Exploratory of CO2 emission in Bangkok

created by Thanapong (Billy)

Background

Chatchart launch the campaign of planting 1 million trees, so how many green space in bkk right now? and what cause the CO2 emission develop over the past?

Objectives

To find the solution for the climate change issue which one of the root cause is "CO2 emission", so it need to be reduced.

Example of Dataset

section 1

	Year	Month	Sector	Quantity	UNIT
0	1987	January	Power Generation	1203.63	1,000 Tons
1	1987	February	Power Generation	1067.01	1,000 Tons
2	1987	March	Power Generation	1286.76	1,000 Tons

section 2

	Year	CO2_world
0	1990	20625272.97
1	1991	20766900.89
2	1992	20796958.43

	Year	Forest
0	1990	31.624509
1	1991	31.568815
2	1992	31.620467

section 3

	จังหวัด	อำเภอ	รหัสไปรษณีย์
0	กรุงเทพมหานคร	พระนคร	10200
1	กรุงเทพมหานคร	ดุสิต	10300
2	กรุงเทพมหานคร	หนองจอก	10530

	ปี เดือน	รหัส จังหวัด	ชื่อจังหวัด	รหัสสำนัก ทะเบียน	ชื่อสำนัก ทะเบียน	รหัส ตำบล	ชื่อ ตำบล	รหัส หมู่บ้าน	ชื่อ หมู่บ้าน	จำนวนประชากร ชาย	จำนวนประชากร หญิง	จำนวนประชากร ทั้งหมด
0	6412	0	ทั่วประเทศ	0	-	0	-	0	-	32,339,118	33,832,321	66,171,439
1	6412	10	กรุงเทพมหานคร	0	-	0	-	0	-	2,592,292	2,935,702	5,527,994
2	6412	10	กรุงเทพมหานคร	1001	ท้องถิ่นเขต พระนคร	0	-	0	-	20,753	22,309	43,062

	Shape_Leng	Shape_Area	ADM2_EN	ADM2_TH	ADM2_PCODE	ADM2_REF	ADM2ALT1EN	ADM2ALT2EN	ADM2ALT1TH	ADM2ALT2TH	ADM1_EN	ADM1
0	0.085417	0.00045	Phra Nakhon	พระนคร	TH1001	None	None	None	None	None	Bangkok	กรุงเทพมหา
1	0.134132	0.00095	Dusit	ดุสิต	TH1002	None	None	None	None	None	Bangkok	กรุงเทพมหา

	รหัส	ชื่อเขต	ประชากร*	จำนวน-แห่ง	ไร่	งาน	ตร.วา	พื้นที่รวม ตร.ม.
0	1	เขตคลองเตย	93,193	278	906	1	42.17	1,450,168.68
1	2	เขตคลองสาน	69,139	202	265	0	24.00	424,096.00
2	3	เขตคลองสามวา	204,900	451	8,271	0	66.65	13,233,866.60

Data Preparation

Method used:

1. info()
2. nunique()
3. unique()
4. head()
5. describe()
6. drop()
7. columns()
8. merge()
9. to_numeric()

```
In [12]: map_df['ADM1_EN'].describe()

Out[12]: count          928
         unique          77
         top        Bangkok
         freq            50
         Name: ADM1_EN, dtype: object
```

```
In [14]: CO2_world.info()# no 'Nan'

<class 'pandas.core.frame.DataFrame'>
RangeIndex: 30 entries, 0 to 29
Data columns (total 2 columns):
 #   Column      Non-Null Count  Dtype
---  ------      --------------  -----
 0   Year        30 non-null     int64
 1   CO2_world   30 non-null     float64
dtypes: float64(1), int64(1)
memory usage: 608.0 bytes
```

```
In [10]: en_sector_data.nunique() #this data compose of 36 years and 4 sector of activities

Out[10]: Year          36
         Month         12
         Sector         4
         Quantity    1701
         UNIT           1
         dtype: int64

In [11]: en_sector_data['Sector'].unique() # the sectors are ...

Out[11]: array(['Power Generation', 'Transport', 'Industry', 'Other'], dtype=object)
```

```
def multi_merge_df(main,*args,**kwargs):
    for arg in args:
        for key in kwargs:
            main = pd.merge(main,arg,on = kwargs[key] )
    return main
```

EDA : section 1

Create the function to extract the summation of CO2 in each year and categorized them into new dataframe

