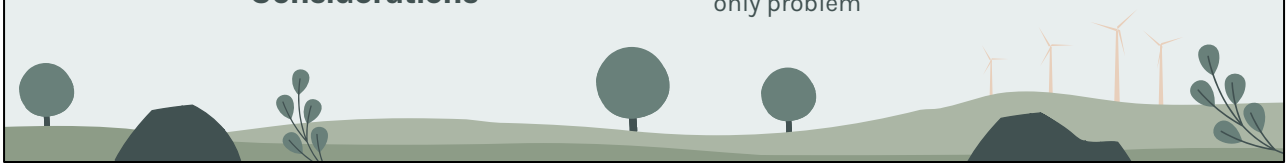
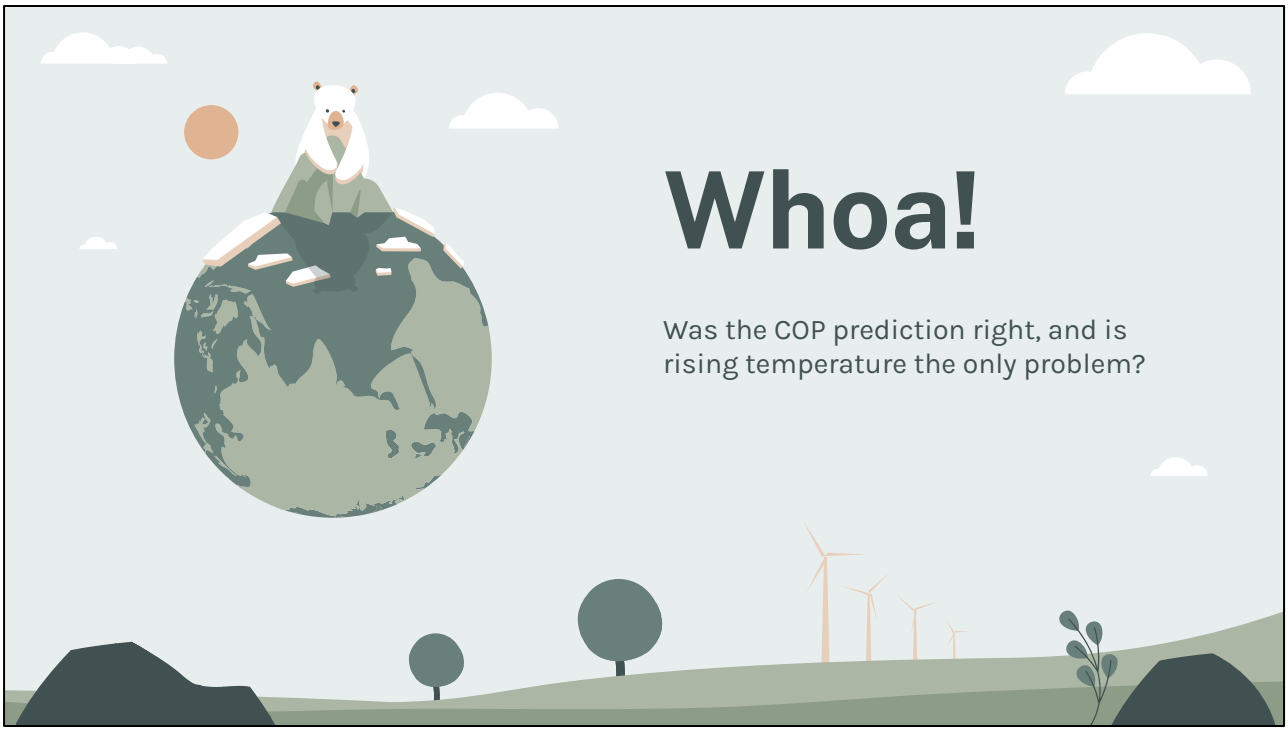
Capstone- Climate Change

The effects, the players, the disasters

Table of contents

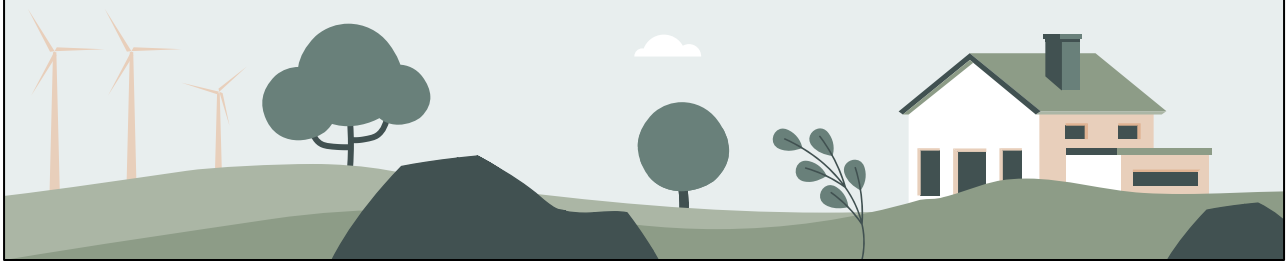




Set out the Aim

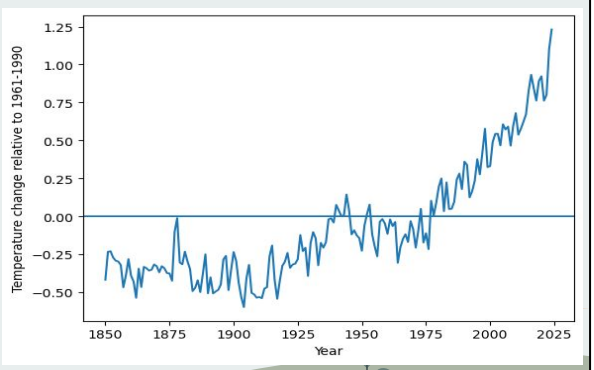
01 The Claim

Why CO_2 is the focus?



1.5C? Wasn't it 2C?

- Since the 60s, Scientists agreed a 2C increase was the limit at which we must maintain (1975 first mention, William Nordhaus, economist)
- After COP26(2021), it became 1.5C
- Is it rising?
- Why relative to the 60s?
- Is this metric targeted?



