate	Reject H_0
CO_2 and GDP Growth Rate	Reject H_0
N_2O and GDP Growth Rate	Reject H_0
HFC and GDP Growth Rate	Reject H_1
SO_2 and GDP Growth Rate	Reject H_1
NO_2 and GDP Growth Rate	Reject H_0
O_3 and GDP Growth Rate	Reject H_1
CO and GDP Growth Rate	Reject H_0
$PM_{2.5}$ and GDP Growth Rate	Reject H_0
PM_{10} and GDP Growth Rate	Reject H_0
Solid Waste and GDP Growth Rate	Reject H_1
Resource Constraints and GDP Growth Rate	Reject H_1

On the other hand, where the H_0 is rejected meaning the dependent variable (components of pollution) and independent variable (GDP Growth Rate) have a strong or moderate relationship. If the economic activities increase the components of pollution would increase thus these relationships are reciprocal and impacts each other. With the increase in GDP growth rate GHG emissions, CO_2, N_2O, NO_2, CO, $PM_{2.5}$, and PM_{10} increase. However, the study shows a complex situation thus the study concludes that for some variables economic growth fosters pollution and for some variables, economic growth has no impact in the case of Bangladesh. The sources of those non-related components might be the result of other countries and trade activities happening around the world where Bangladesh is facing environmental and climate consequences.

5.2: Economic Development Path of Bangladesh

The theory of EKC states that the level of income will determine how the environment is impacted by growth. Japan's per capita income is $49,001 (2019) and CO_2 emission is 9.70 (2016) which is 3.47% of the total share of CO_2 emission (Trending Economics, 2021; Worldometer, 2021). Due to the popularization of Green Technology, Japan has been able to reduce its emissions and create a better environment for sustainability. The US has an income per capita of $ 63,416 (2020) and CO_2 emission is 15.52 (2016) and bears 14.02% of the world share.

On the other hand, the UK has a per capita income of $39,102.90 (2020) and CO_2 emission is 5.55 (2016) which stands at a 1.03% share of the total CO_2 emission in the world. Bangladesh has $2,227 (2021) per capita income with 0.47% per capita emission of CO_2, bearing 0.21% of the total share. However, Sri Lanka has $3,466 (2019) per capita income with CO_2 per capita emission of 0.88% (2016) and shares 0.05% of the total emission. Even though, the income inequality is higher in Sri Lanka than in Bangladesh the share of emissions is less with strong economic growth. Therefore, it can be determined that the EKC is not fixed or true for every economy, rather each economy is unique to EKC and has its mechanisms and type of interventions to degrade or foster the environment.

For example, political change was delayed in East Asian economies, changes in land ownership in the 1940s and 1950s helped prepare the ground for even-handed redistribution (Halton, 2021). Thus, the inequality levels were dictated by politics, not economics, as Kuznets claimed. For cultural reasons, not all cultures in countries with matching per capita GDP are uniformly susceptible to environmental changes (Jean-Marie & Patrick, 2019). Furthermore, not all

countries have a functional and organizational structure capable of rerouting technological innovation in an environmentally friendly manner. According to the Hecksher-Ohlin trade theory, emerging countries would specialize in the manufacture of items that are intense in the variables that they have in the relative abundance of labor and natural resources, under free trade (Stern, 2004).

The wealthy countries would focus on activities that need a lot of human capital and manufacturing goods. This specialization may account for some of the decreases in environmental degradation in wealthy countries and increases in environmental degradation in middle-income countries. As a result, polluting activities may be drawn to developing countries as a result of environmental regulations in developed ones. Therefore, emissions may be dropping at the same time in low- and high-income countries over time, ceteris paribus, while the specific innovations implemented at any given time may vary by country. However, Bangladesh is still not responsible as the rich and developed countries with low populations cause more carbon emissions compared with most developing countries.

As many world-class brands are shifting in the country, for cheap labor and intermediatory goods, rich countries are exploiting the environment of the country. Thus, the core countries have become the main sources of pollution and land occupancy by creating large-scale industries in the country. Right now, it is the duty of rich countries to compensate for their pollution to the poor and developing countries. Bangladesh is facing the biggest threat to climate change due to being only 7ft up from the sea level and it is predicted that before 2070, 10m people would have to migrate because they would lose their lands.

Bangladesh is not responsible for reducing GHG emissions, as the main cause of CC. GHG emissions are increasing in large developed advanced economies and Bangladesh is getting affected by it. Different amendments and climate treaties have promised to provide funds for the country such as COP 15, $100 m by 2020 but the actual scenario is different. Thus, NAPA of 2005, and BCCSAP have come up with several policies to control and manage the effects of CC. Alternative economic activities, migration, water management, development of industries has been the core issue in these plans. Bangladesh is only responsible for 0.35% of total GHG emission but still looking for alleviating measurements compared to most developed countries (IMF, 2019).