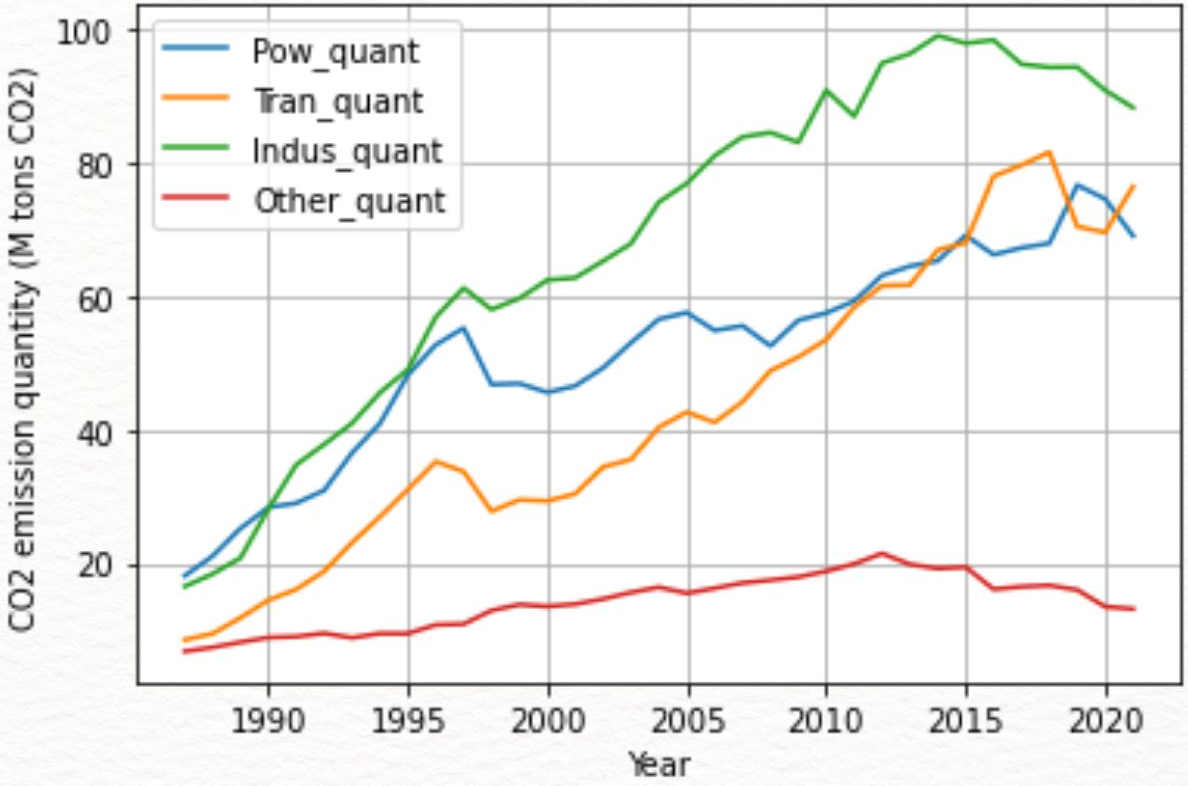
```
def sec1(df,col_scope,group_by,*args):
    list_df = []
    x = 0
    for i in (args):
        i = df[df[col_scope] == i].groupby(group_by).sum() #สร้าง df ใหม่ที่มีผลรวมของปริมาณ CO2 ของแต่ละปี
        list_df.append(i) #เก็บ df ใน list
    mer = list_df[0]
    while x < (len(list_df))-1: # ลบ 1 เพื่อไม่ให้เกิน index
        mer = pd.merge(mer,list_df[x+1],on=group_by) # loop merge
        x = x +1
    return mer

data1 = sec1(en_sector_data,'Sector','Year','Transport','Industry','Power Generation','Other')
```

```
data1 = data1 /1000
data1.columns=['Pow_quant','Tran_quant','Indus_quant','Other_quant'] #rename
```

EDA : section 1 result

- The CO2 emission quantity in every sector trend to increase from 1990 - 2021
- The summation of CO2 quantity in Thailand 2021 is around 134 Mtons CO2
- During the 2019, The CO2 emission in transport sector reduce rapidly