Whilst studies were being done, first public, major claim for 2c was in 1975
Global industrialisation(UK and USA), depression and war are the only reason it didn't keep going up
So people were optimistic/not worried about the increasing co2 levels
Plus, the benefits of industrialisation were more imminent and obvious preferable to an unseen danger

Contributors

Everyone knows of CO_2, Methane, N_2O, and CFCs

But what about water vapour

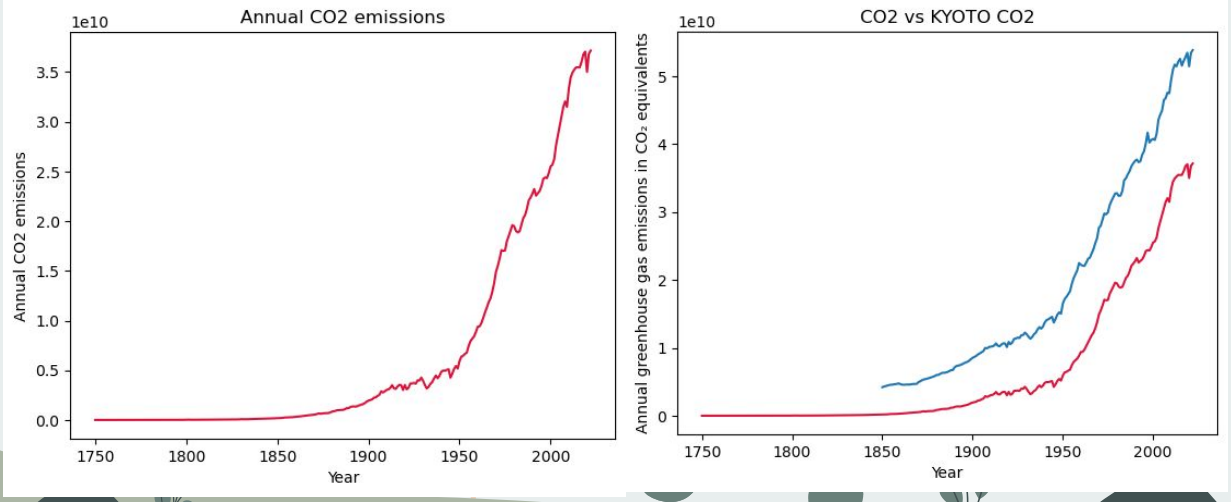
Actually, the 2 top contributors to the warming effect are H_20 and CO_2, but we actually have less direct control on H_20

CO_2 actually has a smaller Global Warming potential than methane and NO_2, but there is so much more of it in the atmosphere

-British Geological Survey

Ch4 23 times, n20 296 times,
So why focus co2, if it has such a small effect
Water vapour accounts for 50%, but that falls out and in constantly, and only gets affected by temp, which we warm through global warming, co2 about 25%
So why focus on co2?

But CO2 increases massively



Explain KYOTO, and point out that majority ghg increase is caused by co2
Talk about global industrialisation (China, Russia, India)
All in tonnes, mass
This is why we focus on CO2 - Because, almost entire increase is the co2 increase
Named after kyoto protocol 1997

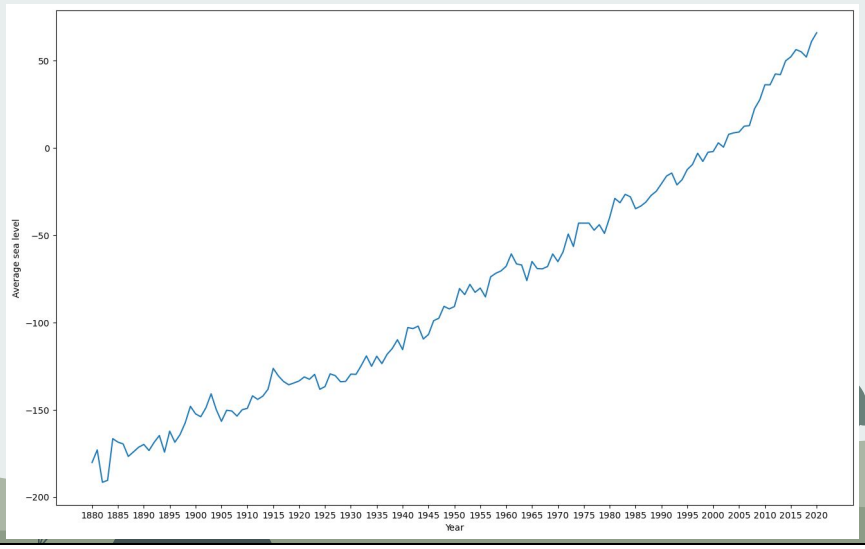

02
The Effects

Sea Level

Sea level is relative to average between 1993 and 2008, around the 2000 mark, as the rates of increase were noticeably bigger.

1900-1990 ~ 1.2-1.7mm per year on average

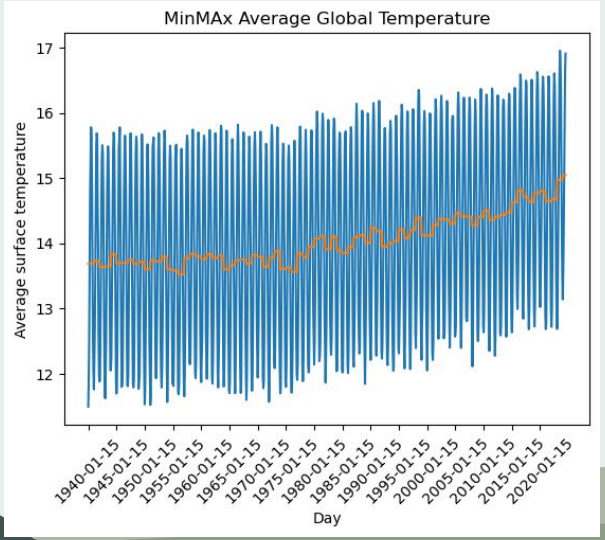
2000 - 3.2mm per year
2016 - 3.4mm per year
- Smithsonian Ocean



Reason for the much later sharp increases could be the fact that global warming didn't mean that the ice caps melted more until later, and thermal expansion.
This also has a Global warming effect, more water in our water cycle/melting ice caps from rising temperatures, which in turn adds to the GW effect due to the increase of potential water vapour in our air at any one time. It's a vicious feedback loop.

Global Temperatures

Whilst small, clear upward trajectory over time, in both maximum and minimum temperatures



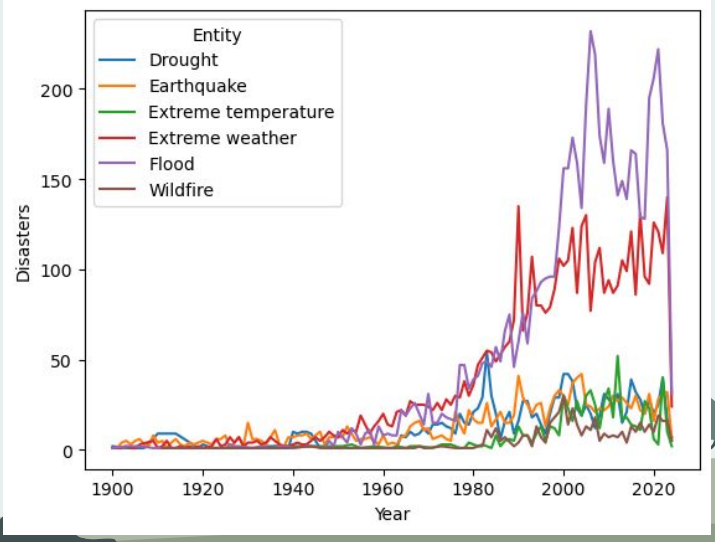
These are not just the global temperature, but the average surface temperatures across the world, and we can see that it is increasing in all spans of the globe. This ties in later regarding how this affects those inputting emissions. As well as this is just the surface, not by country, which we shall explore later.

