

“Estimation of Greenhouse Gas emissions and their impact on the Planet Earth”

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ABSTRACT

Aim and Objective: This project aims to develop relational databases about the greenhouse effect and its factors. This includes greenhouse gas sources, changes in particle pollution concentrations, how the greenhouse effect is causing temperatures to rise, melting of polar ice caps, and rising sea levels, among other things. The objective is to collect data from numerous online sources and turn it into relational databases, establishing relationships between distinct entities and making it easier to retrieve specific data.

Background: The use of these fossil fuels has resulted in a new global concern. It's known as the Greenhouse Effect. The release of greenhouse gases causes this impact. These gases will build up in the atmosphere and block the emitted heat, causing global temperatures to rise¹². We picked this topic to do more study into these consequences and give a compelling conclusion to raise public awareness and ensure that the future is both better and more prosperous.

Materials and Methods: We used MySQL to establish databases for various entities and Tableau to showcase the data we wanted to share with the rest of the world. The project's primary purpose is to depict the immense harm that the planet has suffered through time, in this case since the nineteenth century.

Results: After analyzing the data, we noticed an increase in global temperatures, sea level, and reduction of the glacier masses constantly over five decades, during which the Industrial Revolution picked up its pace across the world.

Conclusion: This initiative enables us to comprehend the magnitude of greenhouse gas emissions and how their implications negatively impact the ecosystem. This project will assist us in better understanding the aspects that play a critical role and allow us to delve into the depths of the losses that have been incurred.

Keywords: Greenhouse gases, Global warming, Temperature, Sea level, Greenhouse sources, Glaciers.

Background

Global warming is a severe problem that has gone unnoticed for too long. However, when nations began to recognize the potential harm it poses to the planet, they began researching and developing strategies to compensate for the damage. However, given the rate at which we consume nonrenewable resources, such as fossil fuels, and produce greenhouse gases, the threat is immediate and greatly surpasses our efforts. The issues addressed by this project are entirely connected to the greenhouse effect produced by the unwise use of fossil fuels and its implications, such as rising temperatures, melting polar ice caps, rising mean sea levels, and the inevitable submergence of coastal areas. Because there is a big uproar in society to move toward greener alternatives, we believe it is high time for every one of us to take responsibility and consider future generations.

Climate change is a contentious topic across the world. Climate change's consequences are already being felt, and the consequent damage will be

massive globally⁶. According to recent studies, the Earth's global temperature has risen at an alarming rate over the previous decade, mainly owing to greenhouse gases generated when humans use fossil fuels. The most common Greenhouse gases include water vapor, carbon dioxide, methane, nitrous oxides, and ozone¹. The global mean sea level is rising because of global warming.

The melting of glaciers and ice sheets throughout the world because of rising temperatures has increased the volume of the ocean. According to several experts, the temperature change is the most important climatic variable determining historical and future global changes in mountain glaciers and ice caps⁹. Both precipitation and evaporation rates increase globally, speeding up our planet's water cycle⁷. It is necessary for lowering greenhouse gas emissions. An increase in air quality is one of the advantages of lowering greenhouse gas emissions⁵. In terms of reducing greenhouse gas emissions, significant progress has been made. A transparent climate debt index was created, incorporating historical CO₂ and CH₄ emissions from greenhouse

gas emissions. It covers 205 nations and is based on emissions, longevity, and radiative forcings¹⁰. We picked this topic after reviewing most of the literature on global warming to help study the fundamental factors of global warming.

The project assists us in analyzing and identifying the major environmental components. There is much research in various sectors, but we're attempting to put it all together to create a complete picture of what's going on throughout the world. This effort is trying to fill gaps that exist between the dots. The initiative will also help us understand why electric vehicles and greener, cleaner energy solutions are essential for the future. We will have a unified database to locate all the causes and effects in a single database by the conclusion of this project.

Methods

Data collection

We began gathering data from various sources, including the internet, scholarly journals, and data collected by multiple labs worldwide. We attempted to link the consequences of greenhouse gas emissions, such as rising global temperatures will cause polar temperatures to rise, resulting in the melting of polar ice caps and the pumping in of more and more water to oceanic bodies, raising Global Mean Sea Levels and eventually flooding coastal communities. We narrowed our data search to these domains after considering all these factors, and we were successful in gathering data from numerous labs, academic journals, and the internet.

