INTRODUCTION

Sustainability 2020, 12, 7427 2 of 11 impacts, and public impacts [4]. This sector is also responsible for significant energy consumption and emission production, such as GHG emissions, particulate matter, sulfur dioxide, carbon monoxide, and nitrogen oxide [5]. As a result of the energy consumption from this sector, the ambient CO2 level has increased, which generates enormous proportions of CO2 emissions [6,7]. Sources of CO2 emissions in this sector can be from the energy utilization required for the manufacturing and transportation of the building materials to the processing of resources, construction waste disposal, and the demands of construction equipment [8]. The building sector consumes a substantial portion of non-renewable energy and prompts the emission of a significant amount of CO2 [9]. Building contributes approximately 39% of the annual global CO2 [10] (Figure 1). It has been reported that more than a third of the usage of total energy and CO2 emissions is a result of the building sector in the developed and developing nations [11]. Therefore, CO2 emission mitigation measures are crucial [12]. To promote CO2 emission mitigation, planning on conservation of energy, and implementation of strategies to reduce potential emission mitigation should be prioritized [13]. This paper aims to provide an overview of the issues, impacts, and mitigation strategies in the building sector to reduce and control CO2 emissions.

PROBLEM DEFINITION & DESIGN THINKING

The challenge in sustainably advancing the building sector is the increasingly large outflows of CO2 due to the utilization of non-sustainable energy sources in the planning, construction, and operations of buildings [9]. CO2 is also emitted from the broad utilization of land in the urbanization process [11]. The energy sourced from fossil fuels is non-sustainable, and yet it accounts for a large percentage of the energy used in the construction and operation processes. Sustainable or renewable energy sources only account for 6% of the total energy used in the sector, while fossil fuel used in construction activities accounts for 40% of worldwide greenhouse gas emissions. Although numerous novel methods have been proposed to lessen the CO2 footprint of buildings, particularly in high-density urban communities, the challenge has yet to be solved appreciably [14]. The utilization of a non-sustainable energy source directly affects the environment, and it is directly proportional to the amount used. The construction of a building emits CO2, both directly and indirectly. Direct CO2 emissions originate from the burning of natural gas, diesel, light fuel oil, and other oil-based commodities, while indirect CO2 emissions come from the application of electricity. Globally, the indirect CO2 emission accounts for 85% of the total CO2 emitted, while only 14% is from direct emissions. Figure 1. Global CO2 emission by sectors. 2. Issues and Challenges The challenge in sustainably advancing the building sector is the increasingly large outflows of CO2 due to the utilization of non-sustainable energy sources in the planning, construction, and operations of buildings [9]. CO2 is also emitted from the broad utilization of land in the urbanization process [11]. The energy sourced from fossil fuels is non-sustainable, and yet it accounts for a large percentage of the energy used in the construction and operation processes. Sustainable or renewable energy sources only account for 6% of the total energy used in the sector, while fossil fuel used in construction activities accounts for 40% of worldwide greenhouse gas emissions. Although numerous novel methods have been proposed to lessen the CO2 footprint of buildings, particularly in high-density urban communities, the challenge has yet to be solved appreciably [14]. The utilization of a non-sustainable energy source directly affects the environment, and it is directly proportional to the amount used. The construction of a building emits CO2, both directly and indirectly. Direct CO2 emissions originate from the burning of natural gas, diesel, light fuel oil, and other oil-based commodities, while indirect CO2 emissions come from the application of electricity. Globally, the indirect CO2 emission accounts for 85% of the total CO2 emitted, while only 14% is from direct emissions. Sustainability 2020, 12, 7427 3 of 11 The 2030 Climate and Energy Framework states that 27% of energy should be sourced from sustainable energy sources, while energy efficiency or productivity should increase by 27% [15]. However, there are challenges in finding sustainable solutions to low productivity and efficiency. One solution is to itemize the processes of construction and operation so that detailed evaluations can be carried out. Construction includes the assembly of the building material, the development of the structure and foundation, and the transportation and operation of machinery. The procedure comprises the maintenance aspect of the building and its infrastructure. The evaluation of the life cycle requires a detailed inventory of these processes in all phases of the building's life. The assessment would highlight strategies that could be made more productive and efficient.

EMPATHY MAPPING

A second step in emission-reduction results from attitudes toward the future. An important ethical judgment embodied in climate-economics models determines how much weight is given to the interests of future generations. Because the effects of today's emissions will be felt for hundreds, if not thousands, of years, every model must make some assumption about the importance of expected future damages for current-day decision-making. In CRED, as in many other models, this key judgment is represented by the "pure rate of time preference," an important component of the discount rate. The pure rate of time preference is the discount rate that would apply if all generations were equally wealthy. (Under the common assumption that future generations will be richer, the discount rate is increased to reflect the expected differences in wealth.) The pure rate of time preference is not a scientific constant; rather, it is an answer to a crucial ethical question: How much should we, as a society, care about the impact of our actions on future generations? Yet the answer to this question has a profound effect on model results. The higher the discount rate, the less important future climate damages are assumed to be for today's decision-makers. At the extremes, a very high discount rate causes a model to ignore any climate damages that occur more than a few decades into the future, whereas at a very low discount rate, climate damages are almost equally important regardless of when they occur.

ADVANTAGES & DISADVANTAGES

Carbon capture and storage is one of the most efficient methods of extracting carbon emissions permanently from the environment.
The numerous advantages of CCS include economic, social, and environmental, and a massive impact on a global and local scale.Carbon capture can increase the power generated with carbon dioxide-based steam cycles. In this process, carbon dioxide is pressured through a supercritical fluid, which could transfer heat more effectively and require less energy to compress steam.Geologically stored carbon dioxide might be utilized to retrieve geothermal heat from the a/rea injected which results in the generation of sustainable geothermal energy.Carbon dioxide captured with carbon capture can also be utilized in the manufacturing of polymers and chemicals such as polyurethanes.The captured carbon dioxide is incorporated into concrete to reinforce it and increase the durability of the infrastructure.

Carbon capture reduces the carbon released in the atmosphere and therefore, it is recognized as one of the solutions to help address climate change and global warming. Despite this, carbon capture and storage (CCS) does not come without some disadvantages.The methods and CCS technologies that are necessary for carbon capture have some cost implications attached to them. Therefore, it can be very costly for power plants to generate electricity through fossil fuels. There are several concerns with respect to the safety of the storage of carbon dioxide in huge volumes at a single location due to the possibility of leakages, which can lead to environmental contamination if not handled correctly.The possibility of leakages could also be a result of natural disasters such as earthquakes or can be a result of human-induced incidents such as damage as a result of wars that can damage underground storage reservoirs.Many critics have questioned the cost efficiency of basalt formation storage. For this option, 25 tons of water will be required for each ton of carbon dioxide to be buried. There is a possibility that volcanic rock microbes can also digest the carbonates and hence produce methane gas which can be another problem.

APPLICATIONS

There have been a number of emerging technologies which are proposing the use of CO2 in the production of various plastic and building materials; some of which could replace hydrocarbons in plastics, which is a truly green usage. Further on this subject, the ultimate goal of successfully using CO2 from flue gas to produce useful products, along with sequestration would represent a double achievement. Some of the concepts below, could eventually yield true break throughs, when scaled up. The problem with flue gas over the years, has been the very high cost of recovery and production into a viable CO2 product which would meet required standards and specifications. Of course, the industry is often concerned with producing a CO2 product which will meet the standards for use in soft drinks and food processing. Such applications which represent a high percentage the CO2 merchant market in the US, are not those which sequester carbon dioxide, but use the BTU value, and perform via their physical properties to achieve results, and such CO2 is eventually returned to the atmosphere.