Natural Disasters

Sudden drop is due to it still being 2024

But as we can see, Floods and Extreme Weather get more frequent as time goes on.

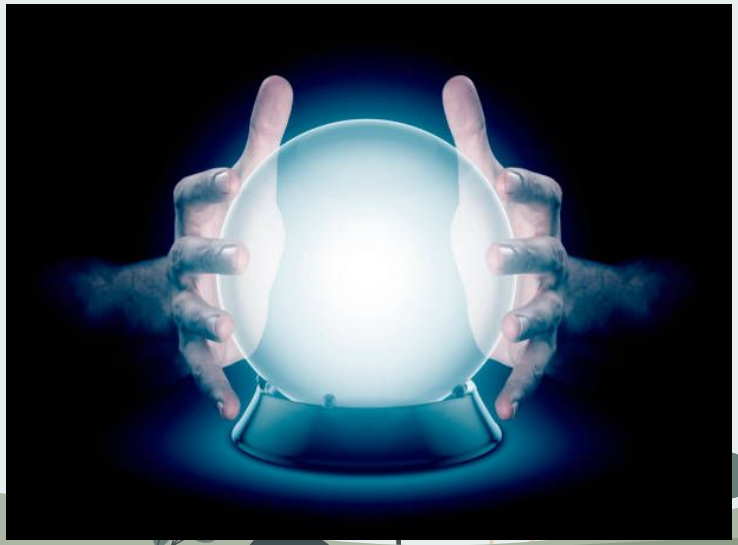
Extreme temperature and Drought can be explained by disproportionate effect. Not that many countries would feel the extremes of these as majority not situated at the equator or poles.



Whilst small, there are still increases in other aspects, but again, the environment for most countries wouldn't induce these problems, and so a disproportionate amount of countries will feel the effects of certain disasters. We will discuss this further later So what are we going to model?

Predictions and Impact

03



https://media.istockphoto.com/id/933666298/photo/hands-on-crystal-ball-and-cryptocurrency.jpg?s=612x612&w=0&k=20&c=rWJ_caa0AZCHYB09wkcLRghIYGZmGqfYe8D2l1JNZE8=

Modelling

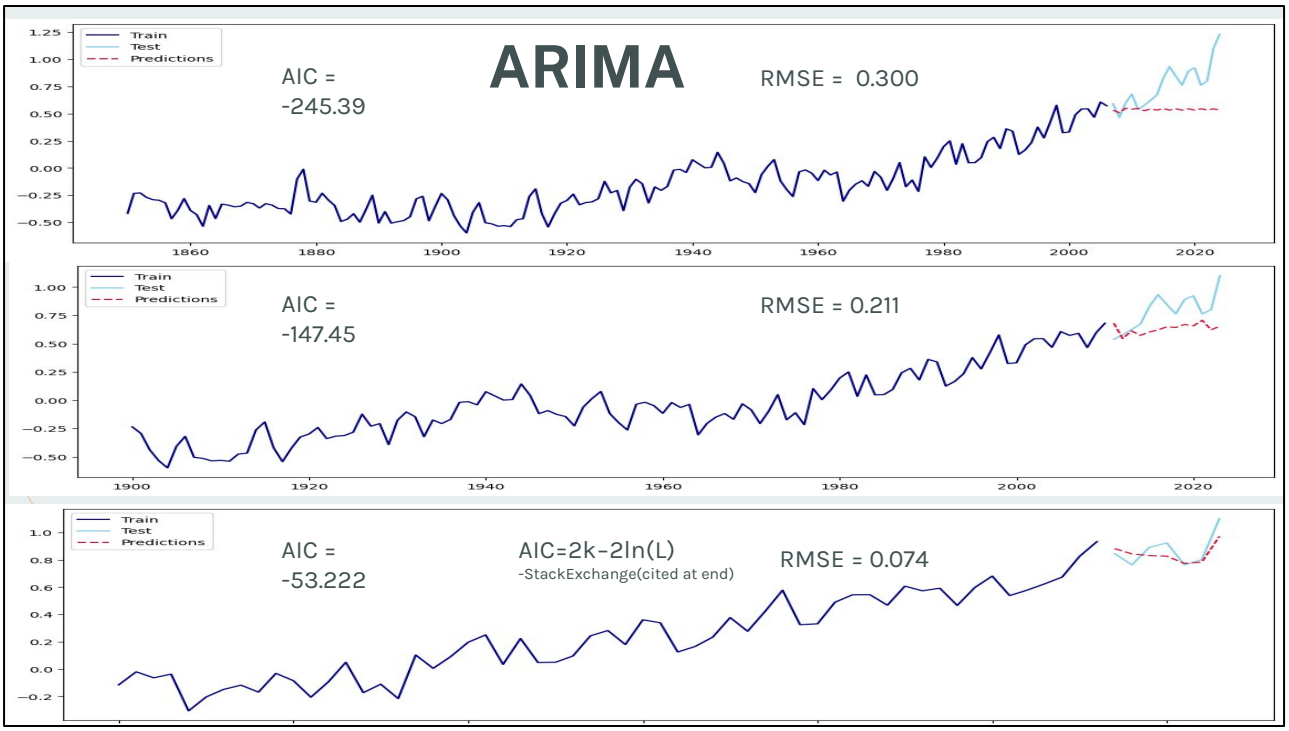
- ARIMA
- VAR
- RNN, (LSTM and GRU)

Why these?

Only Global data

And progressive input?

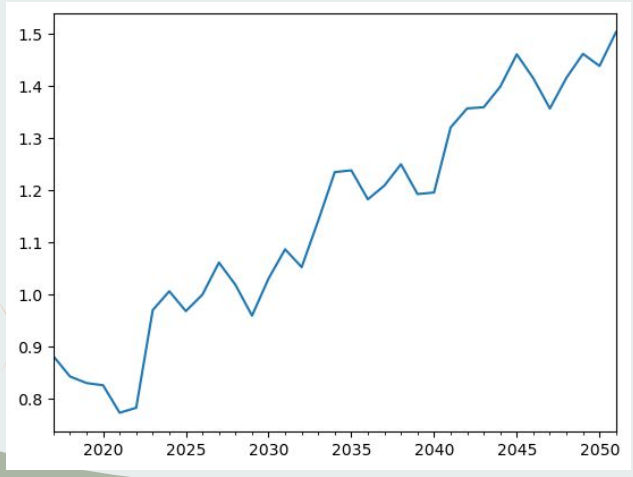
ARIMA is good for single series for a simple predictions to see if there are patterns in just simply frequency/results over time
VAR is good for interdependencies, will be more accurate if our hypothesis that all these things influence each other are true
RNN to help pick up hidden patterns we could not do
Explain nature of RNN and sequence data
Only Global as environment isn't really contained in the metrics that we have chosen.
Progressive input didn't seem as necessary, time, and we'll explain later



This is on global temperatures
More of a pattern and problem starting from the 60s, as we have stated earlier.
As we make exclude more known periods of time where industrialisation halted, due to war and such, we get a better aic, going from, -245.39, -147.45, to -53.22.
AIC may be “lower” but the super negative value indicates overfitting in this manner, as the more data without trend, shows a “lower” score, but too negative, shown to be closer to the absolute values, when contrasting to it’s predictive power, the RMSE shows different. So “lower” not always better. We want low, but not overfit.
AIC isn’t a stand alone metric, but something that finds balance in data, complexity, and prediction. Must be interpreted by the user. So whilst lower is always good, it must be contrast by other metrics at times.
Here, negative is not what we want.