Data description and cleaning

We have used five datasets in total. The Different_greenhouse_gases⁸ dataset contains all information about the quantity of greenhouse gases emitted by various developed and developing countries (1990-2019). Aside from that, this dataset includes information on the emissions of several greenhouse gases such as carbon dioxide, nitrous oxide, hydrofluorocarbons, perfluorocarbons, methane, and nitrogen trifluoride. The Different_greenhouse_sources⁸ dataset contains information about several sources/fields of the economy that contribute to most greenhouse gas emissions, such as industries, agriculture, waste, and energy. The data covers 30 years (from 1990 to

2019), and the emissions from various nations are tabulated.

Temperature_change_data⁴ is a collection of data relating to temperature changes worldwide for 50 years. This data is so detailed that it tells us how much the temperature has risen yearly. Instead of comparing temperatures, we'll concentrate on the temperature differences over time, such that projecting the data with the assistance of a tableau is simple, and we can visualize this using a line graph or a bar graph.

The Glaciers² data set will estimate how much snow cap melts each year (in inches). This dataset also contains information on how often the data was gathered each year, which may be interpreted as an average number for how much snow melts each year. The melting of ice caps has resulted in rising sea levels. The Sea_levels³ data set gives us an idea about how Global Mean Sea Levels are growing by the day, and to demonstrate this, we used data from the mid-nineteenth century to illustrate that sea levels are rising at an alarming rate. Coastal regions will be submerged sooner or later.

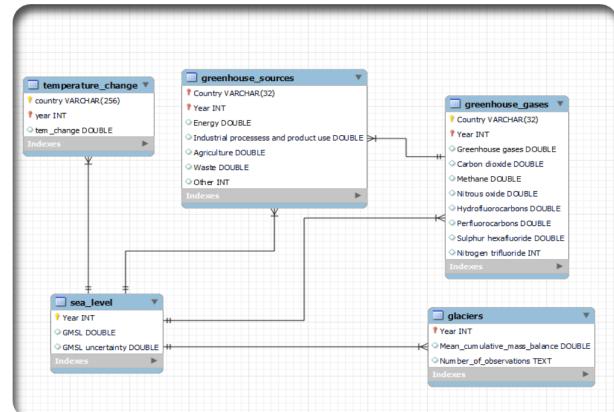


Fig. 1 Entity Relationship diagram

Tools

We utilized MySQL and phpMyAdmin to do SQL operations such as creating tables, adding constraints to the table, inserting data into the table, and retrieving data from the table. The terminal is also utilized to accomplish the same to save time and speed up the operation. The ER diagram (Fig. 1, 4) was created to show the tables, properties, and connections. The MySQL workbench and Terminal are used to import data. We mainly used MySQL

workbench on our local machines to lay the groundwork because we didn't have access to create new databases in phpMyAdmin and reduce discrepancies between existing tables inside it, as well as its drawback of improper data importing due to various reasons such as file size and higher number of rows. We can upload the queries to the shared database in minutes if necessary.



Fig. 2 Connectivity between the tools used.

Tableau was chosen for data visualization because it is adaptable and offers many built-in features for displaying dashboards and graphs more viewer-friendly manner. Because ours is a research project that relies entirely on historical data collected from various sources around the world, as well as data from multiple countries, we decided that the tableau would do the job better in terms of providing a graphical representation of the statistics by utilizing the tableau's world maps functionality. Apart from that, Tableau can replicate the entire database, and all our queries can be made inside Tableau using the custom SQL editor, allowing us to develop additional dashboards. Because tableau enables joins, we may combine numerous joins with building complex outputs tailored to our research concerns (Fig. 3). Tableau makes creating distinct dashboards with many graphs and varied filtering conditions easier than any other visualization tool. Tableau's practicality and versatility drew us to it in the first place. The connectivity between the tools is shown in Fig. 2.

