Updated Emission Inventories from Industrial Sector in Thailand for 2013

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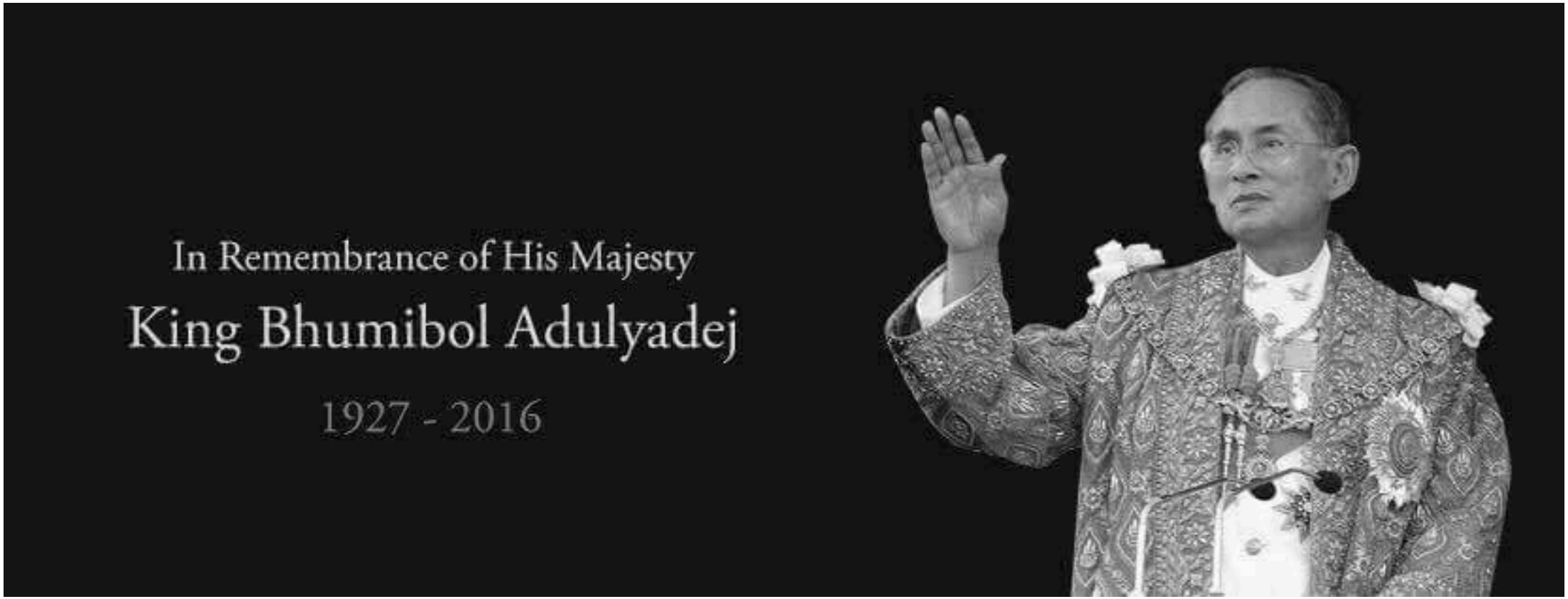
International Meeting on Land Use and Emissions in South/Southeast Asia
Ho Chi Minh City, Vietnam, October 17-19th, 2016