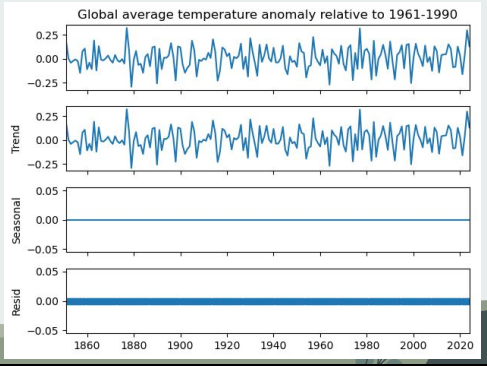
Explain likelihood and still closer to 0 preferred. negative= closer to absolute value, likelihood, but likey due to the simple nature of the data
This shows that perhaps we should only really take into data that starts 1960, as we saw similar trends in the sea level and disasters EDA.

ARIMA forecast



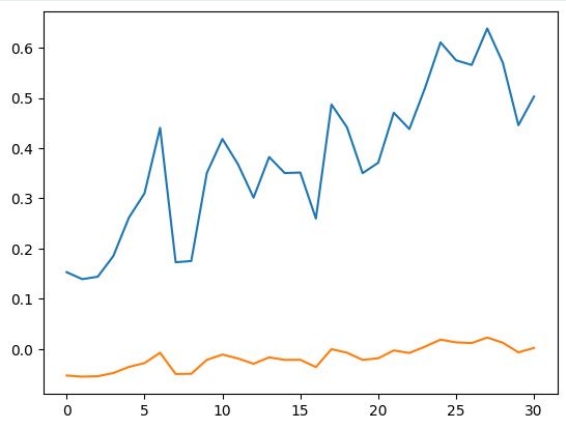
Are we safe?

The forecasting from the best model
Actually hits 1.5C by 2050, considering the rmse is 0.074
And the trajectory is still going upwards as we can see, meaning we are going to maintain a problem going forward



So, using best model this was the forecast. Seems good, but perhaps too simplistic, and trend still up. So we will prove that the other variables are interdependent, then our subsequent models should be more accurate. RNN to prove the correlations, then VAR to hopefully have better models.
One thing to note here are the residuals. Whilst that looks perfect for ARIMA data, it shows signs that perhaps the data is too simplistic. That monotonous line isn't ideal for RNN which takes into account the previous data points error as well.

RNN

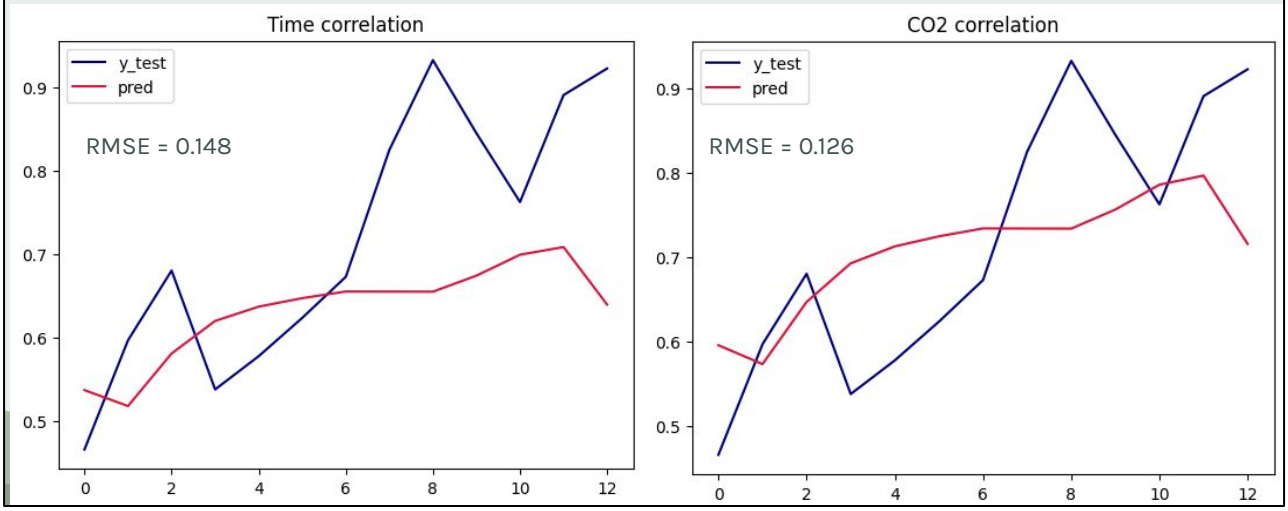


DISCLAIMER

- Better at trends, but...
- Problem with future forecasting
- Sequence Length 1

Used RNN to prove that they are correlated, but not future forecasting, explain the problem you encountered.

What influences temperature?

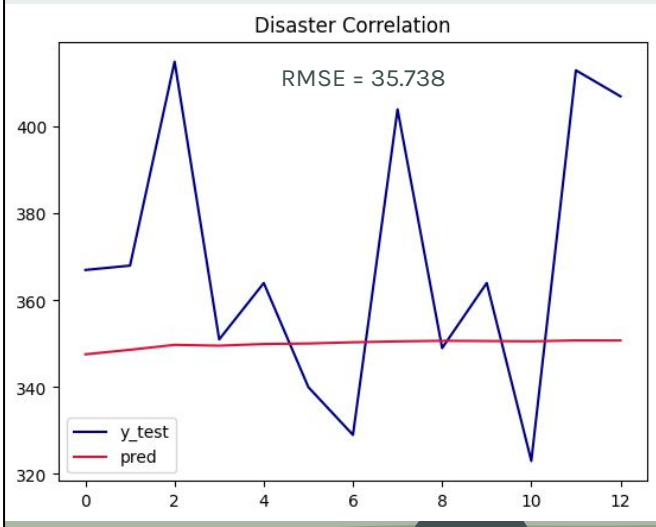


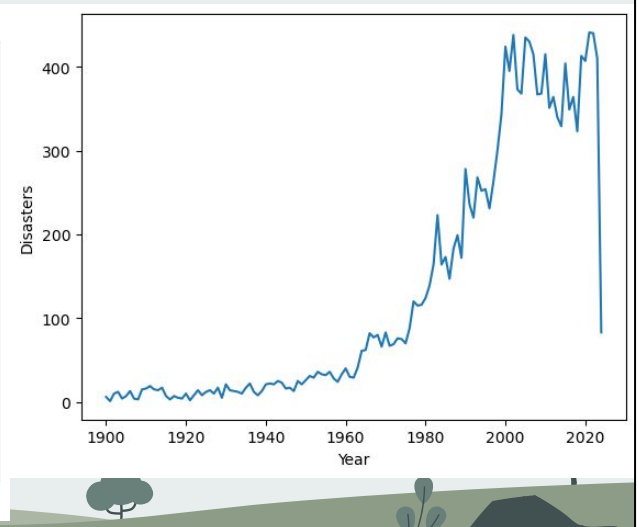
Talk about inherent nature of RNN sequence, and that time is already put into the data, so the extra CO2 data is should prove use right, if hypothesis true, with RMSE being more accurate

Considering that the time aspect was inherent in both, it seems that whilst CO2 does impact, there may be more at play, however, remember, COP is dealing with a 1.5C increase, the scale of change at this level is very impactful. All my models are running of this scale.