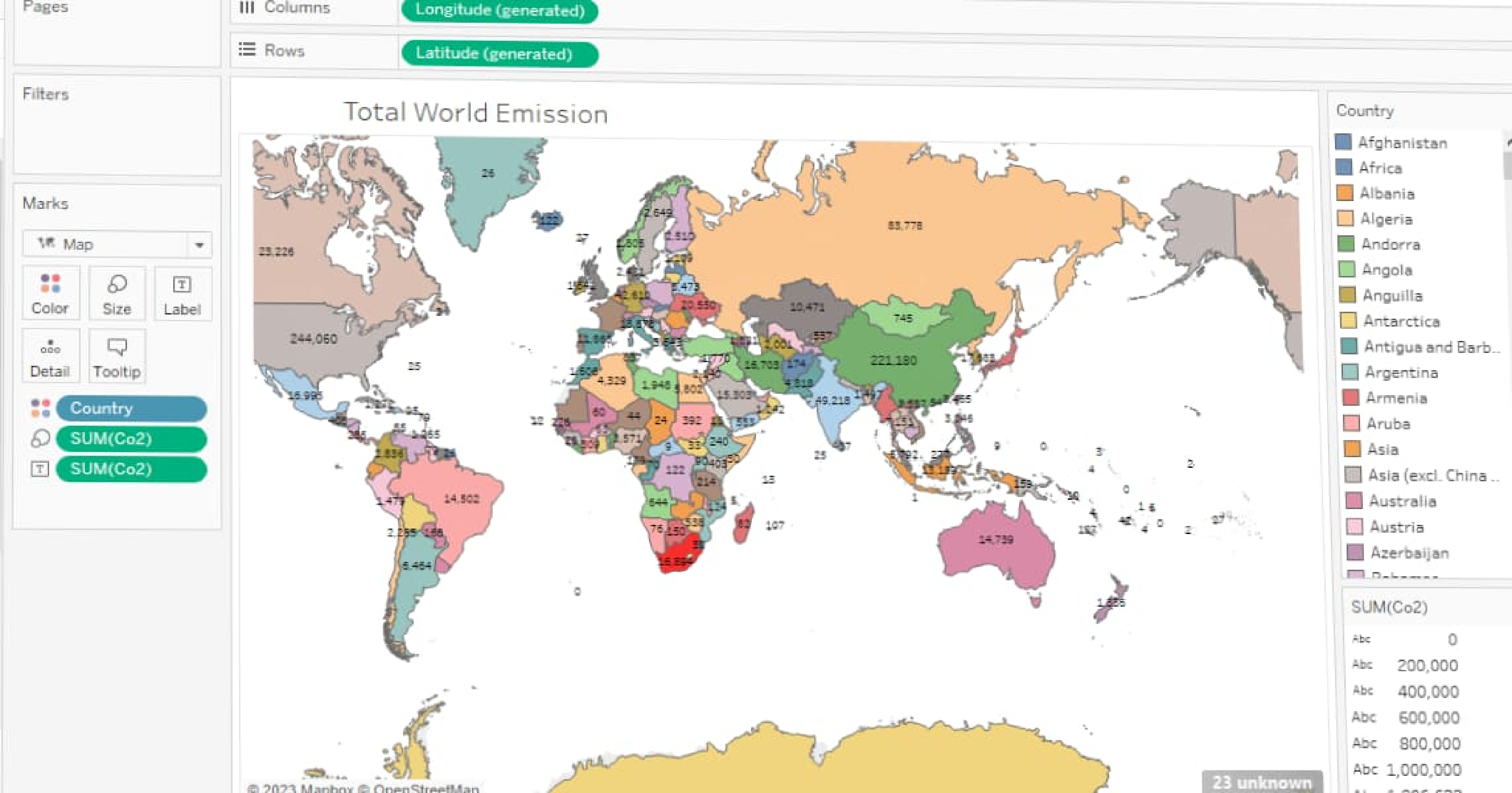
CONCLUTION

According to the results observed through the scientometric analysis, it is evident that the carbonemission research domain has attracted the attention of global researchers. A significant increasein research publications over the past two years is a strong indication of the growth in the carbonemission research domain. Carbon capturing, predicting future carbon emissions through trendanalysis, evaluating carbon performance, identifying carbon mitigation opportunities and ultimatelyachieving zero carbon emission goals are some of the most popular research areas in the carbonemission research domain. The scientometric analysis revealed the trends of carbon emission researchover the past three decades which was the objective of this research.There are certain limitations of this review which should be taken into consideration by thereaders.

Firstly, this paper was based only on the literature data obtained from the WoS core collectionwhich might not cover all the available literature on the domain. Although many authors have usedthe WoS database, the comprehensive nature of this database cannot be assured. Moreover, data wereonly obtained from the journal articles which might not capture all the literature available on carbonemissions. It should also be noted that since the data obtained from the WoS core collection werefiltered using the title, studies which might not reflect the carbon emission related work in the titlewere not included. However, this scientometric analysis provides a reflection of the global carbonemission research for researchers, government institutions and practitioners. It offers an in-depth understanding and a valuable insight into the most significant authors, institutions, countries in thecarbon emission research domain as well as the trends of publications. The findings of this study canbe used to obtain the necessary support and guidance to formulate carbon emission control policicy.

FUTURE SCOPE

The work presented in this article considers multiple possibilities for biofuel market penetration levels, biofuel price, and future travel demand to create five possible scenarios of biofuel utilization (Table 2). The HEFA fuel market penetration level affects the SAF price and the carbon emission intensities. Because the biofuel industry is in its infancy, the high risk and high production costs depress the initial penetration level (Chao et al., 2019a). Additionally, due to the ASTM regulations, the penetration level of biofuel is confined to 50%. Feuvre (Le Feuvre, 2019) estimates that the SPK penetration level will be about 19% in 2040. Based on the available biofuel penetration level information, the authors consider three potential penetration level scenarios. The "Reference" penetration level case follows the prediction of Feuvre (Le Feuvre, 2019). The "Low" penetration level case assumes that the biofuel penetration increases linearly to 10% by 2050. Finally, the "High" penetration level case assumes that the penetration level follows prediction of Feuvre (Le Feuvre, 2019) until year 2030, increasing linearly to 50% by year 2050. Figure 1 shows the different biofuel penetration levels—the blue line shows the "Reference" penetration case, the grey line shows the "Low" penetration level, and the "High" penetration level is depicted by the orange line; the stair-step looking line shape represents the discrete leaps in production facilities. The 2016 Billion-Ton report conservatively estimates that the U.S. biomass can produce biofuel meeting more than 30% of 2005 U.S. petroleum consumption (Langholtz et al., 2016). Considering that the US petroleum consumption in 2019 was 61% of petroleum consumed in 2005 (Administration, 2021a), this means that using the Longholtz et al. estimates, the U.Ss biomass can produce biofuel meeting 49% of U.S. petroleum needs (30%/61% = 49%) of 2019. Because the U.S. aviation sector is responsible for about 6.5% of U.S. petroleum fuel consumption, according to U.S. Energy Information Administration (EIA) estimates for 2020 (Administration, 2021b,c), this means that there is sufficient biomass to supply the SAF needs of aviation, even at 2020 levels.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Africa
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Asia (excl. China ..
Australia
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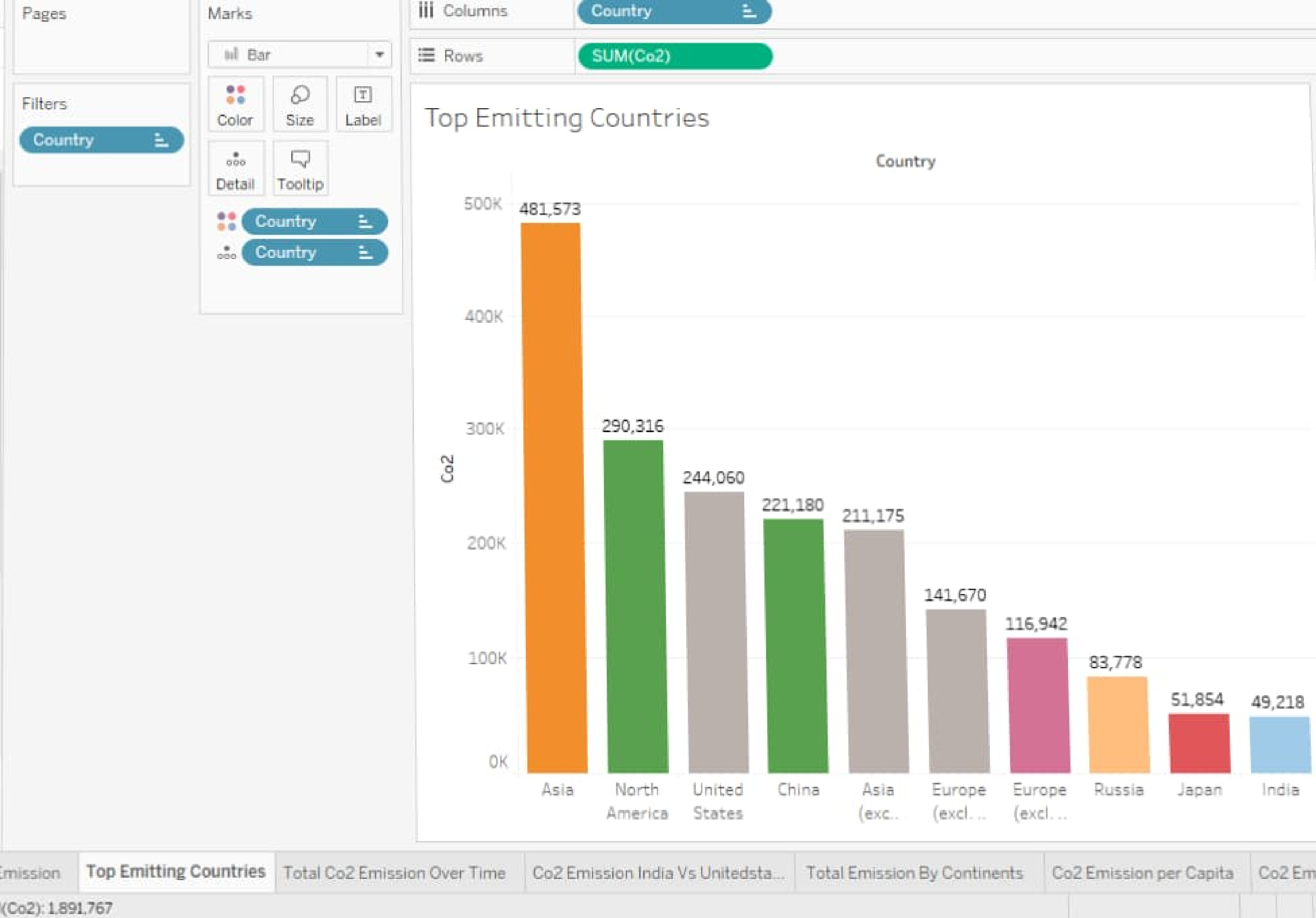