In Remembrance of His Majesty
King Bhumibol Adulyadej
1927 - 2016

Outline

1. Introduction & Previous work
2. Objectives and Scope of Work
3. Methodology
4. Results
5. Conclusions

1.Introduction

Major Sources of Air Pollutants

Industries

Transportation

Open Burning

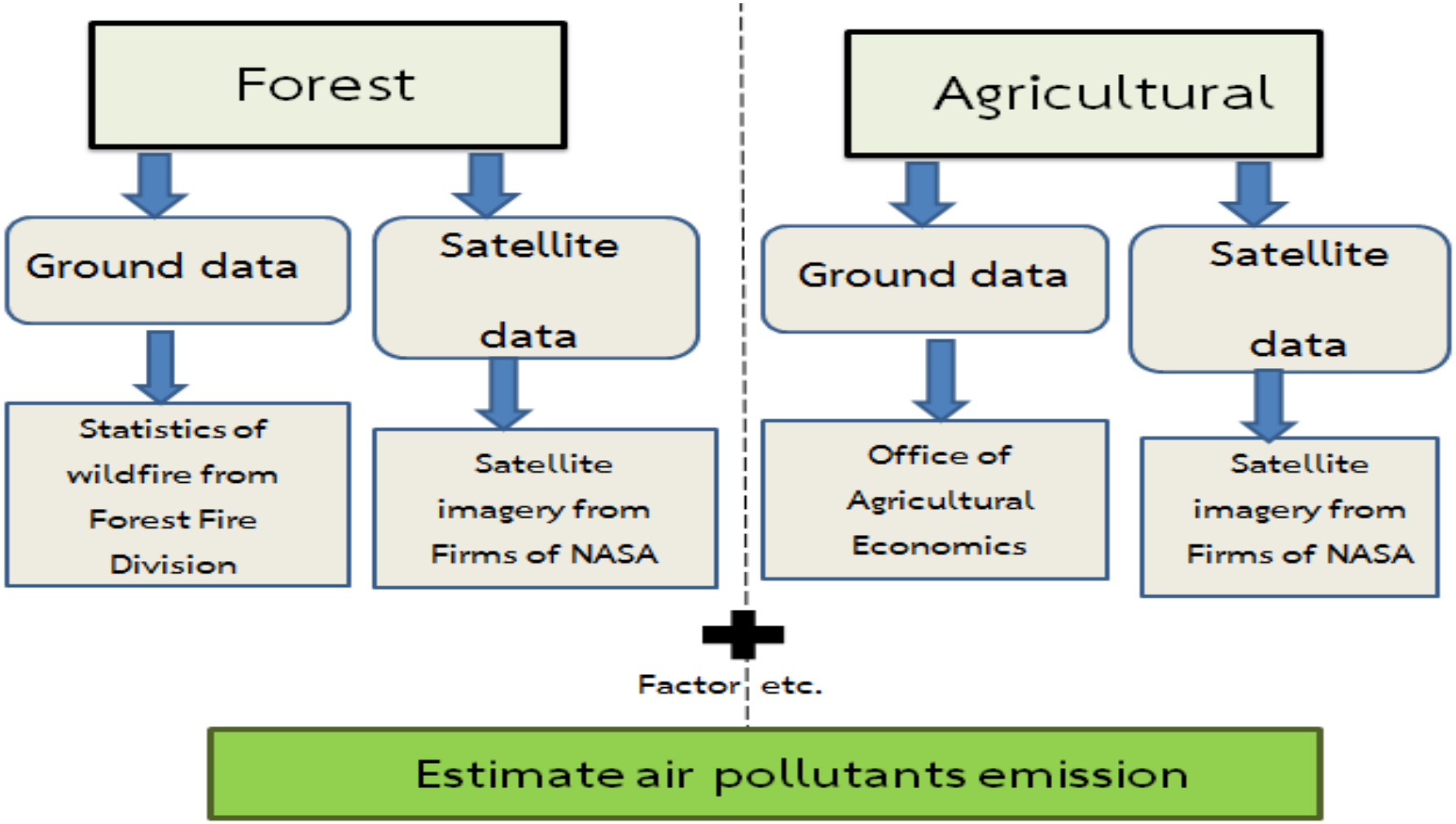
1. Previous Work on Emission Inventory

International Workshop on Air Quality in Asia
Impacts of Land Cover/Land Use Changes on Greenhouse Gases/SLCP and Aerosols, August 4th-7th, 2015, Bogor, Indonesia

Objectives

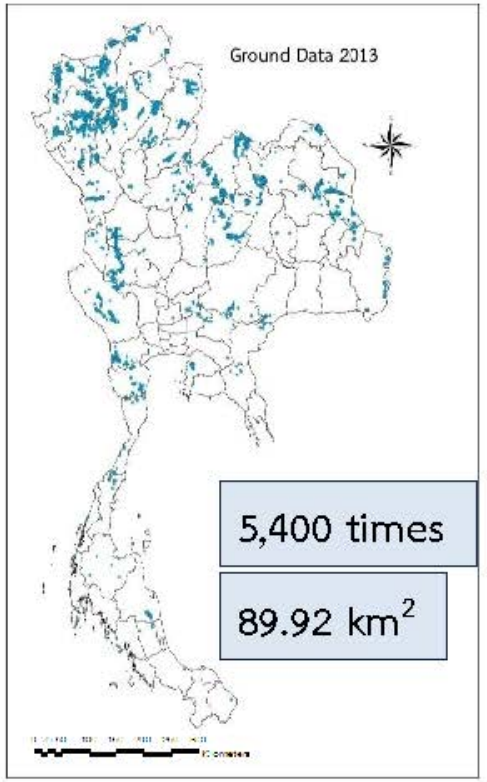
Estimate air pollutants emission from biomass open burning in agricultural area and forest fire by using the Satellite based and ground report fire data for year 2010-2013.