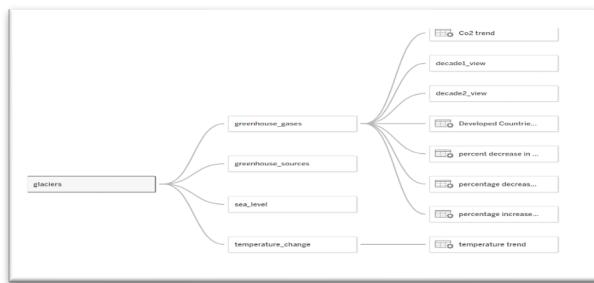


Fig. 3 Tableau connectivity with the database

Data analysis

We used our local computer to store all the datasets, and then we connected the local machine to the MySQL server or phpMyAdmin using the command line, and the files were imported to the server. The queries will be written here, and we'll obtain a raw, tabular result. The MySQL server/phpMyAdmin will then be linked to Tableau through specific drivers found online. After establishing a connection, we created visualizations by importing data from our database. The data will be dynamically populated, which means that any changes we make to the data in the database will instantly reflect in the tableau. There is bidirectional communication between SQL and Tableau.

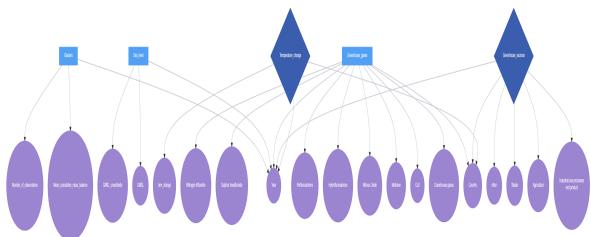


Fig. 4 Chen's notation for the database

Firstly, the data is reviewed and inspected to ensure that it contains fewer null values and is entirely relevant to our study concerns. We stored the data in spreadsheets after cleaning it. We subsequently moved our emphasis to develop a database for the same once the data was available. We attempted to make entities that were linked to each data collection. We kept in mind that each entity should be related, and we made sure that this was done when building the database.

After creating the database, we imported the data and worked on the entities. We then worked on the mandatory constraints for the robustness of the database. We began querying the data with the aid of SQL queries we had learned so far after applying the constraints and ensuring that our entities were entirely ready. We tried to filter out the data and get the data relevant to our project's research objectives using all the aggregate functions, joins, sub-querying techniques, etc. We then switched to Tableau, where we linked our database to the Tableau Server and started visualizing the queries.