They both optimised on LSTM and the same metrics interestingly enough.

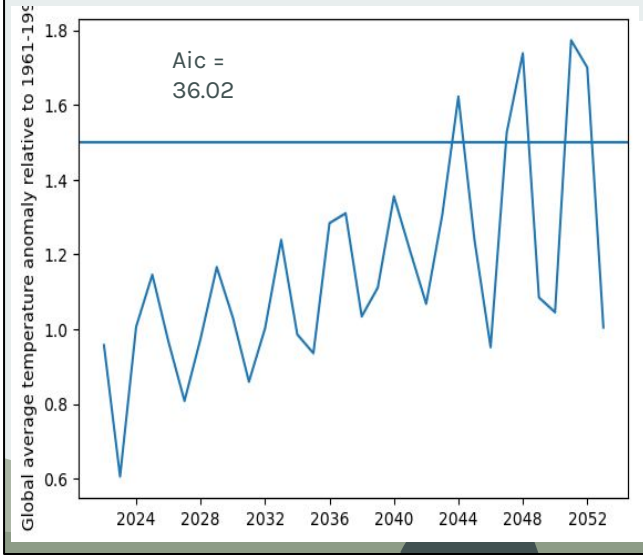
Disaster

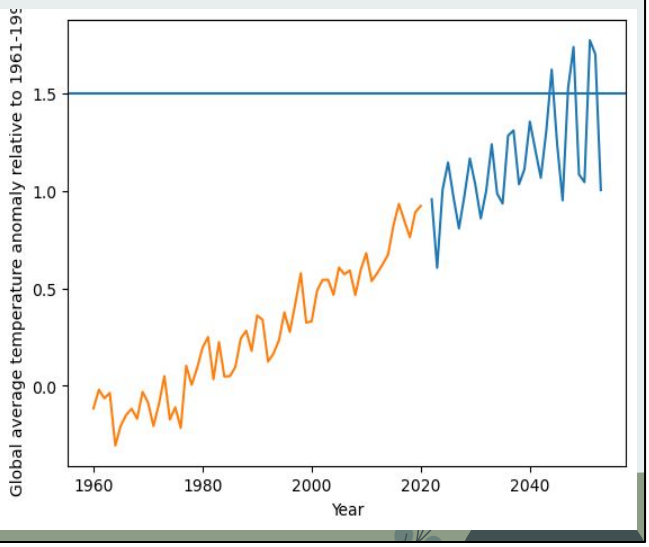




This may look quite bad, but given that the data it was actually predicting, it seems to have picked up the trend quite well, Not amazing, but that can be attributed to the trend in the graph we can see. We can conclude that whilst relatively accurate, and does fit the model, the metrics aren't ideal and not something to really rely on, just under a 9% error. This adds to our notion that perhaps the data set is too simple, however, it is still clear that there is an upward trend, despite us being in this anomalous period.

VAR - Future Forecasting

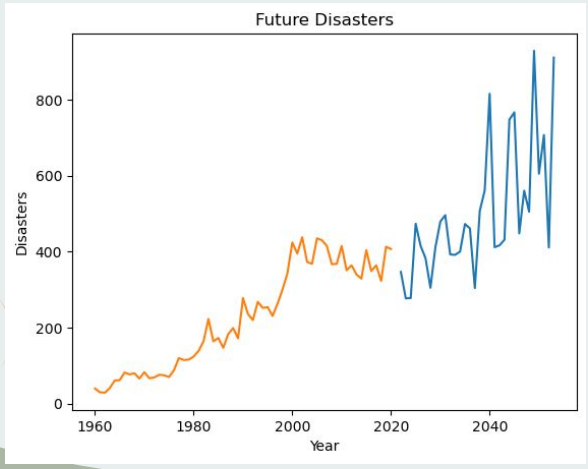


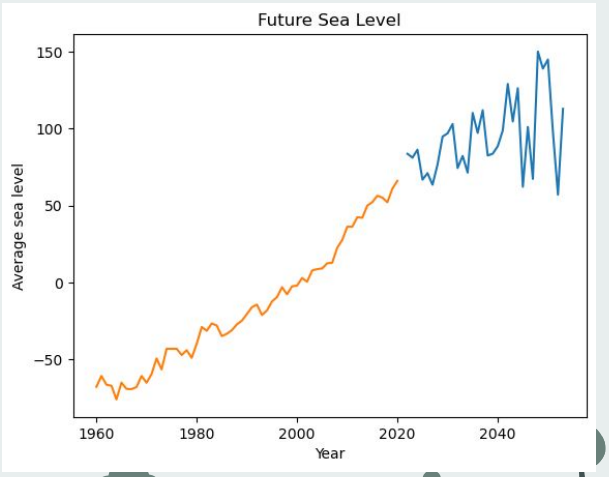


Seems to prove our hypothesis right
There is interdependence, and the AIC proves it right.

Surprisingly fits

AIC = 39.68



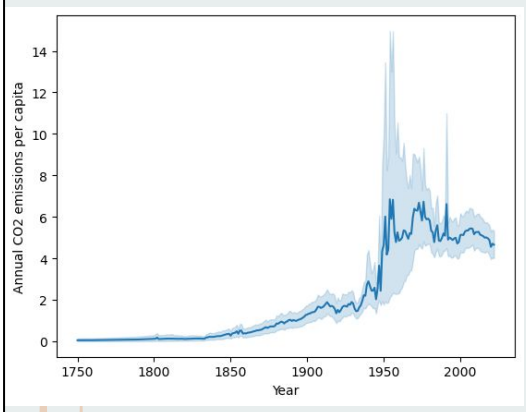


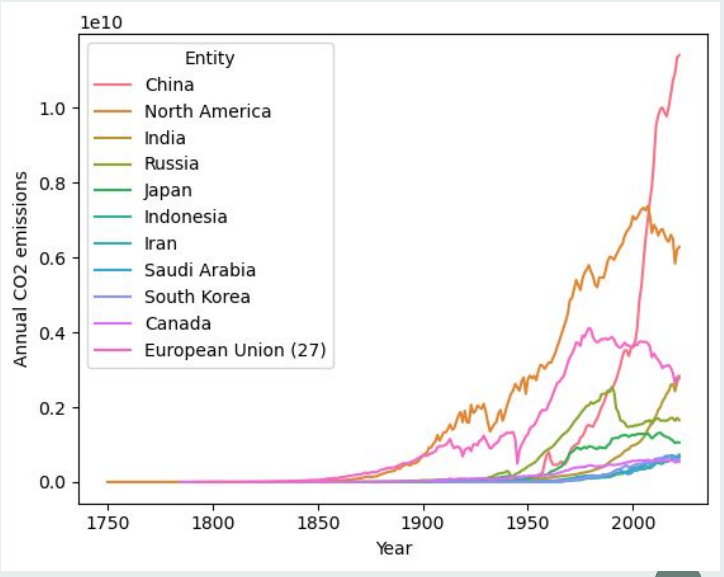
The reason it's one AIC score is that it's VAR, all dependent on each other, but still beat ARIMA

Looks pretty good on visuals, although not really the "lowest" I think it indicates that the model isn't too simple, and that the predictive powers are better at this point.