However, through Green Climate Fund the country is seeking funds to prosper green growth. Bangladesh might lose an annual growth of 2% GDP due to the CC thus hampering the overall economic growth as per the ADB predictions (Climate Expert, 2021). Bangladesh's government has spent more than $10 billion in the last 35 years to make the country strong against fighting natural disasters. Nonetheless, the direct annual cost of natural catastrophes in Bangladesh is projected to be between 0.5 and 1% of GDP during the last ten years (Reliefweb, 2009). Future CC is anticipated to have a greater economic impact, potentially reversing previous advances in economic growth and human reproduction

5.3: COVID 19 Impact:

During the recent countrywide closure, Bangladesh's carbon emissions fell by 24% to 183,000 tonnes per day (Molla, 2021). At the pinnacle of their individual shutdowns, emissions in all countries reduced by 26% on average. Until the end of April 2021, the overall change in emissions due to the pandemic is anticipated to be 1,048 million tonnes of CO_2. The biggest alterations are in China, where its closures began, with daily CO_2 reductions of 242 tonnes, 207 tonnes in the US, and 98 tonnes in India. The closedown of massive enterprises and industries in China resulted in a nearly 50% trimming in N_2O and CO emissions (Rume & Islam, 2020).

According to preliminary estimates, daily CO_2 emissions were perhaps reduced by 17% globally during the critical time of the closedowns, according to the WMO's major annual Greenhouse Gas Bulletin (Dhaka Tribune, 2020). It was predicted that the annual impact would be between 4.2 and 7.5%. Furthermore, water pollution has been cut off in Bangladesh, Malaysia's, Thailand's, Maldives', and Indonesia's coastal regions. Furthermore, industrial water use has decreased, particularly in the textile industries near the coastline.

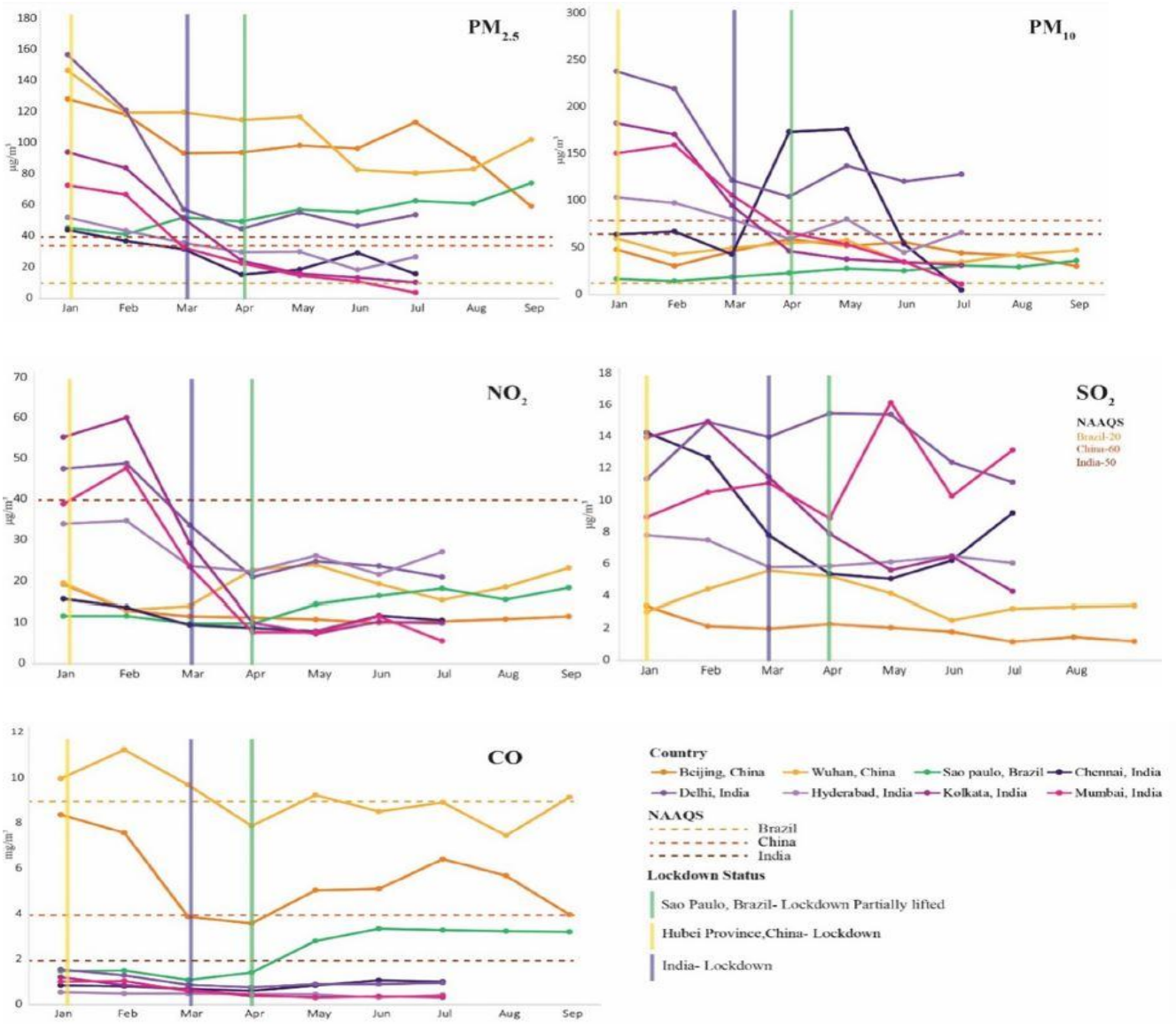
In Cox's Bazar beach, the local authority issued a prohibition on public gatherings and visitors. The coloration of the seawater is converted as an outcome of the limitation, which is usually muddy due to swimming, bathing, playing, and using motorized boats (Rume & Islam, 2020). Right now, nature has a possibility to process human displeasure, and dolphins have been reported coming back to the coast of the Bay of Bengal (in Bangladesh) and the waterways, after such a decade owing to pollution decrease.