Results

Data Analysis

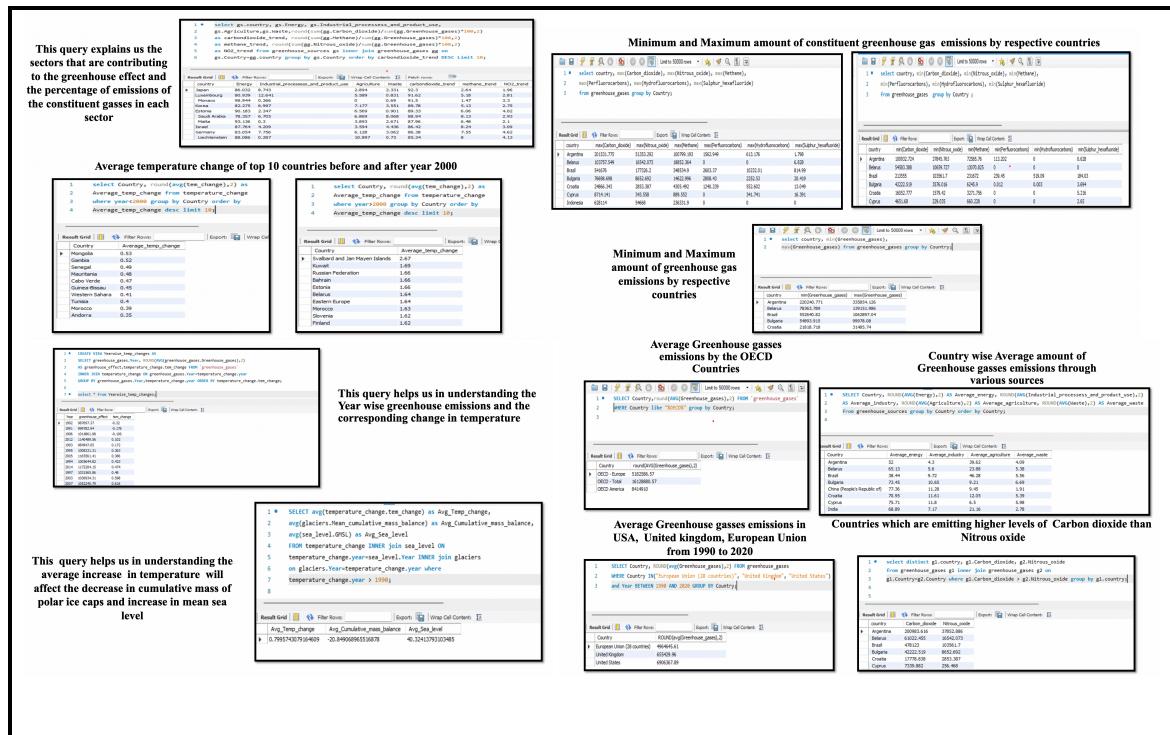


Fig. 5 Screenshot displaying SQL queries to support the research question

The queries we used mainly focus on finding the lowest and highest amounts of greenhouse gas emitted by various countries worldwide and individual amounts of constituent gasses. After calculating these values, we have dived into intricate queries that can help us identify the percentage of emissions emitted by various sectors worldwide. The rate of constituent gasses emitted from each industry is also incorporated so that for each sector, the corresponding constituent greenhouse gas emissions are visible. We calculated the amount of greenhouse gas emissions by developed nations like the United States, the United Kingdom, European Union, and OECD to get an idea about the primary culprit amongst the group of gasses (Fig. 5). We found out that Carbon dioxide is the primary greenhouse gas that is being emitted, and it is being emitted from the Energy sector. We tried to identify a relationship between Carbon Dioxide and Nitrous Oxide and the countries emitting more CO₂ than NO₂. We succeeded in

projecting a connection between the rise in greenhouse gas emissions and the change in temperature over twenty years. The maximum difference in temperature we observed was 1.5°C, and the average temperature increase was 0.8°C. We observed that the colder regions near the poles are more heated than the hot and humid regions near the equator. As a result of this temperature rise, we observed an average decrease in Global Polar Icecaps by 20 meters and a moderate rise in Sea level by 40 meters. We created two separate views to see the temperature differences in the previous decade and the temperature differences in the current decade. Then we tried to join both the views to project the countries that have increased greenhouse gas emissions from the previous decade and the countries that have decreased greenhouse gas emissions (Fig. 6). This shows us that several developed nations have reduced greenhouse gas emissions, and it shows that they are implementing strict laws to curb this issue.

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Percentage increase and decrease in the green house gases emissions between 2 decades
Decade 1 - 1990 to 2000
Decade 2 - 2000 to 2020

CREATE VIEW decade1 AS SELECT Country, MAX(avg(greenhouse_gases)) AS
AS decades FROM greenhouse_gases WHERE Year BETWEEN 1990 AND 2000 GROUP BY Country
CREATE VIEW decade2 AS SELECT Country, MAX(avg(greenhouse_gases)) AS
AS decades FROM greenhouse_gases WHERE Year BETWEEN 2000 AND 2020 GROUP BY Country