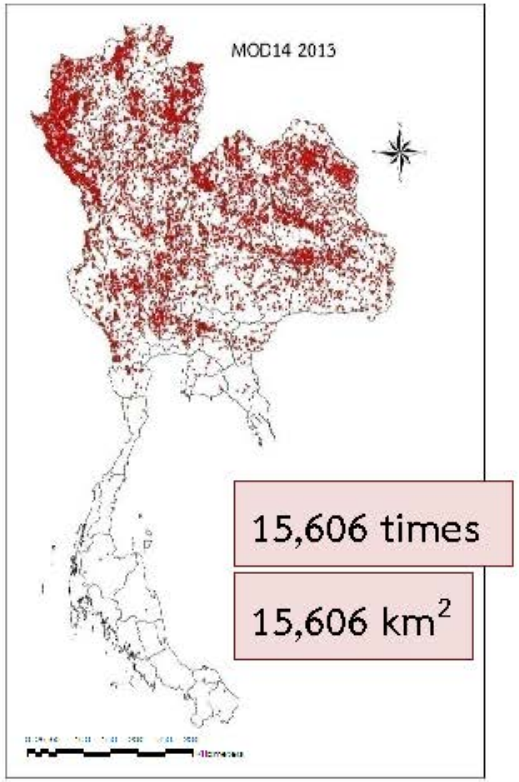
Methodology

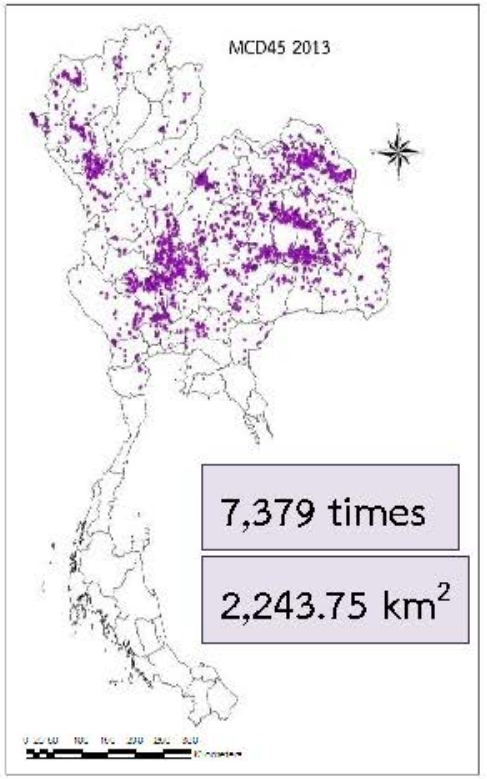


Results

Spatial Distribution of Fire in 2013







Results

Table 16 Air pollutants emission in 2013

Vegetable type		Emission (tons)					
		CO	CO_2	NO_x	TPM	$PM_{2.5}$	BC
Forest Fire	Ground data	48,477	712,746	1,996	7,697	5,747	-
	MOD14	4,652,430	69,094,906	184,368	694,314	527,828	-
	MCD45	346,009	5,280,949	15,425	54,643	40,481	-
Agricultural Burning	Ground data	1,624,207	15,124,967	-	-	296,673	9,364
	MOD14	376,524	3,813,125	-	-	69,766	2,275
	MCD45	80,371	762,913	-	-	15,723	474

Results

40

Conclusion

- Emissions in Forest Fire Area
  - MOD 14 was the best of the three sources of data due the larger coverage area and similar trend to ground data. However, emissions were systematic overestimated since average of burned area in Thailand is far less than 1 km^2 approximation.
- Emissions in Agricultural Area
  - Ground based data gave more reasonable amount of emissions but lack of spatial and temporal distribution.
  - Satellite Based data, MCD45 was better than MOD 14 from capability to discover peak of fire in Dec.
- Emissions from Forest Fire were greater than crop residue burning. However, the difference of this two sources was closer for certain year.