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SUM(Co2)
Top Emitting Countries
Country
Co2
500K
400K
300K
200K
100K
0K
481,573
290,316
244,060
221,180
211,175
141,670
116,942
83,778
51,854
49,218
Asia
North America
United States
China
Asia (exc..
Europe (excl. ..
Europe (excl. ..
Russia
Japan
India
Emission
Top Emitting Countries
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Total Emission By Continents
Co2 Emission per Capita
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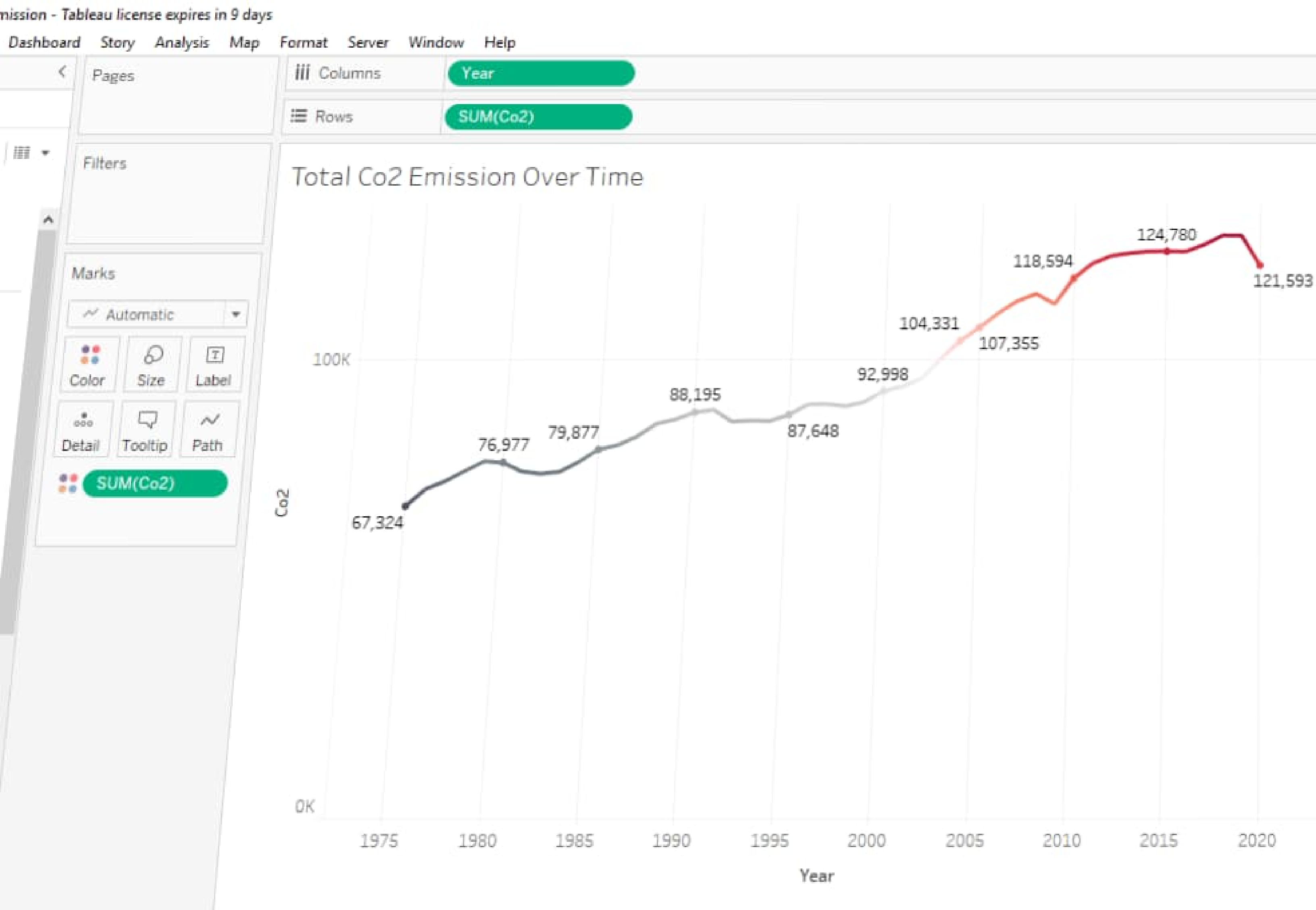
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SUM(Co2)
Total Co2 Emission Over Time
124,780
118,594
121,593
104,331
107,355
100K
92,998
88,195
87,648
79,877
76,977
Co2
67,324
0K
1975
1980
1985
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2005
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2015
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Year

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Co2 Emission India Vs Unitedstates
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1980
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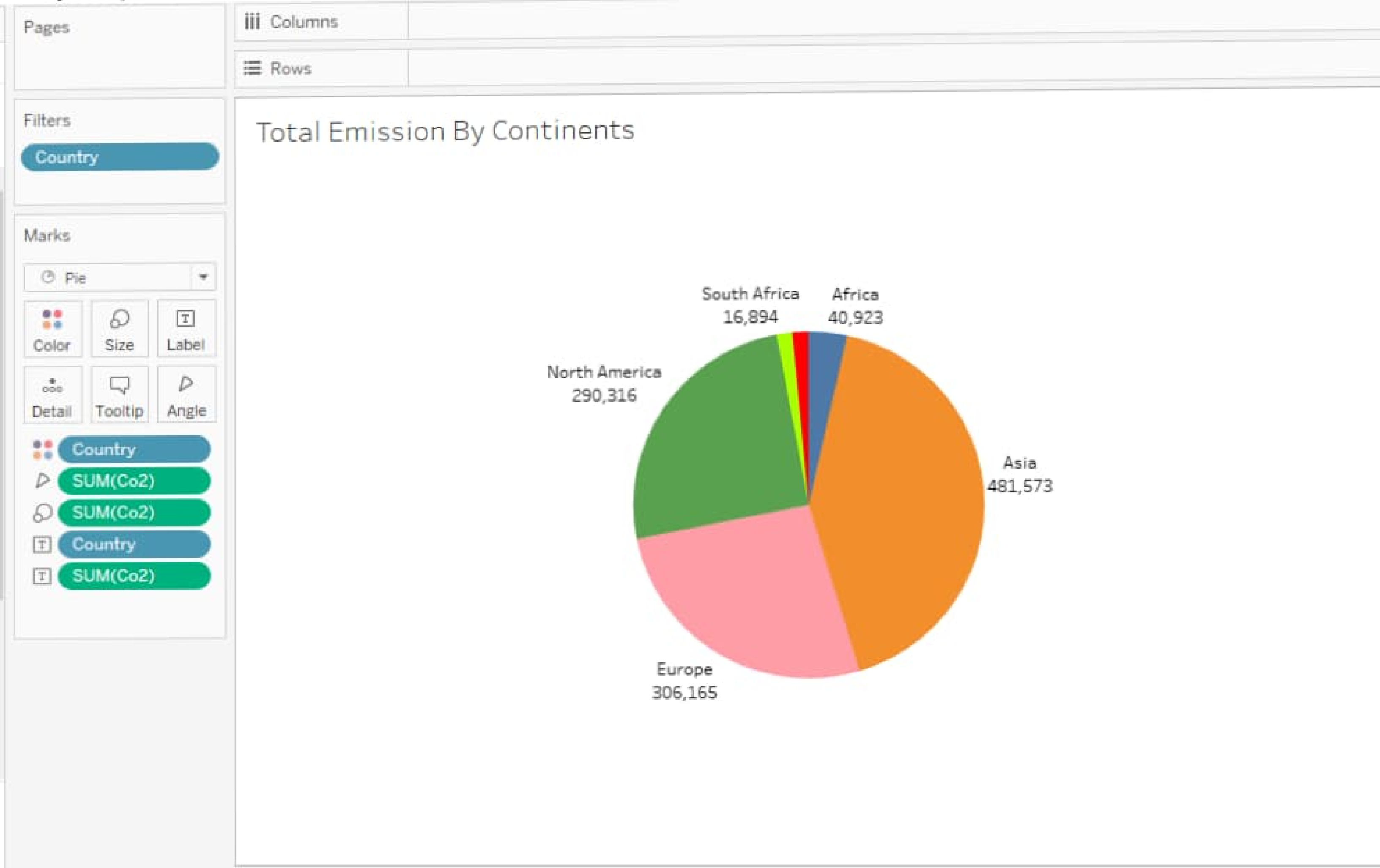
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SUM(Co2)
Total Emission By Continents
South Africa
16,894
Africa
40,923
North America
290,316
Asia
481,573
Europe
306,165