EDA : section 2

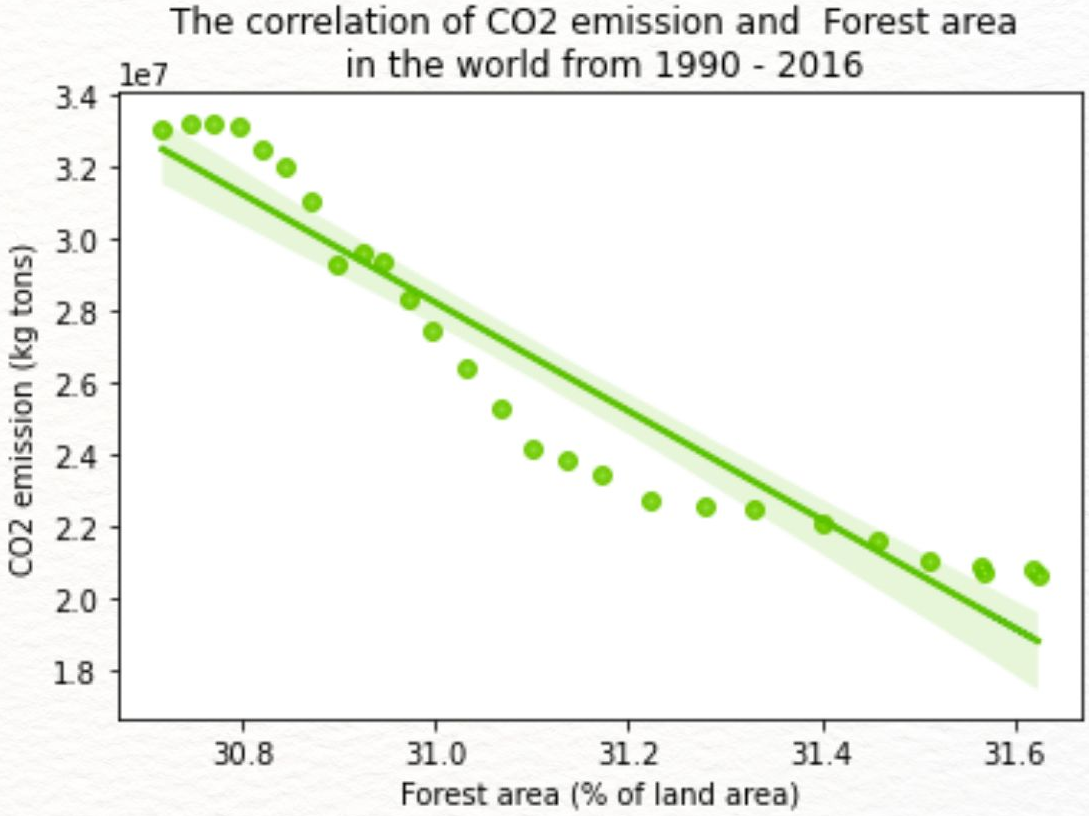
Merge to dataset to find the correlation between forest area and CO2 quantity by using linear regression model

```
data2 = pd.merge(CO2_world,forest_world,on='Year')
data2.head(3)
```

```
plt.plot(data2['Forest'].loc[0:26],data2['CO2_world'].loc[0:26], 'o',color = '#97EB42',markersize=0.5)
m, b = np.polyfit(data2['Forest'].loc[0:26], data2['CO2_world'].loc[0:26], 1)
plt.plot(data2['Forest'].loc[0:26], m*data2['Forest'].loc[0:26]+b)
sns.regplot(data2['Forest'].loc[0:26],data2['CO2_world'].loc[0:26],color = '#60C100')
plt.title('The correlation of CO2 emission and  Forest area \n in the world from 1990 - 2016')
plt.xlabel('Forest area (% of land area)')
plt.ylabel('CO2 emission (kg tons)')
```

EDA : section 2 result

- The correlation of Forest area and CO2 emission is negative correlation
- The more deforestation the more CO2



EDA : section 3

Use the population in each district to estimate the quantity of CO2 emission, and use the green space to estimate the quantity of CO2 reduction . Finally, visualize by heat map.

```
bkk_data['POPS'] = pd.to_numeric(bkk_data['POPS'])
bkk_data['local_CO2(tons CO2/y)'] = round(bkk_data['POPS'] *3.731602163)
```

```
bkk_data['Green_area(ไร่)'] = round(pd.to_numeric(bkk_data['Green_area(ไร่)'])/1600)
bkk_data['CO2_reduction(tons CO2/y)'] = round((5*1256)*bkk_data['Green_area(ไร่)']*0.278*1e-6*0.785*365*1e-3*1600)
```

total heat absorbed = Quantity of heat absorbed around green space * Area of green space

↓

Convert heat to electrical power

↓

Convert electrical power to CO2 emission will equal to capability of CO2 reduction