-- 1. select d1.Country,d1.decade1,d2.decade2;
2. ROUND((d2.decade2-d1.decade1)/d1.decade1)*100,2
as percentage_increase_in_greenhouse_gases from decade1 d1
as decade2 d2 where d1.Country=d2.Country
where d1.decade1<d2.decade2
order by percentage_increase_in_greenhouse_gases desc limit 10

```

Result Grid	Filter Rows
<pre> Country decade1 decade2 percentage_increase_in_greenhouse_gases China (People's Republic of) 45251.17 1008378.00 22.04 United States 45021.36 1007210.00 21.96 Russia 34537.36 65192.81 19.34 Indonesia 25800.00 52000.00 19.26 Brazil 25200.00 49028.34 19.21 Chile 24651.93 52152.52 21.56 Korea 24000.00 48000.00 20.83 Argentina 23500.00 47000.00 20.92 Brazil 23051.49 491951.15 20.21 Peru 22800.00 47000.00 20.87 Croatia 9244.67 22552.46 26.15 </pre>	

Fig.6 SQL query to display temperature change

Data Visualizations

We have clustered the visualizations broadly into three categories.

1. Visualizations related to greenhouse gas emissions and their constituent gasses (Fig. 7).
2. Visualizations related to greenhouse gas emissions and the primary sources of emissions (Fig. 8).
3. Visualizations related to temperature change and sea-level changes (Fig. 8, 9).

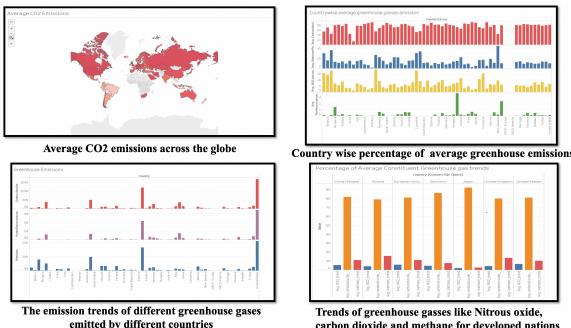


Fig.7 Screenshot displaying Visualizations

1. Visualizations related to greenhouse gas emissions and their constituent gasses:

The visualizations show the Average CO2 emissions, represented on the world map. As we can see, the redder the graph is, the more amount of CO2 is being emitted into the atmosphere. We can say that since Asian regions are highly populated, the emissions are more, and since the developed countries like the USA, UK, and Europe have more industries, the emissions are more. We also tried to plot the country-wise average greenhouse gas emissions to understand the amount of individual constituent gasses. We also plotted the trend of greenhouse gas emissions emitted by different countries. We also plotted greenhouse gasses like

Nitrous Oxide, carbon dioxide, and methane trends for developed nations. These visualizations show that Carbon dioxide is the primary culprit, followed by Nitrous oxide and Methane.

2. Visualizations related to greenhouse gas emissions and the primary sources of emissions:

These visualizations primarily focus on the sectors responsible for the greenhouse effect. We concluded from the graphs that the Energy sector is the primary source, so we must investigate better, cleaner, and more reliable alternatives to generate energy. We also saw a constant trend of energy being the primary source but a decline in trend for other sectors. This tells us that other sectors are adapting better techniques that help in reducing greenhouse emissions.

3. Visualizations related to temperature change and sea-level changes:

We plotted a graph representing the relation between the change in temperature and the rise in greenhouse gas emissions. As we can see, though there are fluctuations in the greenhouse emissions, there is a constant increase in temperature slowly but surely. We plotted a graph between the decline in polar ice cap levels and the increase in the mean sea level. There is a downward trend going on in between both the attributes. We plotted two more graphs which show the percent increase in temperature from the last decade, whereas the other one shows the percentage decrease in the temperature.

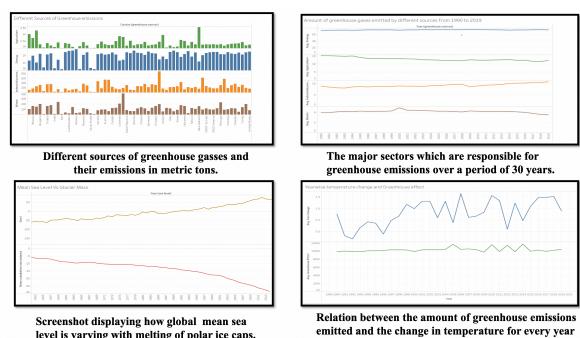


Fig. 8 Screenshot displaying Visualizations

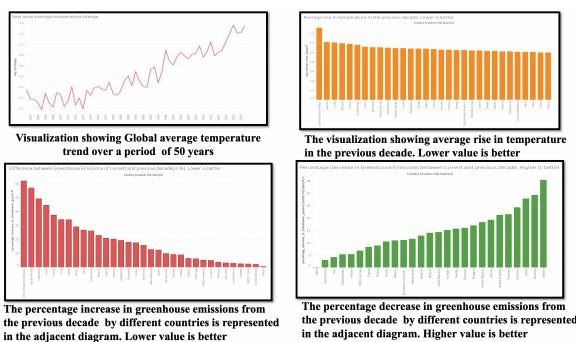


Fig. 9 Screenshot displaying Visualizations

Discussion

The primary goal of this initiative is to identify the problems created by the greenhouse effect and raise public awareness about its severe and catastrophic consequences. We attempted to use the DIKW pyramid in our project and began looking for data. After scouring the internet and other research journals, we obtained enough facts to support the research ideology. The DIKW pyramid (Fig. 10) comprises the following elements.

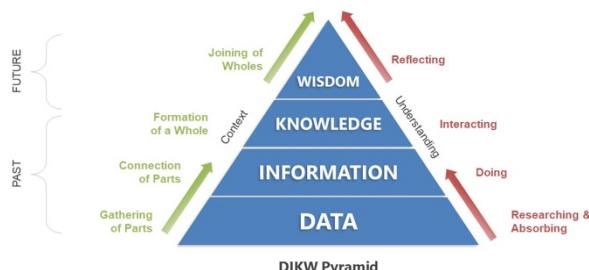


Fig. 10 The DIKW Pyramid
Data→Information→Knowledge→ Wisdom

Data