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SUM(Co2 Per Capita)
Filters
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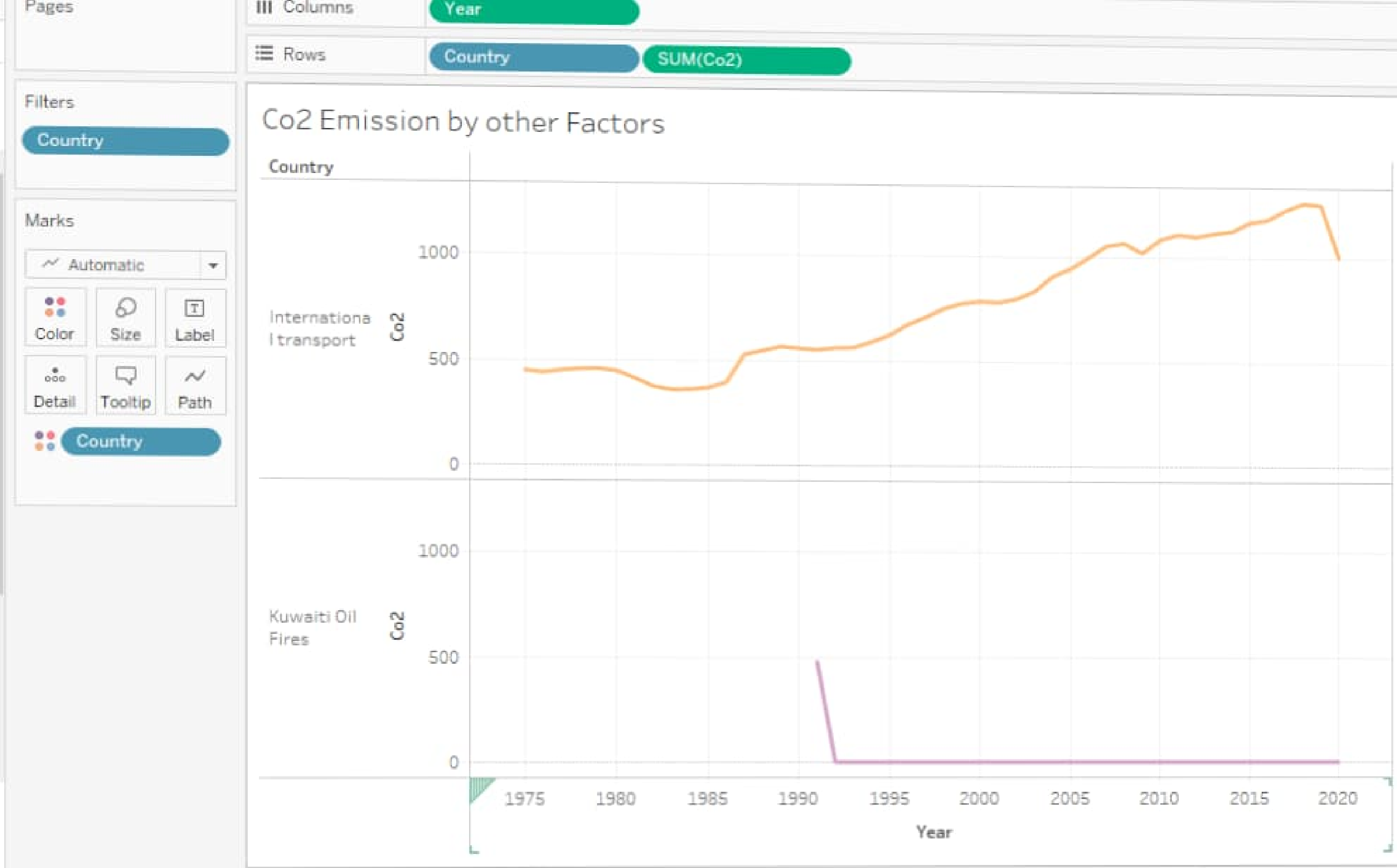
Country
Co2 Emission per Capita
Country
Co2 Per Capita
2000
1500
1000
500
0
2,197
1,761
1,554
1,356
1,099
1,094
1,060
998
994
937
Qatar
Curacao
Sint Maa rten..
United Arab ..
Luxembo..
Bahrain
Kuwait
Bonaire Sint E..
Trinidad and To..
Brunei