EDA : section 3

Class created for CO2 & Green space mapping:

```
class CO2:
    '''This is a class to plot CO2_emission in local area, Green space ratio in your area, and The CO2 _ reduction need
    def __init__(self,postcode):
        self.postcode = postcode

    def show_CO2_local(self):
        map_data = bkk_data[bkk_data['postal']==self.postcode]#edit pen postcode
        fig, ax = plt.subplots(figsize=(20, 10))
        map_data.plot(column=map_data['local_CO2(tons CO2/y)'],ax=ax,cmap='Reds')
        map_data.apply(lambda x: ax.annotate(text=x['ADM2_EN']+'\n'+str(x['local_CO2(tons CO2/y)'])+'\ntons CO2/y', xy=
                                             ha='center'), axis=1)
        plt.title('Quantity CO2 emission')
        plt.show()
    def show_green_local(self):
        map_data = bkk_data[bkk_data['postal']==self.postcode]#edit pen postcode
        fig, ax = plt.subplots(figsize=(20, 10))
        map_data.plot(column=map_data['Green_area(ไร่)'],ax=ax,cmap='Greens')
        map_data.apply(lambda x: ax.annotate(text=x['ADM2_EN']+'\n'+str(x['Green_area(ไร่)'])+'\nrai', xy=x.geometry.cen
        plt.title('Quantity green space')
        plt.show()

    def show_green_bkk(self):
        fig, ax = plt.subplots(figsize=(30,20))
        bkk_data.plot(column=bkk_data['Green_area(ไร่)'],ax=ax,cmap='Greens')
        bkk_data.apply(lambda x: ax.annotate(text=x['ADM2_EN']+'\n'+str(x['Green_area(ไร่)'])+'\nrai', xy=x.geometry.cen
        plt.title('Quantity green space',fontsize=80)
        plt.show()

    def show_CO2_bkk(self):
        fig, ax = plt.subplots(figsize=(30,20))
        bkk_data.plot(column=bkk_data['local_CO2(tons CO2/y)'],ax=ax,cmap='Reds')
        bkk_data.apply(lambda x: ax.annotate(text=x['ADM2_EN']+'\n'+str(x['local_CO2(tons CO2/y)'])+'\ntons CO2/y', xy=
        plt.title('Quantity CO2 emission',fontsize=80)
        plt.show()

    def show_CO2_local_reduce(self):
        map_data = bkk_data[bkk_data['postal']==self.postcode]#edit pen postcode
        fig, ax = plt.subplots(figsize=(20, 10))
        map_data.plot(column=map_data['CO2_reduction(tons CO2/y)'],ax=ax,cmap='Blues')
        map_data.apply(lambda x: ax.annotate(text=x['ADM2_EN']+'\n'+str(x['CO2_reduction(tons CO2/y)'])+'\ntons CO2/y',
        plt.title('Quantity CO2 reduction')
        plt.show()

    def show_CO2_bkk_reduce(self):
        fig, ax = plt.subplots(figsize=(30,20))
        bkk_data.plot(column=bkk_data['CO2_reduction(tons CO2/y)'],ax=ax,cmap='Blues')
        bkk_data.apply(lambda x: ax.annotate(text=x['ADM2_EN']+'\n'+str(x['CO2_reduction(tons CO2/y)'])+'\ntons CO2/y',
        plt.title('Quantity CO2 reduction',fontsize=80)
        plt.show()
```

```
postcode =int(input('Exploratory of CO2\nWhat is your zip code : '))
ans = CO2(postcode)


while True:
    print('<------------------------------------------------------------>')
    print('Please select the number of interested\n \n1.show the quantity of CO2 in your area \n2.show the quantity of
    \n3.show the quantity of CO2 reduced in your area \n---------------------------------------------- \n4.show the q
    \n6.show the quantity of CO2 reduced in bkk')
    option  = int(input('Enter the option number (1,2,3,4,5,6) or enter -1 to exit : '))
    print('You have select option',option)
    if option == 1:
        ans.show_CO2_local()
    elif option == 2:
        ans.show_green_local()
    elif option == 3:
        ans.show_CO2_local_reduce()
    elif option == 4:
        ans.show_CO2_bkk()
    elif option == 5:
        ans.show_green_bkk()
    elif option == 6:
        ans.show_CO2_bkk_reduce()
    elif option == -1:
        print('Thank you for using')
        break
```