We gathered information from various sources and organized it into spreadsheets for simple access. The data initially made little sense because it was just numbered, but we arrived at our final datasets after condensing the data based on qualities and joining columns. Finally, we were left with datasets containing information on the number of different greenhouse gases emitted by other countries, different areas that emit these greenhouse gases, changes in global temperatures, changes in the concentration of the Polar ice caps, and an increase in the Mean Sea Level. We moved on to the next phase of the pyramid once these datasets were accessible.

Information

We began identifying the essential information from the datasets after they were merged. The conclusions we drew from the data are unmistakable. The data pertains to the amount of greenhouse gases emitted (in metric tons) by various countries throughout the world, the areas that play a crucial part in those greenhouse emissions, and the consequences of this effect, such as temperature rises, rise in mean sea levels, and so on. The numerical values of the qualities over time make up the data. While some evidence spans two centuries, others are only a few decades old, as the consequences have only recently become apparent. As a result of this research, we began to understand how the greenhouse effect is slowly but steadily destroying our planet.

Knowledge

The databases provide a wealth of data that is both interesting and thought-provoking. We intended to transfer the data we have in the form of datasets into a database where we could break different effects into different entities and build their own tables. We started querying the databases concerning the research questions we had in mind at the outset of the project after the databases were formed and the links were established. The primary goal of our study was to identify the principal industries that are contributing to these emissions, as well as the significant hazardous gases that these sectors are emitting throughout the world. We selected the method of grouping the data by the nation to determine the average values of these emissions and the greatest and minimum values for each country, and the Top 10 countries responsible for this effect. After our investigation concluded, we compared the gas emissions to other gas emissions to see which ones were the most prevalent. This is eye-opening since we discovered that carbon dioxide is the principal pollutant responsible for this impact, with other dangerous gases following closely behind. So, to back up our claim, we compared the emission values of carbon dioxide and other gases. Then, using a model, we looked at the consequences of this impact based on our data. We began querying data associated with the Temperature Change entity. We discovered a decline in the early twentieth century but that there has been an increase since then. Temperatures are rising steadily and significantly worldwide. As a result, we considered

considering a worldwide average of this temperature change as an average rather than selecting a country. The melting of polar ice caps is an immediate result of this temperature rise, as is the increase in Global Mean Sea Levels. So, we tried to link these tables to see whether this assumption is correct. The results, unsurprisingly, backed the hypothesis since there is a significant shift in Cumulative Ice Concentration in the polar ice caps and a continual and alarming rise in sea level. We also attempted to link the amount of greenhouse gases generated globally and global temperature changes. By connecting our database to the Tableau Server, we created various dashboards in Tableau. Our results have allowed us to construct stunning dashboards that enable even an ordinary person to glance through tedious and enormous data and understand what's happening instantly and easily, which is the project's primary goal. So far, we have addressed several research issues that we had at the start of the project, and by the conclusion, we will have answers to the remaining ones.

Wisdom