04 The Players

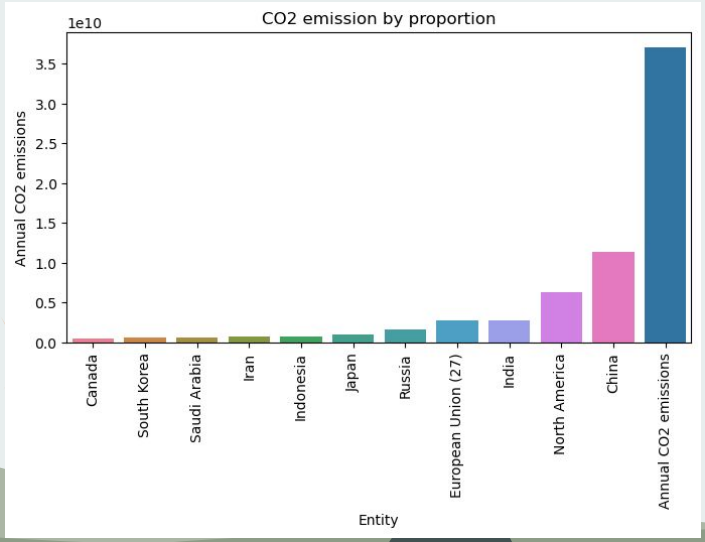
Proportional damage?





Talk about the propoirtions here, the per capita is also indicative of imbalance

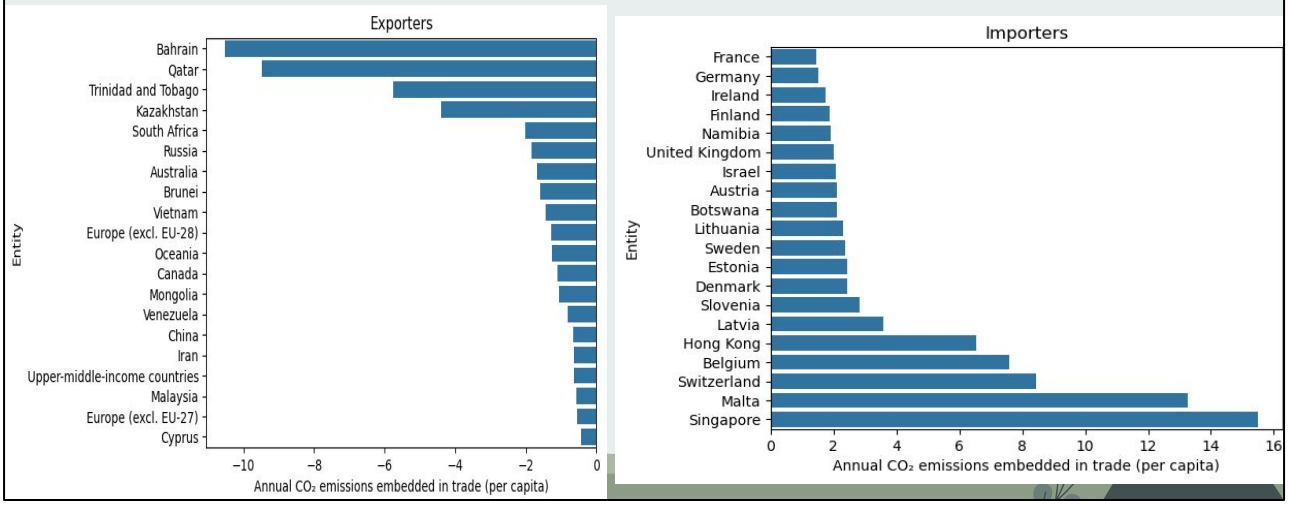
Proportionate Input



- These collection of countries: 37 out of 196(depending where you look) - ~80% of all CO_2

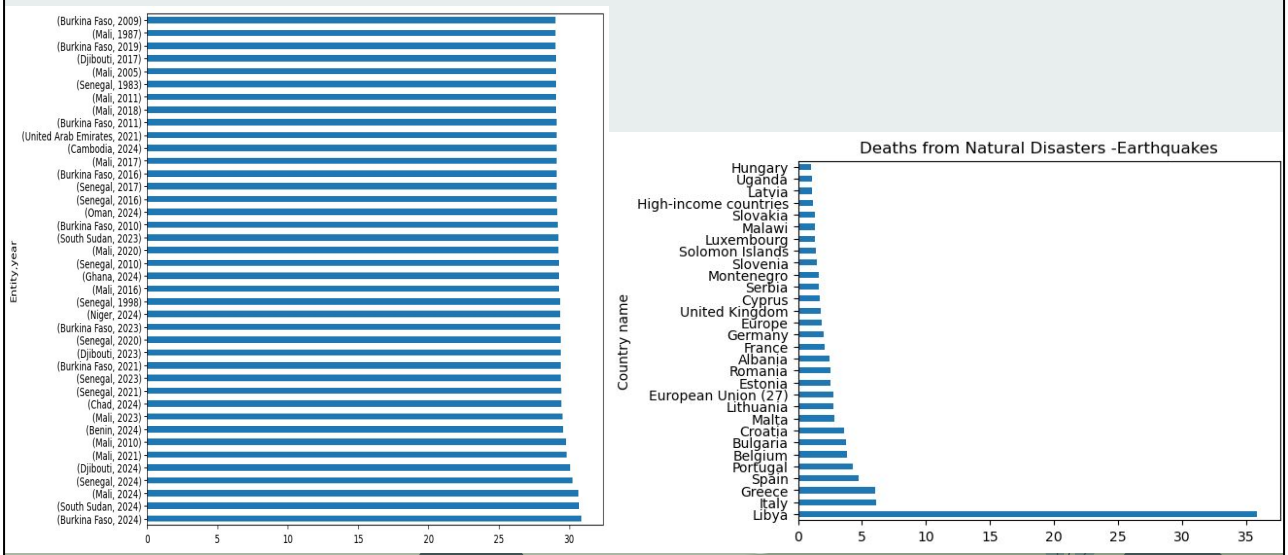
Secret Players

Those who don't show up in pure metrics, as they either sell off or buy CO2 emissions indirectly