COVID-19 creates approximately 206 million tonnes of medical waste per day in Dhaka. Other cities, including Manila, Hanoi, Kuala Lumpur, and Bangkok, had near growths, generating around 154 and 280 million tonnes of medical waste each day, compared to previous periods than the pandemic. Since the rise of COVID-19, the generation and use of plastic-based personal protective equipment (PPE) have surged globally. For example, from February 2020, China has pushed the daily creation of medical masks to 14.8 million, a drastic rise above the previous level (Rume & Islam, 2020).

The European Environmental Agency (EEA) estimated that NO_2 emissions in numerous European cities, together with Milan, Barcelona, Madrid, Rome, and Paris, would reduce by 30-60% due to the COVID-19 shutdown. $PM_{2.5}$ with the dangerous gas NO_2 levels fell by more than 70% in Delhi, where the air is often stifling. As seen in fig, the concentrations of SO_2 and NO_2 both decreased in every study. The most prevalent byproduct of the burning of sulphur-based fuels, such as coal and crude oil, is SO_2. Industrial shutdowns caused by the lockdown resulted in lower SO_2 emissions, particularly in coal-dependent India and China. According to a study of 34 countries, average ground level NO_2 concentrations were 60 % lower throughout the lockdown period than would have been thought given the weather with the time of year.

Although the concentrations of each air pollutant dropped drastically, aerial ozone levels soared across the shutdown, rising 30% in Sao Paolo, Brazil, 37 % in Delhi, India, and over 300 % in Milan, Italy (Chowdhury et al 2021). This is dedicated to the natural method for removing ozone from the air, which is conciliated by a series of titration reactions induced by NO, where NO breaks down O_3 to produce NO_2 and O_2. Such reactions produce NO_2 while also removing ozone from the atmosphere. As a result, the drop in NO concentration, as seen in Fig 12, has increased O_3. Elevated ozone exposure could have a variety of health effects, and with such a short research period and the majority of the population remaining indoors or wearing masks, the actual consequences are impossible to predict.

Fig 12: COVID 19 and Air Pollution



Source: Chowdhury et al 2021 p4

Chapter 6:

Discussion

This part of the study debates the climate success of Bangladesh including the success and drawbacks in achieving SDGs. Although Bangladesh has always performed great in terms of all climate agreements and MDGs there are available loopholes in the junction of SDG. In this section not only the great achieving points are discussed but also the flaws are figured out. As the pandemic

is grasping the economy and the environment the country needs new policies to protect its people and establish economic justice following the environmental development. Lastly, the section is concluded by talking about the limitations of the study.

6.1: Relating with SDGs Achievements

Bangladesh is a proactive member in the global development affairs and this is why it has incorporated the agenda of 2030 to its FYP (started from 7th), the national development agenda of the country. It has achieved tremendous success in terms of the neighboring country and has great performance in many indicators and needs improvement in some goals. Even though the country is facing the harsh reality of COVID 19, it is trying its best to hold the achievements from previous years. For the study, goals 9,11,12,13,14, and 15 (table 15) are relevant (see appendix 8) as these goals are related to climate change and economic relationship with the climate.