The wisdom our project imparts is that many developed countries, in the name of modernization and industrialization, are unintentionally laying a path to global devastation. According to our findings, the temperature change is evident. There is a higher risk of this temperature change value increasing every other year; if this continues, we will see catastrophic outcomes sooner than we expect⁷. The melting of the polar ice caps will reduce the density of ice accumulation at the poles, destroying wildlife and other natural resources there. Every chance that this melted ice will join the oceans and gradually raise the sea level, submerging many coastal areas¹¹. The Earth becomes inhabitable due to the temperatures skyrocketing, there won't be enough land to accommodate the ever-growing population, and there will be complete chaos everywhere. So, with the wisdom this project has provided us, we are tenants here, and as tenants, we should use the resources available more vigilantly while not plundering the entire wealth available; we should move toward greener alternatives for energy production, the use of Electric Vehicles should be promoted everywhere, and governments should bring in more and more carbon-neutral policies and enforce them in every sector. If this happens, the future generations will

live up to tell tales with a bright smile on their faces and a green, clean Earth around them¹³.

Special Considerations

Since we are using statistical data collected from different sources, the data is primarily numerical. We tried to reduce the number of null values present in the data as it might affect the output of the queries. We came up with multiple primary critical approaches for some tables as it is challenging to use a single attribute as a primary key as the data is repeating. Choosing multiple primary keys allowed us to combine them into attributes, a unique key. We used aggregate functions like Average, max, count, etc., rigorously in our queries as it gives us an exact big picture of all the available data points. We used inner joins in multiple questions to combine multiple tables to fetch meaningful information from our data. So far, it has worked perfectly, and we can bring the data without any issues. We tried to implement some questions using Tableau instead of MySQL using Tableau's Custom SQL query editor.

Challenges

We were importing data with null values if we used MySQL import wizard or PHPMyAdmin, inbuilt import wizard. We used the command line to import data that worked like a charm to overcome this. We used the following syntax to import data using the command line.

Conclusion

The analysis we did during our project proved our initial assumptions regarding the effects of the greenhouse effect. So far, the beliefs we had and the research questions we had are ascertained by our results. Apart from proving it, this project has given an insight into the extent of the damage that has been caused so far due to the irresponsible and unquenchable thirst for energy.

Carbon dioxide is the primary culprit, reaping the greenhouse effect. So appropriate measures should be taken to curb the CO₂ emissions in all possible ways. The average temperature change between the previous decade and the current decade is astonishing. Our research shows that the cooler regions are becoming hotter and hotter by the day. There is an average rise in temperature of 0.8 degrees Celsius globally, which led to the melting

of 20 meters of polar ice caps, leading to the increase of sea level by 40 meters. If this continues, our coastal areas will soon be submerged under oceans. The energy sector is the leading emitter of greenhouse gasses. This includes Thermal energy and automobiles since they both use fossil fuels to generate power. Better, greener, and safer ways of generating energy should be implemented. Developed nations have more industries, but they should develop stricter and more efficient laws to prevent this chaos from getting out of hand. They should develop better and more able initiatives to follow other countries. We also found that out of all Sources of greenhouse gasses, The Energy sector (which includes both fossil fuels for vehicles and Power generation) is causing the most damage, followed by the industrial sector. We also found that out of all Sources of greenhouse gasses, The Energy sector (which includes both fossil fuels for vehicles and Power generation) is causing the most damage, followed by the industrial sector. We also proved that Carbon dioxide is the primary effluent emitted by the industries, and other sectors are contributing more to this havoc when compared to other dangerous gasses. We also found that cold and polar regions also see a surge in temperature apart from hot and humid areas, which can wreak havoc not today but tomorrow. Overall, this project helped us shed light on the dark places of the greenhouse effect with valid and viable proof.

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