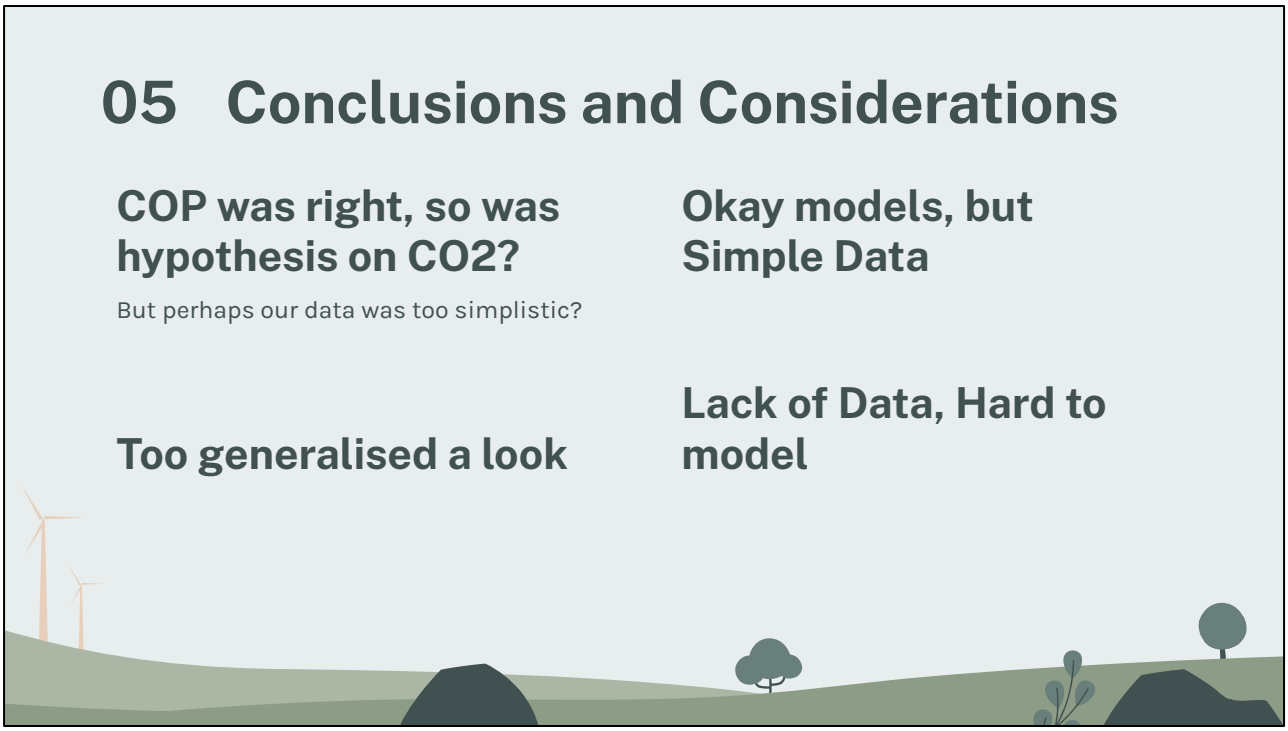


Easy way to white wash is through export, explain the countries for export fossil fuels and products/product.

Disproportionate Output?



Having scoured through EDA, it is mainly the same african nations that have to deal with extreme heats, plus UAE. Talk through deaths, interesting, but that isn't the only metric, rising temperatures are something that people have to deal with, when they are already in hot nations.



Talk about AIC
Perhaps could have done linear regression for comparison?
Can talk about renewable changes, mainly in developed/most co2 emitting nations
Could have scraped sneakily
Consider more data, RNN failed, I believe, due to the simplistic nature of the dataset, hence why ARIMA and VAR were fine
Looked at individual disasters more, and compared them to sea level, flood, extreme temperature and weather, rising temperatures
Done hypothetical modelling, what if we had reduced co2, global temps were warmer. Would have been interesting data
RNN was not really optimized due to simplistic nature of data
I didn't talk about rising sea level threats

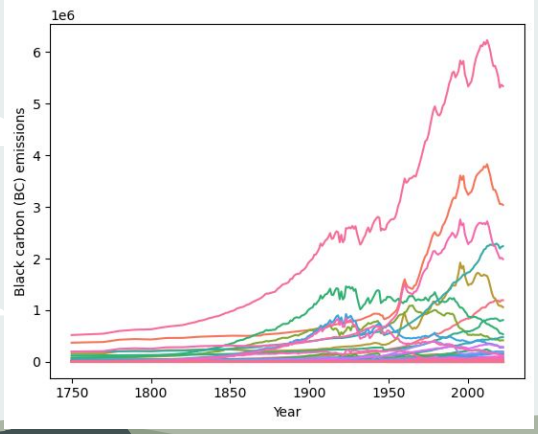
These all feed into the narrative that it is a divisive topic, for all these reasons on data and predictions. Environmental data is hard enough to model as it is, any anomalies can throw off predictions, and chaos theory is ripe in the environmental data, which is so intertwined and complex. I may have produced something that is "working" but it's actually very hard to say how accurate or precise I can be with the data I am working with.

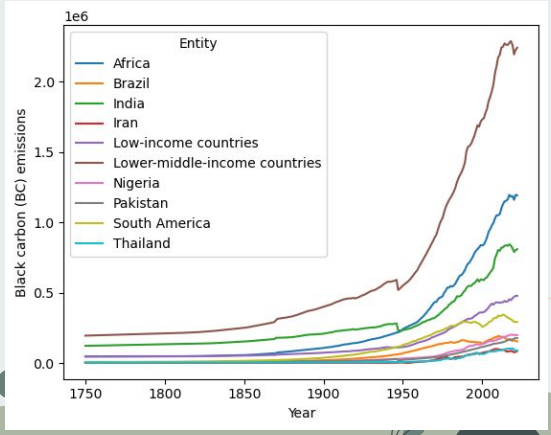
Is Climate Change the only problem?

What other problems to consider?

Are what I've talked about the only things we should consider regarding climate, change?