Table 15: Current Progress of Bangladesh

Goal 8.4	**Goal 11**	**Goal 12**	**Goal 13**	**Goal 14**	**Goal 15**
30 Indicators					
2 targets	9 targets	11 targets	5 targets	10 targets	12 targets
Significant challenges remain	Major challenges remain	Achieved	Achieved	Major challenges remain	Major challenges remain
Stagnating 	Moderately improving 	On track or maintaining SDG achievement 	On track or maintaining SDG achievement 	Stagnating 	Decreasing 

Note: Green arrow indicates achievements, orange arrow indicates stagnation, yellow arrow indicates moderate improvements and the red arrow indicates worsening situation**.

Source: UN 2021

Goal 9: Bangladesh is trying to reduce CO_2 emission through various actions and among them, the establishment of green Garments has been very successful and popular while having the highest number in the world. BGMEA states that the U.S. Green Building Council (USGBC) has listed Bangladesh as holding the top 9 green garment factories out of 10 in the world where 500 more factories are undergoing the certification process (Kiron, 2021).

Goal 11: The long-term Bangladesh Delta Plan 2100 and the Second Perspective Plan (2PP, 2021-2041) integrate the core guidelines of urban policy for urban environmental sustainability (GED, 2020). Due to a lack of land, the government has promised to use modern technology for trash disposal, such as cremation. ECNEC has already approved land purchase projects for DSCC, DNCC, and Narayanganj City Corporation (NCC). Similarly, city governments have emphasized the 3Rs (reduce, recycle, and reuse) approach.

Goal 12: Bangladesh's main worry is food loss and waste during consumption. According to a recent study, food waste is now around 3% occurring during the sourcing and preparation stages, 5.5% in rural regions, 1.4% in serving, and 1.1% at the plates (GED, 2020). Furthermore, during post-harvest procedures, about 10% of the crops are lost. As the government struggles to manage municipal solid wastes, industrial wastes, and urban air pollution, waste management has become a serious issue. Bangladesh has started to work on smart cities and has taken on many public and private projects. The city of Jasore has built Bangladesh's first combined landfill and resource recovery complex, which recycles everyday city garbage into electricity, biogas, power, and fertilizers. The Sylhet City Corporation has also pushed the green city model and the use of community service organizations to recycle garbage into fertilizer.

Goal 13: Bangladesh has vowed to cut off its emissions to 5% from the industry case voluntarily, and an extra 15% with private sector investment support, with a commitment to the NDC to CO_2 emission reduction (GED, 2020). Furthermore, the BCCSAP has been modified while in 2018 the country received Green Climate Fund (GCF) allocation for clean cooking fuel program, sustainable and resilient infrastructure, solar irrigation pump method and increasing coastal communities' adaptive skills for better climate management. However, the pandemic of COVID 19 is threatening the progress of the country.

Goal 14: With the implementation of four zones around the Swatch of No Grounds in the Bay of Bengal, Bangladesh has significantly improved its maritime-protected territory. Different conservation such as Hilsha conservation and VGF program for the fishermen has benefited the economy and the biodiversity at large.

Goal 15: Bangladesh has successfully increased the terrestrial and freshwater biodiversity by 3% in 2018 and targeting to go for 5% in 2030. Furthermore, the country is also aiming to increase the forest land from 15% to 20% by 2030.

6.2: Climate Change Trust Funds

BCCTF and BCCRF are the only two national climate funds that funded more than 377 projects in the country where BCCRF solely accounts for 13 projects (MoFA, New Zealand, 2018). Through the trust funds, the government has allocated roughly USD 390 million and USD 146,4 million, respectively. The development of two climate funds came from disagreements about fund control and fiduciary risk between the government and NGOs on one hand, and various donors on the other. Initiatives presented to either fund must meet BCCSAP priorities, with the BCCTF adhering to MoEF standards and the BCCRF following World Bank rules. The collection of environmental statistics is also crucial for the country as it helps to monitor and reduce the amount of degradation and further the amount of emission.

The total process of achieving the environmental statistics outlined in BESF (15^{th}) is expected to be BDT. 33630.00 million, with BDT. 9955.00 million allocated to the first four years (July 2017 to June 2021), and BDT. 23675.00 million allocated to the long term (July 2021 to June 2030). Bangladesh presently invests US$1 billion per year on adaptation to climate change, accounting for 6–7% of its yearly budget. Following the public environmental and institutional evaluation process on climate change, the government included a climate budget code with metrics in the 2013 national budget (UNDP, 2015).