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Country
Co2 Emission by other Factors
Country
Internationa l transport
Co2
1000
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0
Kuwaiti Oil Fires
Co2
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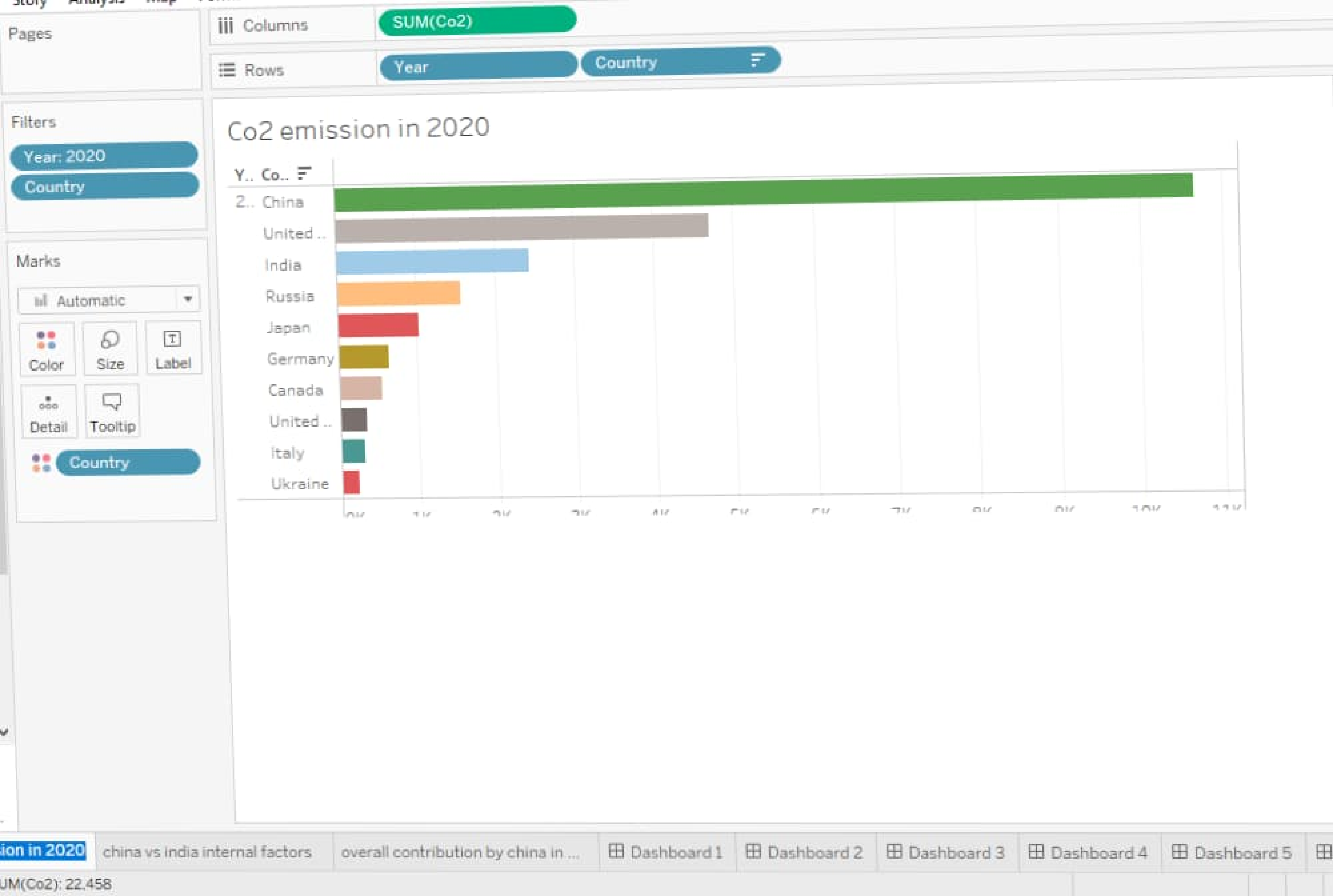
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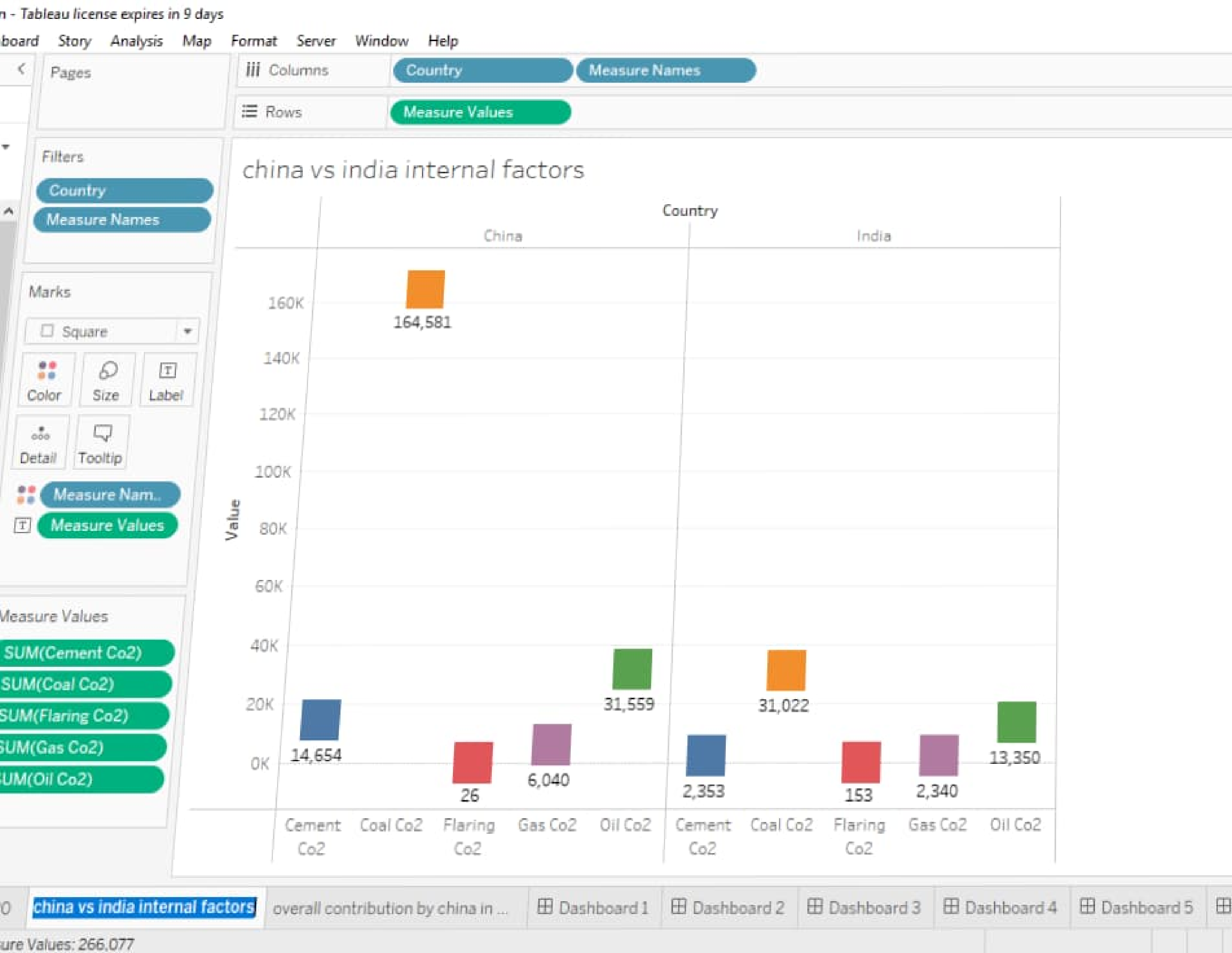
UM(Co2): 22,458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Measure Values
Measure Values
SUM(Cement Co2)
SUM(Coal Co2)
SUM(Flaring Co2)
SUM(Gas Co2)
SUM(Oil Co2)
china vs india internal factors
Country
China
India
Value
160K
140K
120K
100K
80K
60K
40K
20K
0K
164,581
14,654
26
6,040
31,559
2,353
31,022
153
2,340
13,350
Cement Co2
Coal Co2
Flaring Co2
Gas Co2
Oil Co2
Cement Co2
Coal Co2
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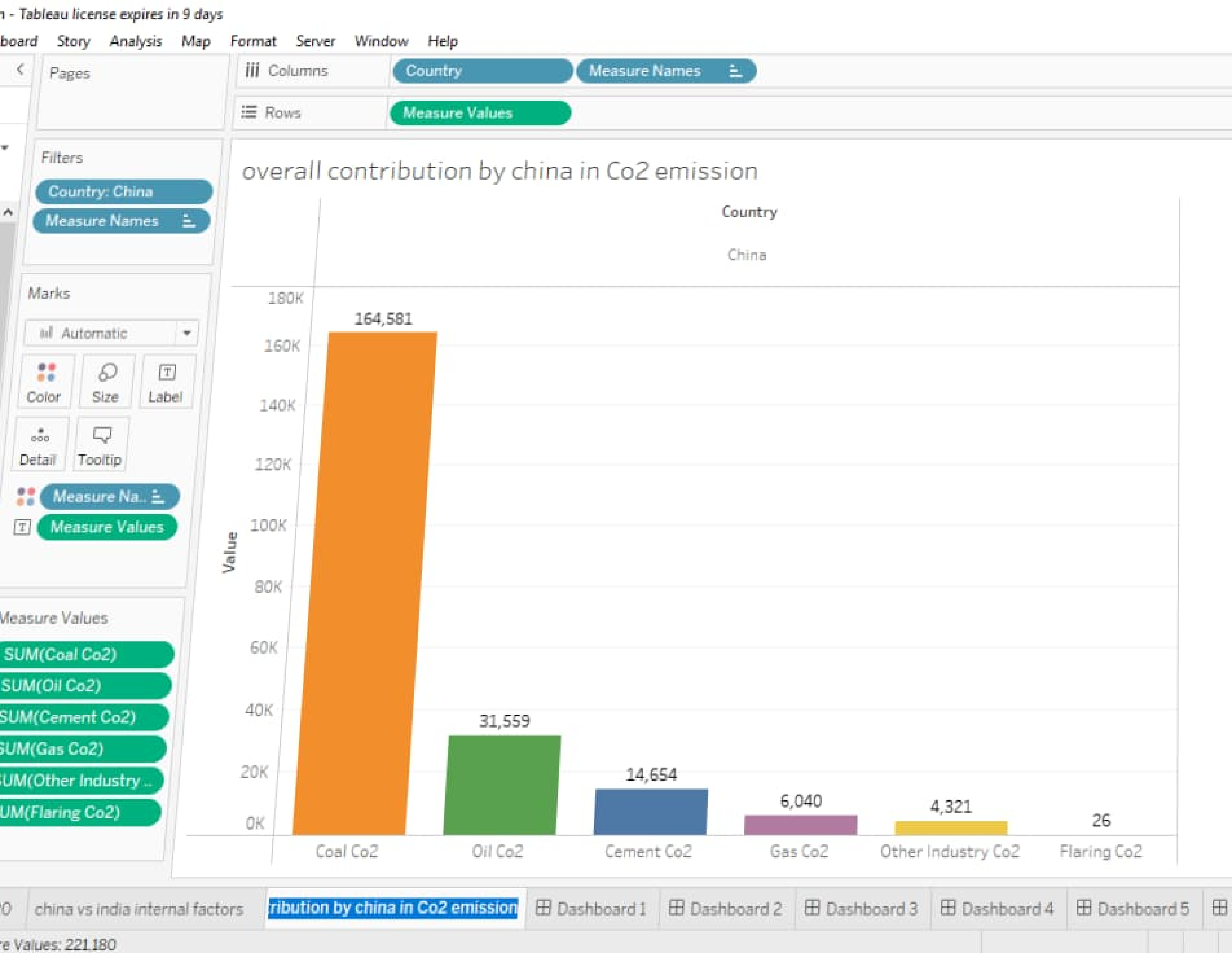
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Measure Names
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Measure Values
Measure Values
SUM(Coal Co2)
SUM(Oil Co2)
SUM(Cement Co2)
SUM(Gas Co2)
SUM(Other Industry ..
UM(Flaring Co2)
overall contribution by china in Co2 emission
Country
China
Value
180K
160K
140K
120K
100K
80K
60K
40K
20K
0K
164,581
31,559
14,654
6,040
4,321
26
Coal Co2
Oil Co2
Cement Co2
Gas Co2
Other Industry Co2
Flaring Co2
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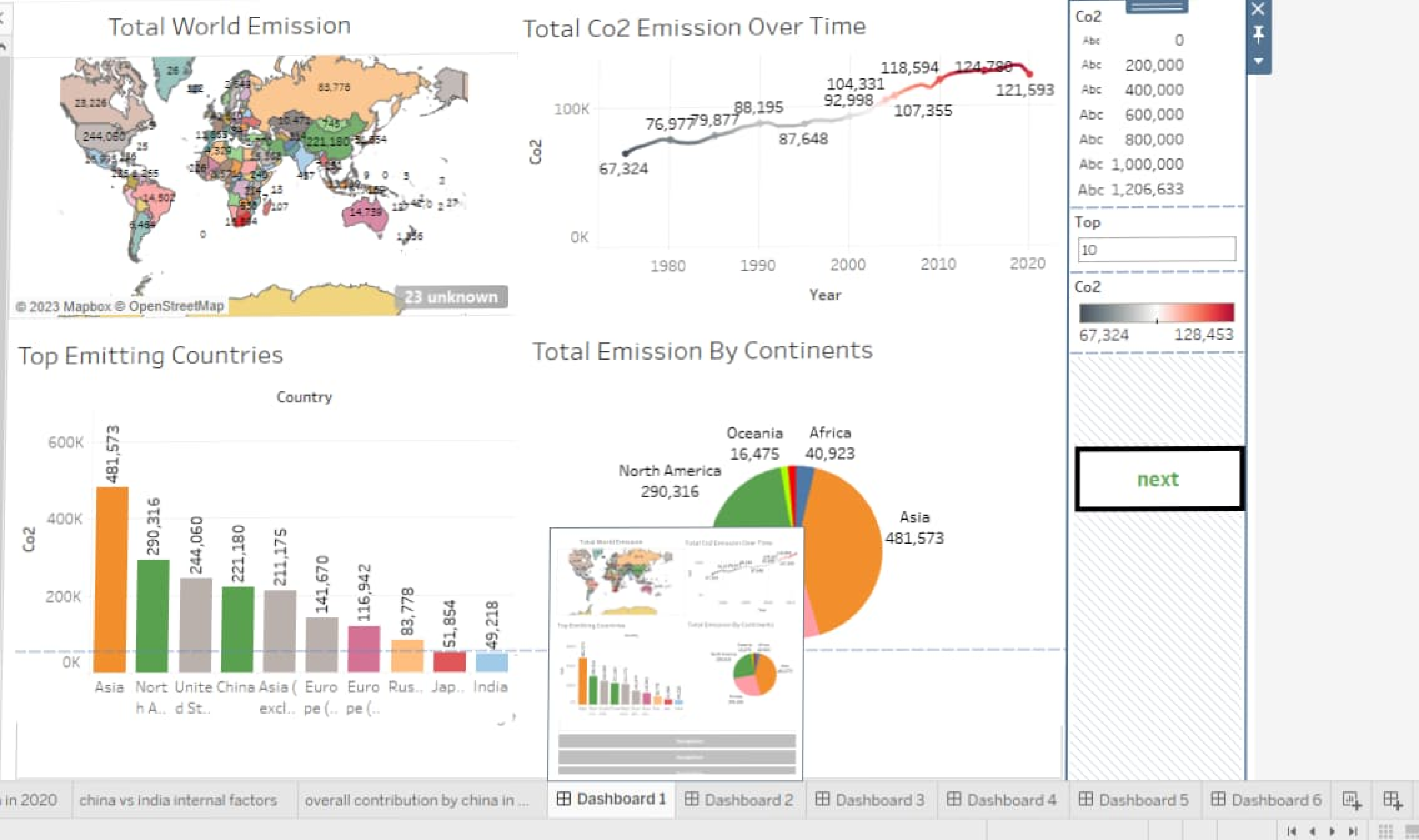
re Values: 221,180