Previous Work on Emission Inventory

Emission Inventory of Air Pollutants in Bangkok from Road Transportation in 2013

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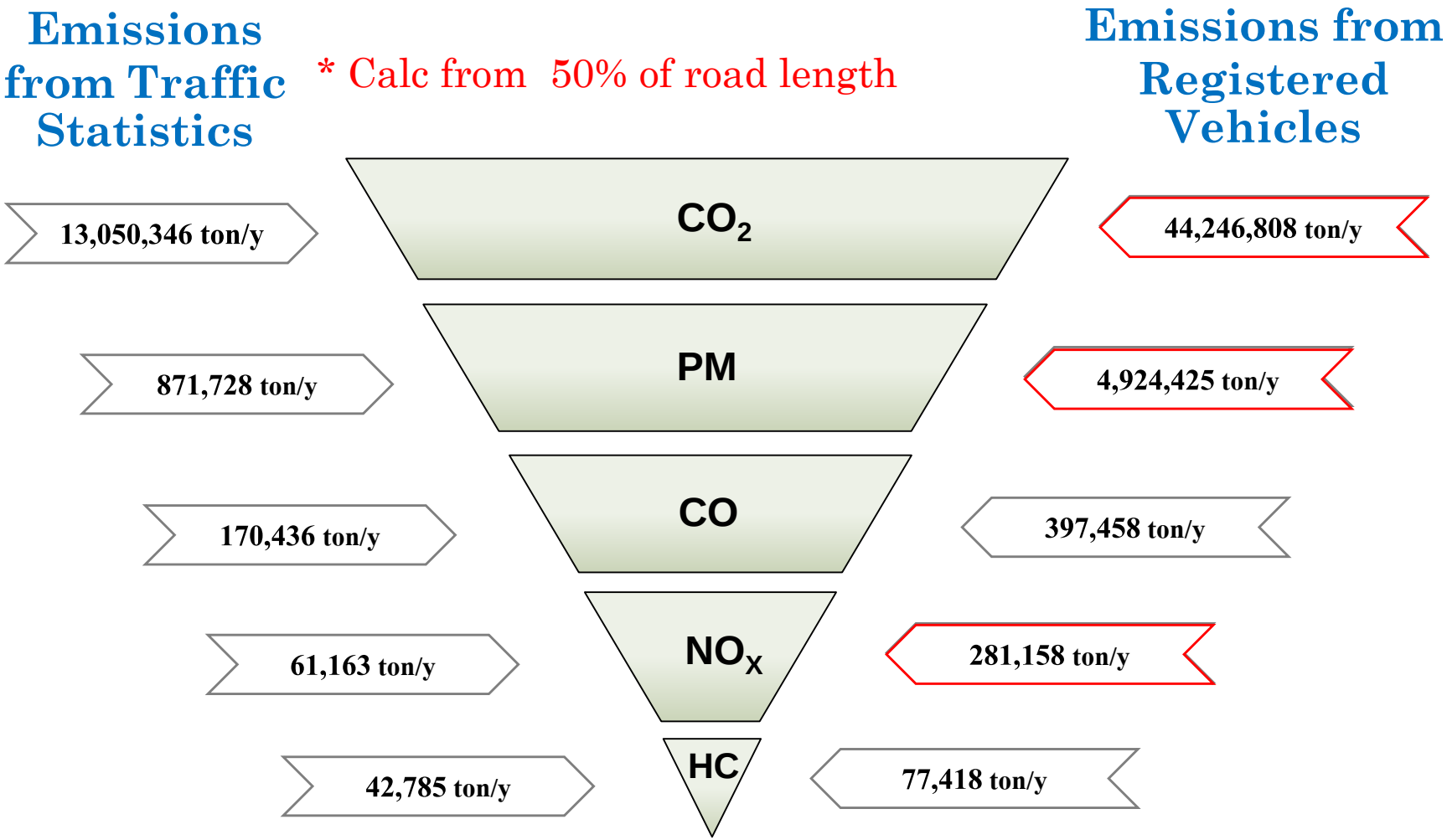
The 17th World Clean Air Congress (WCAC) and the 9th Better Air Quality Conference (BAQ), August 31, 2016, Busan, South Korea