6.3: Limitations

The core limitations of the study are-

- **Lack of data:** as the data is collected from secondary sources there are quite a few gaps in a specific topic and it has made the results a bit hazy, the correlations and regressions were difficult to measure.
- **Lack of prior study in the topic:** the topic of COVID 19 is a new topic thus it has a very limited knowledge pool. Further, the absence of statistical updates of variables made the study less clear to all.
- **Unexpected results:** the obvious relationship between high waste generation and economic growth is known to all, but the study has failed to display, rather came up with different results.
- **Lack of time:** as the topic is extensive, the study requires more time to reach its full potential.

Chapter 7:

Conclusion

Bangladesh is a small country with economic wonders. It is thought to be the 37th largest economy in the world and a miracle in the least developed countries. COVID 19 put a pause to the growth and it is through this pause that we see impacts on climate change. However, it is assumed that the situation would not exceed the short term. Currently, it is in its stride of massive infrastructural change and social reform, however, it is also listed as the most vulnerable country for climate change. CC can undo all the tremendous gains. Climate change is affecting the overall development of the country and destroying lands and life. Bangladesh would suffer from ponderous monsoons, and the melting of Himalayan glaciers will bring larger river flows and devastating floods, according to the IPCC fourth report (Reliefweb, 2009). Droughts will become more common as rainfall becomes heavier and more unpredictable.

Due to the geographic location of the country and the high population rate the country will face massive consequences as well as huge economic loss. It is predicted that in 2050 around 10million people of the country have to migrate to Dhaka city as they would lose their land to flood as the country is one of the low laying countries in the world. On the other hand, we see that while CC can impact economic growth, economic growth also impacts CC.

As the COVID 19 hit the country the health system suffered alongside the impact of flood and cyclones in 2020 and 2021 made the situation worse for the people. However, the country overcame these situations but it will always be vulnerable to such situations and would fall into poverty traps. We see that there are a few key factors impacting Bangladesh's environment and climate change trajectory. The first is economic activity. Without any policies such as taxation of polluting industries, or regulation, increased economic activity is associated with increased production of pollutants. An economic theory such as the EKC posits this to be true for developing countries such as Bangladesh.

EKC theory predicts that as a country develops further and per capita income rises beyond a certain level that the extra income will then go into improving the environment. Thus after a certain level of development pollution will go down. For Bangladesh though, given the level of development, the prediction is that pollution will increase with economic activity. With the interruption in economic activities brought about by the pandemic we see less pollution is some of the indicators, but more pollution in others from medical waste.

Looking globally, while we see this is the relation predicted by EKC to be true for some pollutants and some countries, for climate change the polluting factors are greenhouse gas emissions, which are highest for developed countries. Moreover, a reduction in pollution in developed countries has also come about through moving the polluting industry overseas, usually to developing nations. The findings indicate there is no simple relation, but rather point to the importance of policy. In the last (2021) COP (COP 26) the global leaders have agreed to limit the temperature rise to 1.2℃ and the UNEP has urged the developing countries to prepare themselves for the upcoming climate consequences (Sarkar, 2021).

As the climate has come to an unreversible stage, most parts of the world will feel the wrath of frequent climate disasters while the poor nations are stuck, getting the worst out of everything. Bangladesh has been red-listed long before, and now waiting for the Global Climate Adaptation Fund which is the responsibility of rich nations as Bangladesh is like a microscopic polluter on earth. Although, the country is participating in every possible climate discussion but not being provided enough ground to incorporate its agenda at the global level due to poor actions taken inside the country.

Bangladesh needs to move very fast to protect its people and reverse the climate consequences as the country is not responsible for the cause rather facing the consequences. An interconnected economical (economic and environmental) approach is necessary for the country which follows Environmental Impact Assessments (EIA) of all projects and livelihoods and it is the duty of the government and the major NGOs to maintain such guidelines and sustain policies. Further, the recommendations below can be very useful for the country to put an end to pollution and achieve sustainability.

7.1: Policy Suggestions

- **Promoting Green Growth**- Bangladesh has already started to go for green growth technologies in major manufacturing sectors. The age-old tradition of agriculture is needed to be changed following green growth for the country and to do so the country needs to reduce CH_4. Reduction in cattle farming and CH_4 heavy crops would be difficult but not impossible for the country, it requires development and research in crops variation. Thus, funding the public and private research institutions and military for developing low emission agricultural products would be the best option for the country.

- **Implementing Low Emissions Analysis Platform (LEAP)-** this is crucial for the country to measure the emission and harmful gases available in the country. Merging of the public and private sector is the ultimate option to implement LEAP through monitoring the use of fuels and energy resources in Bangladesh through setting parameters for every sector. An increase in tax will also reduce the amount of emission and unnecessary energy consumption along with carbon footprint.