Total World Emission
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Total Co2 Emission Over Time
Co2
100K
0K
67,324
76,977
79,877
88,195
87,648
92,998
104,331
107,355
118,594
124,780
121,593
1980
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Top Emitting Countries
Country
Co2
600K
400K
200K
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481,573
290,316
244,060
221,180
211,175
141,670
116,942
83,778
51,854
49,218
Asia
North A..
United St..
China
Asia (excl..
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Europe (..
Rus..
Jap..
India
Total Emission By Continents
Oceania
16,475
Africa
40,923
North America
290,316
Asia
481,573
in 2020
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overall contribution by china in ...
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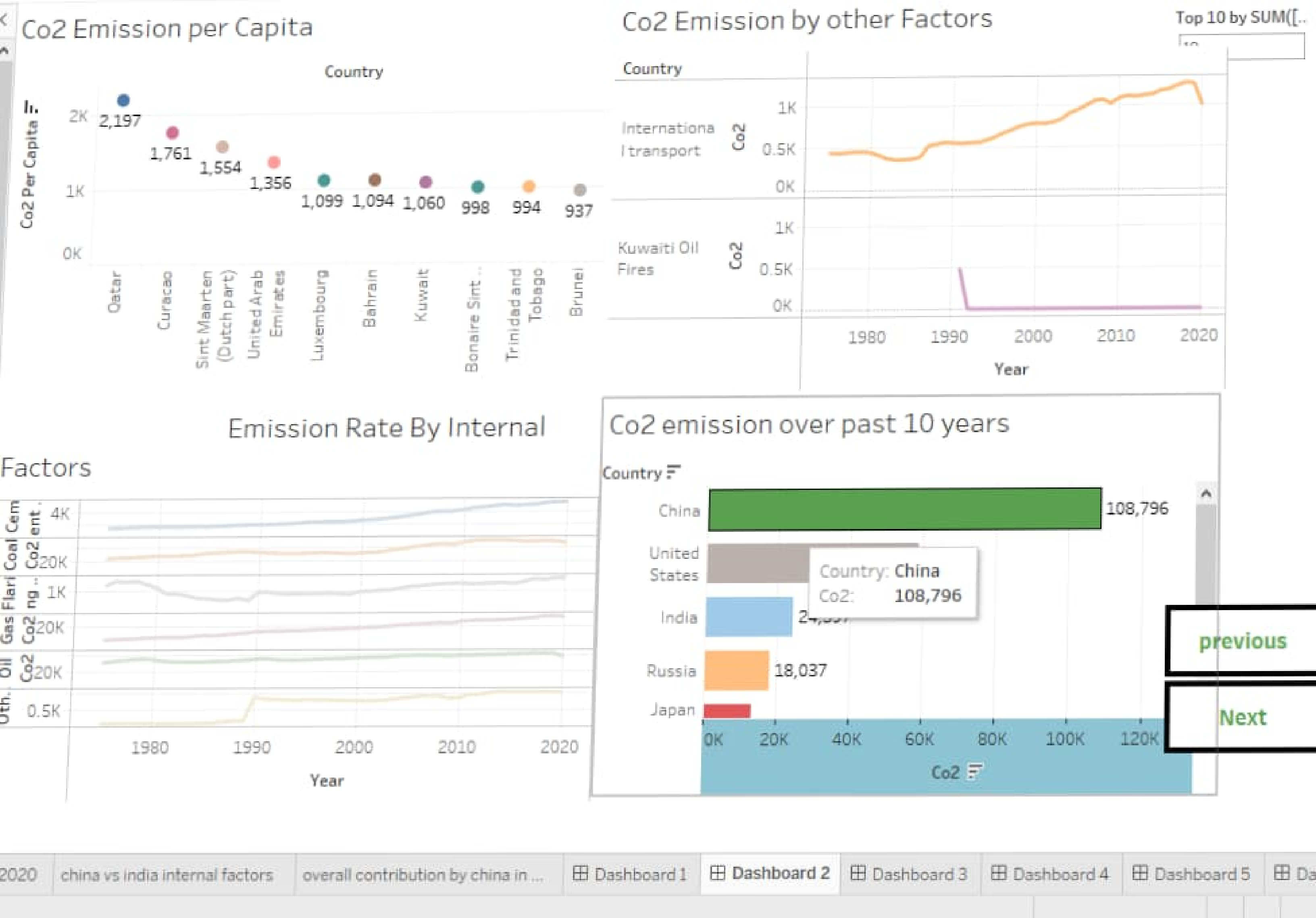
Co2 Emission per Capita
Country
Co2 Per Capita
2K
1K
0K
2,197
1,761
1,554
1,356
1,099
1,094
1,060
998
994
937
Qatar
Curacao
Sint Maarten (Dutch part)
United Arab Emirates
Luxembourg
Bahrain
Kuwait
Bonaire Sint ..
Trinidad and Tobago
Brunei
Co2 Emission by other Factors
Top 10 by SUM([..
Country
International transport
Kuwaiti Oil Fires
Co2
1K
0.5K
0K
1980
1990
2000
2010
2020
Year
Emission Rate By Internal Factors
4K
20K
1K
20K
20K
0.5K
1980
1990
2000
2010
2020
Year
Co2 emission over past 10 years
Country
China
United States
India
Russia
Japan
108,796
18,037
Country: China
Co2: 108,796
0K
20K
40K
60K
80K
100K
120K
Co2
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2020
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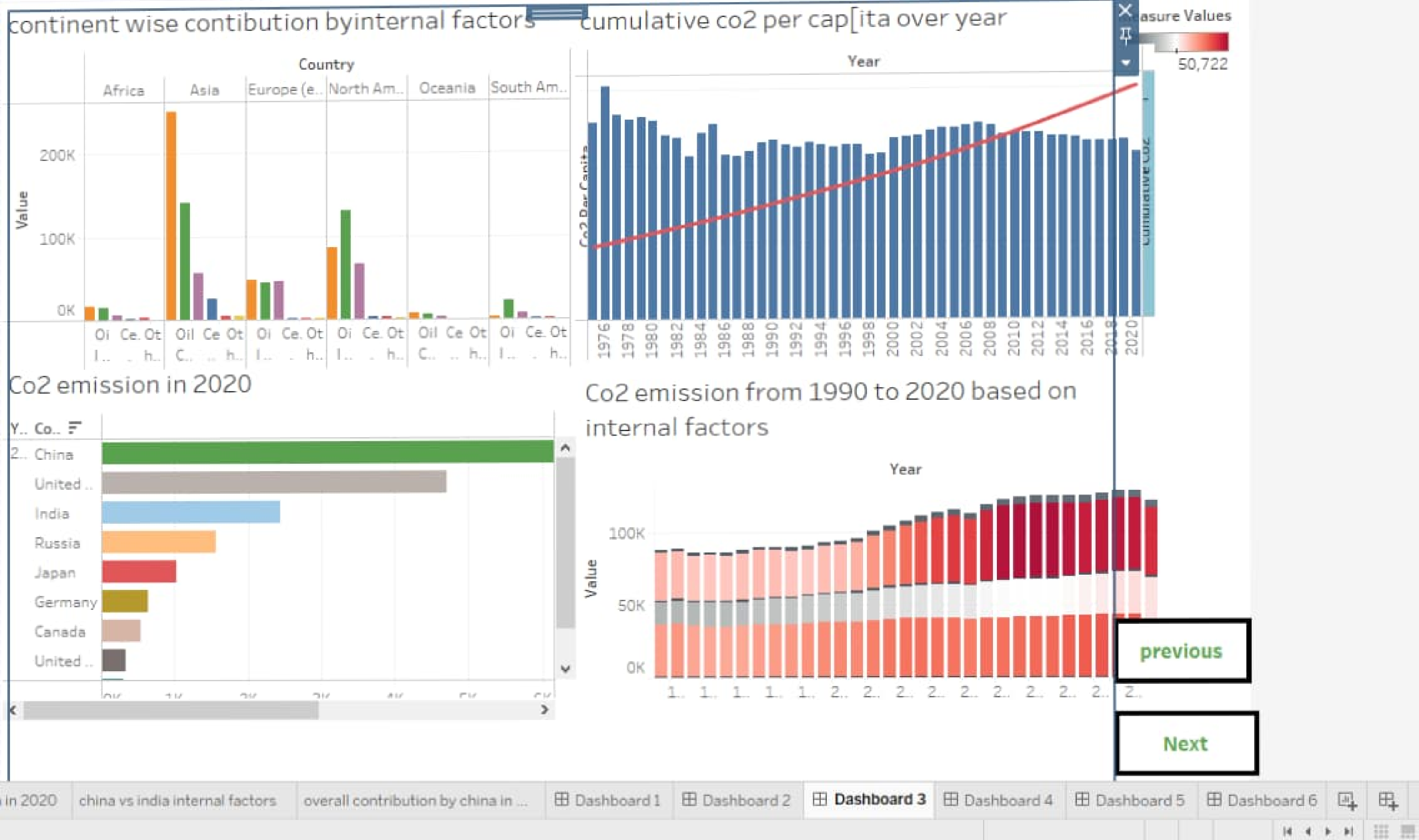
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cumulative co2 per cap[ita over year
Measure Values
50,722
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Africa
Asia
Europe (e..
North Am..
Oceania
South Am..
Value
200K
100K
0K
Year
Co2 Per Capita
Cumulative Co2
1976
1978
1980
1982
1984
1986
1988
1990
1992
1994
1996
1998
2000
2002
2004
2006
2008
2010
2012
2014
2016
2018
2020
Co2 emission in 2020
Co..
China
United ..
India
Russia
Japan
Germany
Canada
United ..
Co2 emission from 1990 to 2020 based on internal factors
Year
Value
100K
50K
0K
previous
Next
china vs india internal factors
overall contribution by china in ...
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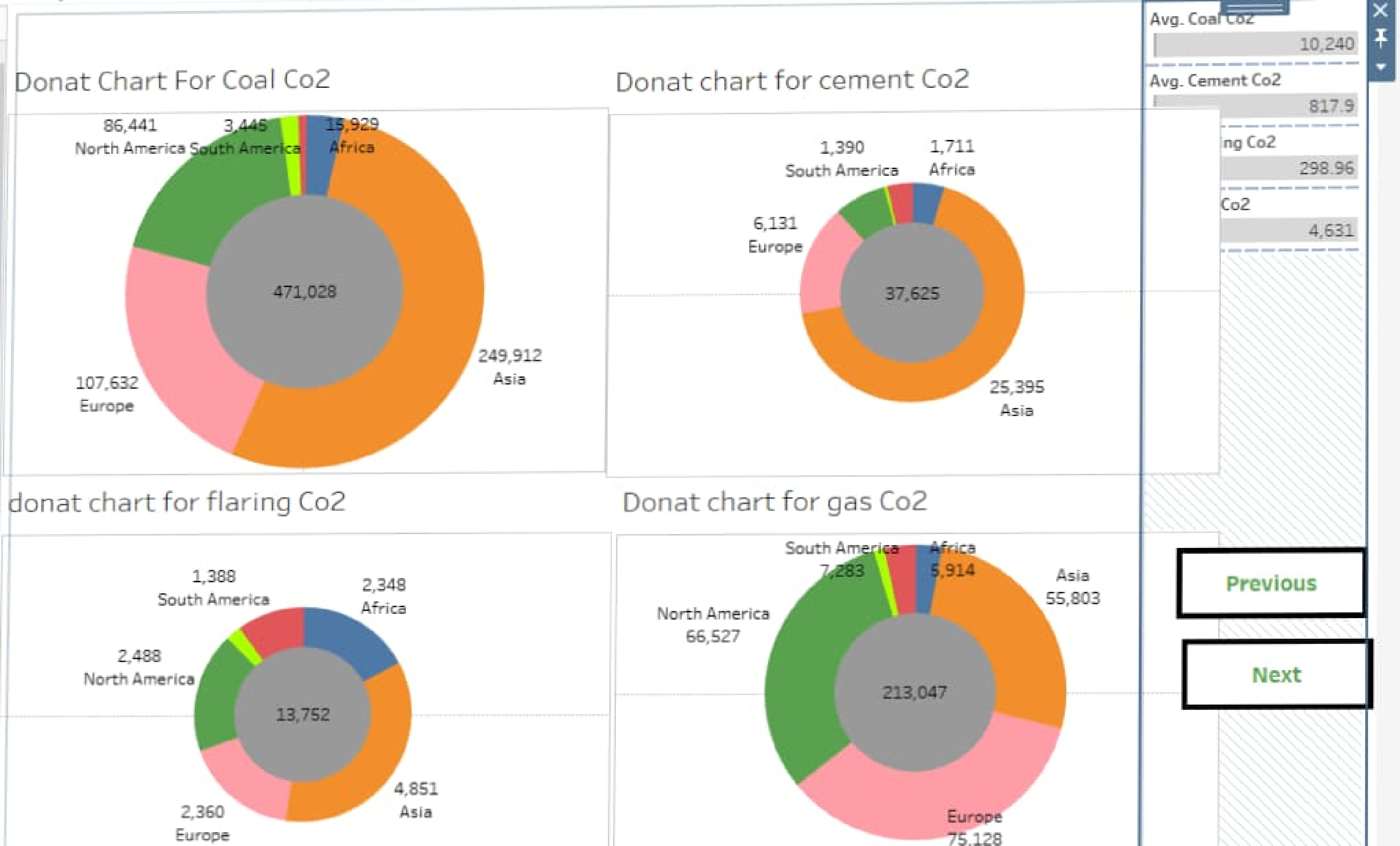
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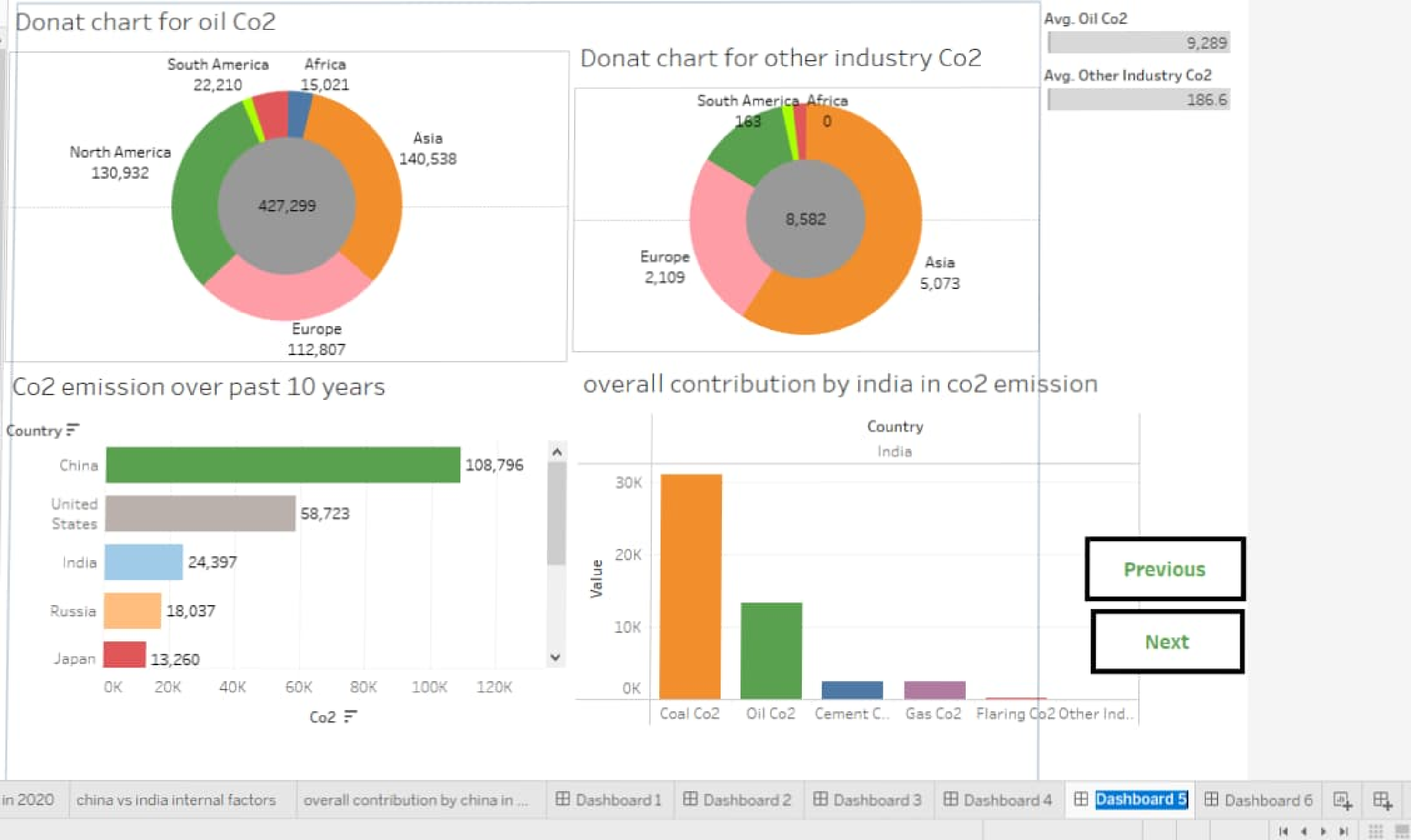
86,441
North America
3,445
South America
15,929
Africa
471,028
249,912
Asia
107,632
Europe
Donat chart for cement Co2
1,390
South America
1,711
Africa
6,131
Europe
37,625
25,395
Asia
donat chart for flaring Co2
1,388
South America
2,348
Africa
2,488
North America
13,752
4,851
Asia
2,360
Europe
Donat chart for gas Co2
South America
7,283
Africa
5,914
Asia
55,803
North America
66,527
213,047
Europe
75,128
Avg. Coal Co2
10,240
Avg. Cement Co2
817.9
ing Co2
298.96
Co2
4,631
Previous
Next