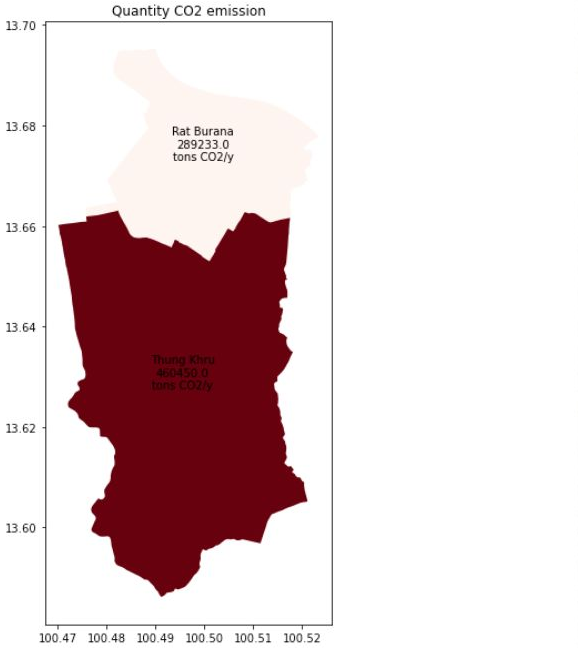
```
Exploratory of CO2
What is your zip code : 10140
<------------------------------------------------------------>
Please select the number of interested

1.show the quantity of CO2 in your area
2.show the quantity of green space in your area
3.show the quantity of CO2 reduced in your area
-----------------------------------------------
4.show the quantity of CO2 in bkk
5.show the quantity of green space in bkk
6.show the quantity of CO2 reduced in bkk

Enter the option number (1,2,3,4,5,6) or enter -1 to exit :
```

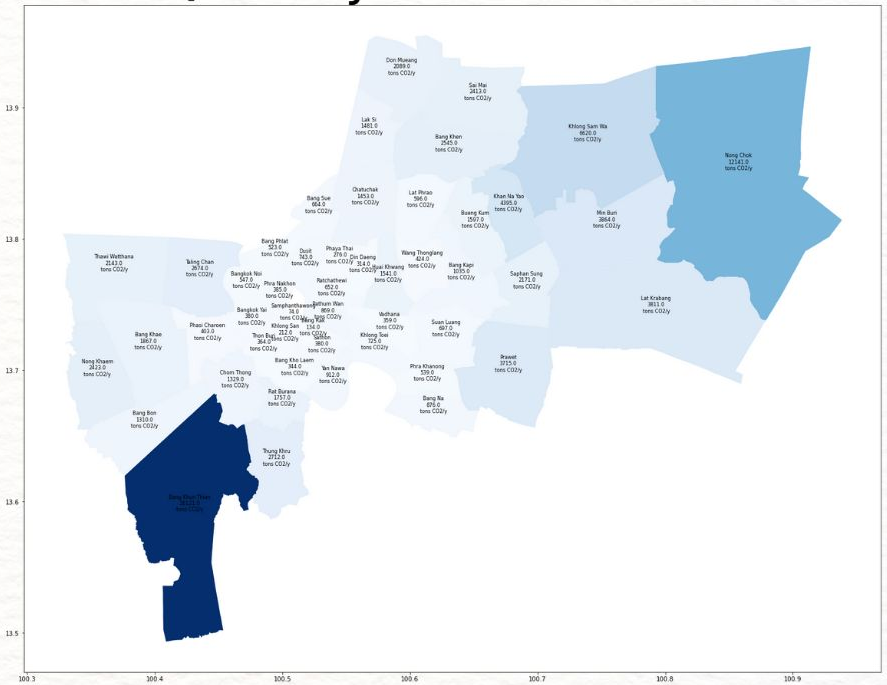
EDA : section 3 result

```
Enter the option number (1,2,3,4,5,6) or enter -1 to exit : 1
You have select option 1
```




```
<------------------------------------------------------------>
Please select the number of interested
```

Quantity CO2 reduction



Conclusion

Key-Finding

1. CO_2 trends to increase continuously which some of the solution to reduce are WFH, public transport, EV cars, expand green space
2. Forest area has the negative correlation with the CO_2 which mean the less forest the more CO_2
3. CO_2_reduction_ratio around 0.5%, so should increase the green space 4 times

Recommendation

1. The green area map should use the green space ratio
2. map graph should add color bar
3. In the CO_2 reduction estimation should add other factor i.e. water land

Non-financial benefit

1. create awareness among people in the area
2. can be used to see the quality of life in each district (carbon content, green space in the district)

Financial benefit

1. If there is a carbon tax, it can be used as an inspection tool.
2. Environmental businesses such as electric cars, tree businesses, etc. will have more demand in carbon-rich areas.