- **Incorporation of BCCSAP in the healthcare system of the country**- the healthcare system of the country is very vulnerable and out-of-pocket expenditure (more than $42) is very high and the healthcare system needs urgent reformation with the notion of climate change. As almost every year the natural disasters and epidemics are occurring in the country, it needs to be reformed and maintain the quality. COVID 19 has shaken the country with high death rates and new diseases might be struck in upcoming years due to environmental pollution.

- **Implementing Clean Air Act**- Bangladesh has been ranked the worst place to stay for air pollution more than 3 times, the level of pollution is at an alarming rate as it is causing many diseases and slowly poisoning the entire pollution. Thus, regular monitoring and data resourcing must be implemented by the government to reduce air pollution and punish the main culprits.

- **Implementing new tax policies:** use of the proper process from industries and filtration should be made essential and must be fined for exceeding amount of pollution. Government must tax (Pigouvian Tax) the major polluters at a high rate, it will bring down pollution at a rapid rate. However, the application of the tax would be difficult but it will benefit the whole country in a long run. Furthermore, the GoB must also develop strong policies towards pollution and proper punishment for breaking rules. Environmental Impact Assessment (EIA) reports are made for each development project but it is hardly implemented, the GoB must assure the proper implementation. Bangladesh needs to allocate more resources towards the environmental budget to improve the worsening situation.
- **Banning Polythene, PVC, and BPA**: previously polythene was banned in the country but since a few years it has grasped the whole country with high rates of pollution. Every year, roughly 800,000 tons of polythene garbage accumulate in Bangladesh due to a lack of efficient treatment, whereas in Dhaka, roughly 20 million polybags are used every day (Mannan, 2021). Scientists argue that by guaranteeing frequent monitoring and application of the rules, polythene bags can be banned from the market while alternative alternatives are introduced. The Court has prompted the government to ban polythene in 2020 and phase out single plastic goods by 2024. Further, the country has imported plastic waste from UK and US in the last few years despite the legal bans.

7.2: Other Recommendations:

- **Behavioral Change:** for the betterment of the environment and reduction of the carbon footprint we have to limit our lifestyles regarding less consumption of consumer goods and plastic, switching to organic food products rather than processed foods, proper disposable of harmful items and medical wastes, and proper recycling.

- **Sustainable growth of industries**: it is mandatory to convert to less emission from industries, use of cleaner fuels and technology, and robust energy-efficient policies to achieve long-term industrialization. The industrialists must use proper resources dictated by the government so that any ecology would not be harmed while dumping industrial wastes or wastewater to allocated zones. Filtration of industrial waste is a proper solution to reduce emission and water pollution and it should be made mandatory for specific industries.
- **Restoring damaged ecologies:** all the citizens should get involved in cleaning the environment so that diseases will not be spread and the environment will be better for all to live in. Tourist attractions should be closed for some time to empower ecological rehabilitation. Furthermore, ecotourism needs to be bolstered in the country to hold up economic durability and nature conservation.
- **Development and funding eco-friendly products**: the country has developed eco-friendly and biodegradable products such as plastic-like jute bags- Sonali Bag needs to be popularized from the national level. Using organic materials for massive production should be prioritized from the national level to inspire the youth. The vertical gardening practice has been seen in few entrepreneurs but due to lack of knowledge and resources, few people can get in this sector. Hydroponics has been practiced in the southern part of the country for 300 years but it needs to be popularized in the world country to minimize land consumption and sustainable production, even in disasters. Both the private and public sector needs to fund such researches to develop biodegradable consumer products and it will not only help the environment but also the farmers of the country.
- **Responsibility of International agencies:** most of the natural disasters happening right now is caused by high rates of pollution in developed countries and they should take responsibility for it. Although, many international organizations aid Bangladesh for environmental improvement it is not enough to avoid their mistakes. In some cases, the international industries shifted in the country do not maintain environmental policies, this practice should be penalized harshly.

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Appendix

1: Regression for CO2 and GDP Growth Rate

Source	SS	df	MS	Number of obs =	20
				F(1, 18) =	27.20
Model	6.2400e+09	1	6.2400e+09	Prob > F =	0.0001
Residual	4.1294e+09	18	229413358	R-squared =	0.6018
				Adj R-squared =	0.5796
Total	1.0369e+10	19	545762554	Root MSE =	15146

CO2kl	Coef.	Std. Err.	t	P>|t|	[95% Conf.	Interval]
GDPGrowthRate	16661.32	3194.66	5.22	0.000	9949.584	23373.05
_cons	-50984.4	19953.82	-2.56	0.020	-92905.81	-9062.989

2: Regression for CH4 and GDP Growth Rate

Source	SS	df	MS	Number of obs =	19
				F(1, 17) =	14.69
Model	195885270	1	195885270	Prob > F =	0.0013
Residual	226613583	17	13330210.7	R-squared =	0.4636
				Adj R-squared =	0.4321
Total	422498853	18	23472158.5	Root MSE =	3651.1