Donat chart for oil Co2
South America
22,210
Africa
15,021
Asia
140,538
North America
130,932
427,299
Europe
112,807
Donat chart for other industry Co2
South America
163
Africa
0
8,582
Europe
2,109
Asia
5,073
Avg. Oil Co2
9,289
Avg. Other Industry Co2
186.6
Co2 emission over past 10 years
Country
China
108,796
United States
58,723
India
24,397
Russia
18,037
Japan
13,260
0K
20K
40K
60K
80K
100K
120K
Co2
overall contribution by india in co2 emission
Country
India
Value
30K
20K
10K
0K
Coal Co2
Oil Co2
Cement C..
Gas Co2
Flaring Co2
Other Ind..
Previous
Next
in 2020
china vs india internal factors
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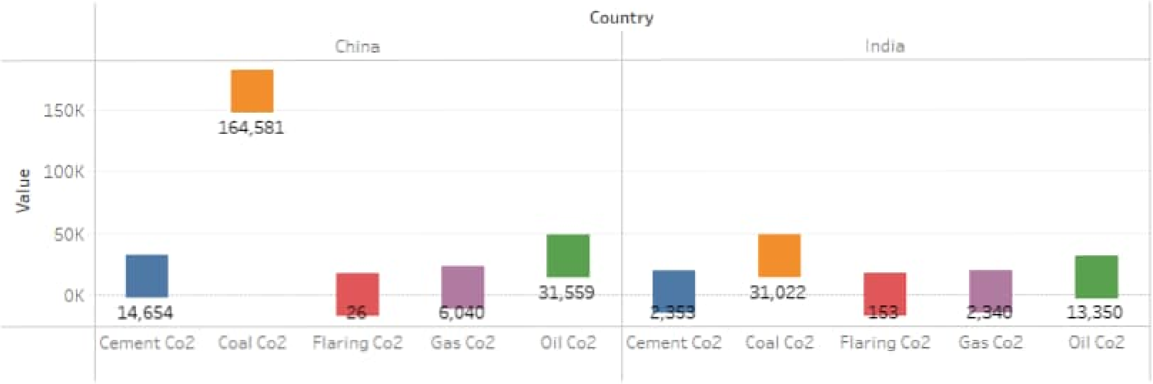