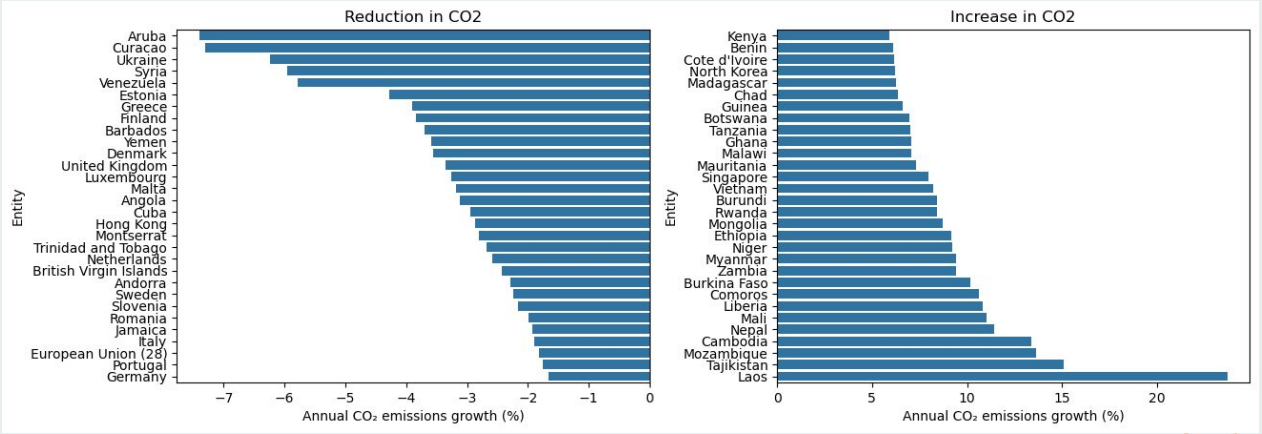
- There are other immediate impacts that are massively under considered, such as air pollution, in the form of Black Carbon Emission, Carbon Monoxide, and Fine Particulate Matter.
- Burning Fossil Fuels through: transport, industry, infrastructure and basic necessity is still a problem in your ambient air.
- Plus, still developing nations



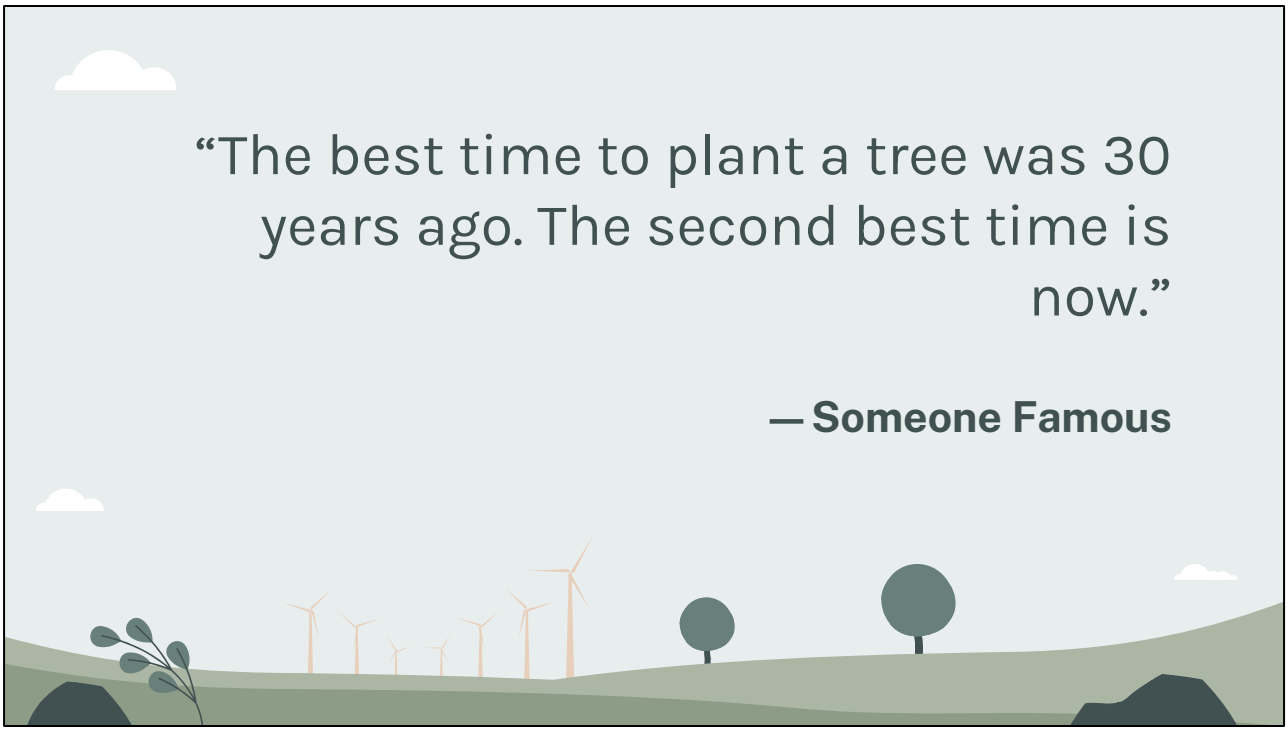


I can do EDA, but modelling was hard as air pollution deaths and ailments are mostly attributions and estimation due to the nature of outdoor air pollution, which is where they are more focused now, which is also considerably “Safer” than indoor air pollution. Data is not massively available. I removed more developed nations and most of the BCE was gone, by proportion, and so we see that less developed/developing(Nigeria) countries are most at risk, as well as the most industrialised, china, india, russia middle east so on. So But since this data is still not here, hard to encourage. Also, BCE is a good precursor to indicate which nations will start becoming more pollutors, as these are actually mainly produced in fuel for industry, rather than indoor pollution, which is the main danger. But..

Negative Feedback?



Easy to blame, do we do that to developing nations?
We talk about greenwashing, but at least it is in the right direction
The solution may be to reach out to developing nations to provide alternative industry/technologies that don't put them at risk, or their futures. Hard to say, for do we inhibit another nations development when we already have industrialised? Could argue for their sake, just unfortunate circumstances, it simply is just reality at this p



This project I believe isn’t a proponent of fear, but just that there is always time to act. We don’t need to do drastic changes, as a lot is beyond our control in policy advocation, but that individually you can support things that surmount to a global change. We saw that it was never one individual country that enacted anything to the whole, but that it has to be a collective effort. Small actions build up over time, just as global warming did, and that on the whole, the world is on the right track or innocent from the devastation of the few.

Thanks!

Questions?

Resources

- https://www.bbc.co.uk/news/science-environment-45678338
- https://www.wri.org/insights/cop26-key-outcomes-un-climate-talks-glasgow
- https://www.wri.org/data/greenhouse-gas-emissions-over-165-years#:~:text=While%20the%20United%20States%20kept,annual%20emitter%20until%202005%2C%20when%E2%80%A6&text=Between%201850%20and%201960%2C%20the,particularly%20in%20the%20United%20States.
- https://www.bgs.ac.uk/discovering-geology/climate-change/how-does-the-greenhouse-effect-work/#:~:text=The%20contribution%20that%20a%20greenhouse,carbon%20dioxide%20(CO2
- https://ec.europa.eu/eurostat/statistics-explained/index.php?title=Glossary:Kyoto_Protocol
- https://www.e-education.psu.edu/earth104/node/1262#:~:text=Overall%2C%20though%2C%20it%20is%20fairly,others%20just%20under%20a%20tenth.
- https://ocean.si.edu/through-time/ancient-seas/sea-level-rise#:~:text=Between%201900%20and%201990%20studies,at%203.4%20millimeters%20per%20year%20.
- Our World in Data(many databases), cited in README
- https://www.who.int/news-room/fact-sheets/detail/ambient-(outdoor)-air-quality-and-health
- https://stats.stackexchange.com/questions/84076/negative-values-for-aic-in-general-mixed-model