CH4kl	Coef.	Std. Err.	t	P>|t|	[95% Conf.	Interval]
GDPGrowthRate	3273.569	853.9631	3.83	0.001	1471.864	5075.273
_cons	56425.71	5234.134	10.78	0.000	45382.65	67468.77

3: Regression for N2O and GDP Growth Rate

Source	SS	df	MS	Number of obs =	19
				F(1, 17) =	14.63
Model	54456237.7	1	54456237.7	Prob > F =	0.0014
Residual	63259425.5	17	3721142.68	R-squared =	0.4626
				Adj R-squared =	0.4310
Total	117715663	18	6539759.06	Root MSE =	1929

N2Okl	Coef.	Std. Err.	t	P>|t|	[95% Conf.	Interval]
GDPGrowthRate	1726.014	451.1893	3.83	0.001	774.0882	2677.94
_cons	14751.41	2765.442	5.33	0.000	8916.843	20585.99

4: Regression for HFC and GDP Growth Rate

Source	SS	df	MS	Number of obs =	13
				F(1, 11) =	0.01
Model	1.21995239	1	1.21995239	Prob > F =	0.9131
Residual	1076.64457	11	97.8767792	R-squared =	0.0011
				Adj R-squared =	-0.0897
Total	1077.86452	12	89.8220436	Root MSE =	9.8933

HFCkl	Coef.	Std. Err.	t	P>|t|	[95% Conf.	Interval]
GDPGrowthRate	.2195113	1.966189	0.11	0.913	-4.108041	4.547064
_cons	24.50709	12.55934	1.95	0.077	-3.135821	52.15001

5: Regression for Air Pollution and GDP Growth Rate

Equation	Obs	Parms	RMSE	"R-sq"	F	P
SO2ppb	6	2	1.82922	0.5233	4.390824	0.1042
NO2ppb	6	2	1.951306	0.7100	9.793308	0.0352
O3ppb	6	2	1.138399	0.5479	4.848114	0.0925
COppm	6	2	.0414155	0.7293	10.77605	0.0304
PM25gm3	6	2	6.94552	0.7053	9.575111	0.0364
PM10gm3	6	2	6.412139	0.7798	14.16528	0.0197

	Coef.	Std. Err.	t	P>|t|	[95% Conf.	Interval]
SO2ppb						
GDPGrowthRate	1.551543	.7404415	2.10	0.104	-.5042523	3.607338
_cons	-1.385406	4.888717	-0.28	0.791	-14.95866	12.18785
NO2ppb						
GDPGrowthRate	2.471809	.7898602	3.13	0.035	.2788057	4.664813
_cons	-1.423432	5.215001	-0.27	0.798	-15.9026	13.05573
O3ppb						
GDPGrowthRate	1.014625	.4608072	2.20	0.092	-.2647806	2.294031
_cons	44.11295	3.04245	14.50	0.000	35.66576	52.56015
COppm						
GDPGrowthRate	.0550323	.0167644	3.28	0.030	.0084869	.1015778
_cons	.3232251	.1106859	2.92	0.043	.0159118	.6305384
PM25gm3						
GDPGrowthRate	8.699644	2.811445	3.09	0.036	.8938216	16.50547
_cons	32.85859	18.56238	1.77	0.151	-18.67885	84.39603

6: Regression for Water Pollution and GDP Growth Rate

Source	SS	df	MS
Model	92301535.3	1	92301535.3
Residual	1.1836e+09	19	62297124.7
Total	1.2759e+09	20	63797345.2

Number of obs	= 21
F(1, 19)	= 1.48
Prob > F	= 0.2384
R-squared	= 0.0723
Adj R-squared	= 0.0235
Root MSE	= 7892.9

SolidWastet~s	Coef.	Std. Err.	t	P>|t|	[95% Conf.	Interval]
GDPGrowthRate	1599.328	1313.914	1.22	0.238	-1150.726	4349.382
_cons	10960.84	8037.824	1.36	0.189	-5862.523	27784.2

7: Regression for Resource Constraints and GDP Growth Rate

Source	SS	df	MS
Model	7.7427e+09	1	7.7427e+09
Residual	2.5952e+11	19	1.3659e+10
Total	2.6727e+11	20	1.3363e+10

Number of obs	= 21
F(1, 19)	= 0.57
Prob > F	= 0.4607
R-squared	= 0.0290
Adj R-squared	= -0.0221
Root MSE	= 1.2e+05