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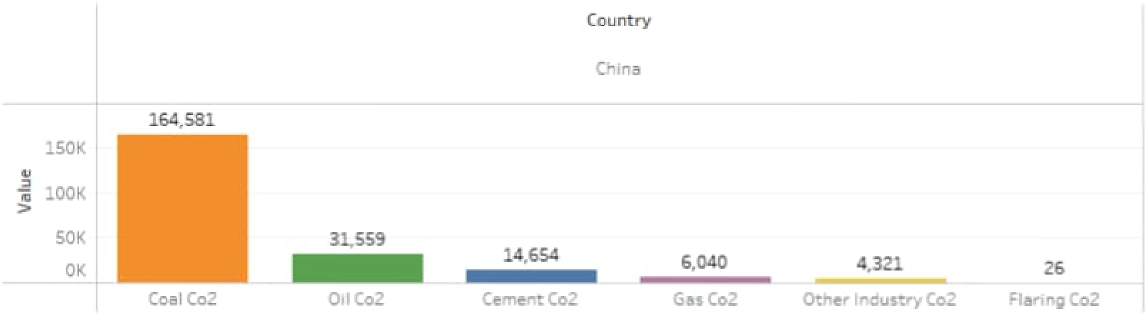
overall contribution by china in Co2 emission



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Countries Total World Emission	Countries Emitting Higest Co2	Total Co2 Emission by Cfrom 1975 to 2020	Co2 Emission India Vs United States	Total Co2 Emission by Continents	Co2 Emission Due to Internal reasons	Co Int

Country

- Afghanistan
- Africa
- Albania
- Algeria
- Andorra
- Angola
- Anguilla
- Antarctica
- Antigua and Barb..
- Argentina
- Armenia
- Aruba
- Asia
- Asia (excl. China ..
- Australia
- Austria
- Azerbaijan
- Bahamas
- Bahrain
- Bangladesh
- Barbados
- Belarus
- Belgium