ResourceCon~e	Coef.	Std. Err.	t	P>|t|	[95% Conf.	Interval]
GDPGrowthRate	14648.04	19455.57	0.75	0.461	-26072.93	55369.02
_cons	-6482.317	119018.8	-0.05	0.957	-255591.4	242626.8

8:Relevant SDG Goals and Related Indicators for the Study

Goals	Target	Indicators
GOAL 9: Build resilient infrastructure, promote inclusive and sustainable industrialization and foster innovation	9.4: By 2030, upgrade infrastructure and retrofit industries to make them sustainable, with increased resource-use efficiency and greater adoption of clean and environmentally sound technologies and industrial processes, with all countries taking action under their respective capabilities	9.4.1: CO2 emission per unit of value-added
GOAL 11: Make cities and human settlements inclusive, safe, resilient and sustainable	11.6: By 2030, reduce the adverse per capita environmental impact of cities, including by paying special attention to air quality and municipal and other waste management	11.6.1: Proportion of urban solid waste regularly collected and with adequate final discharge out of total urban solid waste generated, by cities 11.6.2: Annual mean levels of fine particulate matter (e.g. PM2.5 and PM10) in cities (population weighted)
GOAL 12: Ensure sustainable consumption and production patterns	12.2: By 2030, achieve the sustainable management and efficient use of natural resources 12.4: By 2020, achieve the environmentally sound management of chemicals and all wastes throughout their life cycle, by agreed international frameworks, and significantly reduce their release to air, water and soil to minimize their adverse impacts on human health and the environment 12.5: By 2030, substantially reduce waste generation through prevention, reduction, recycling and reuse 12.c: Rationalize inefficient fossil-fuel subsidies that encourage wasteful consumption by removing market distortions, by national circumstances, including by restructuring taxation and phasing out those harmful subsidies, where they exist, to reflect their environmental impacts, taking fully into account the specific needs and conditions of developing countries and minimizing the possible adverse impacts on their development in a manner that protects the poor and the affected communities	12.2.1: Material footprint, material footprint per capita, and material footprint per GDP 12.2.2: Domestic material consumption, domestic material consumption per capita, and domestic material consumption per GDP 12.4.1: Number of parties to international multilateral environmental agreements on hazardous waste, and other chemicals that meet their commitments and obligations in transmitting information as required by each relevant agreement 12.4.2: Hazardous waste generated per capita and proportion of hazardous waste treated, by type of treatment 12.5.1: National recycling rate, tons of material recycled 12.c.1: Amount of fossil-fuel subsidies per unit of GDP (production and consumption) and as a proportion of total national expenditure on fossil fuels
GOAL 13: Take urgent action to combat climate change and its impacts	13.2: Integrate climate change measures into national policies, strategies and planning	13.2.1: Number of countries that have communicated the establishment or operationalization of an integrated policy/strategy/plan which increases their ability to adapt to the adverse impacts of

		climate change, and foster climate resilience and low greenhouse gas emissions development in a manner that does not threaten food production (including a national adaptation plan, nationally determined contribution, national communication, biennial update report or other)
	13.a: Implement the commitment undertaken by developed-country parties to the United Nations Framework Convention on Climate Change to a goal of mobilizing jointly $100 billion annually by 2020 from all sources to address the needs of developing countries in the context of meaningful mitigation actions and transparency on implementation and fully operationalize the Green Climate Fund through its capitalization as soon as possible 13.b: Promote mechanisms for raising capacity for effective climate change-related planning and management in the least developed countries and small island developing States, including focusing on women, youth and local and marginalized communities	13.a.1: The mobilized amount of United States dollars per year starting in 2020 accountable towards the $100 billion commitment 13.b.1: Number of least developed countries and small island developing States that are receiving specialized support, and amount of support, including finance, technology and capacity-building, for mechanisms for raising capacities for effective climate change-related planning and management, including focusing on women, youth and local and marginalized communities
GOAL 14: Conserve and sustainably use the oceans, seas and marine resources for sustainable development	14.1: By 2025, prevent and significantly reduce marine pollution of all kinds, in particular from land-based activities, including marine debris and nutrient pollution	14.1.1: Index of coastal eutrophication and floating plastic debris density
GOAL 15: Protect, restore and promote sustainable use of terrestrial ecosystems, sustainably manage forests, combat desertification, and halt and reverse land degradation and halt biodiversity loss	15.3: By 2030, combat desertification, restore degraded land and soil, including land affected by desertification, drought and floods, and strive to achieve a land degradation-neutral world 15.4: By 2030, ensure the conservation of mountain ecosystems, including their biodiversity, to enhance their capacity to provide benefits that are essential for sustainable development	15.3.1: Proportion of land that is degraded over a total land area 15.4.1: Coverage by protected areas of important sites for mountain biodiversity

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