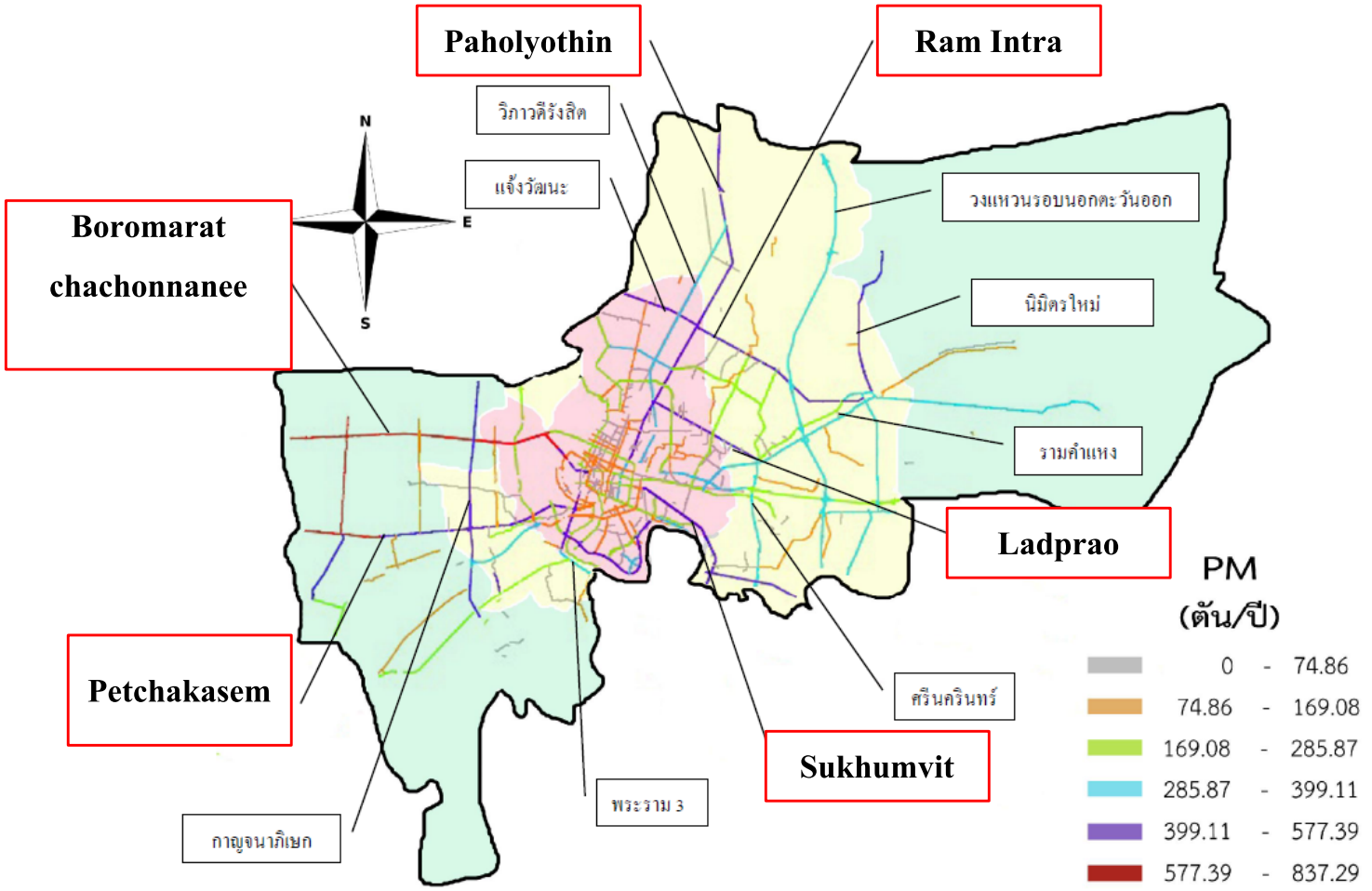
Results

Estimated emissions



Results

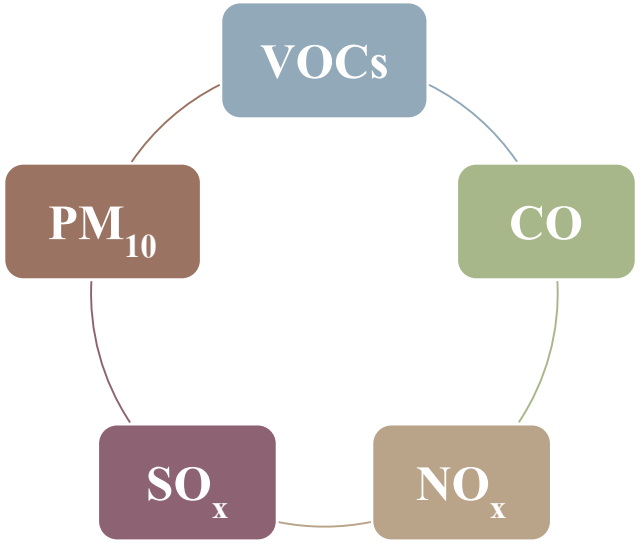
TPM distribution of Bangkok Road Network



2.Objectives and Scope of Work

Objectives: To estimate air pollutant emitted from Energy Use in Industrial Sector in Thailand for 2013

Emission Species :



3.Methodology

Emission Factors : Semi-bottom up

$$\mathbf{E = A \times EF \times (1 - ER / 100)}$$

E = Emission rate
A = Activity rate
EF = Emission Factor
ER = Overall Emission Reduction Efficiency:%

3.Methodology

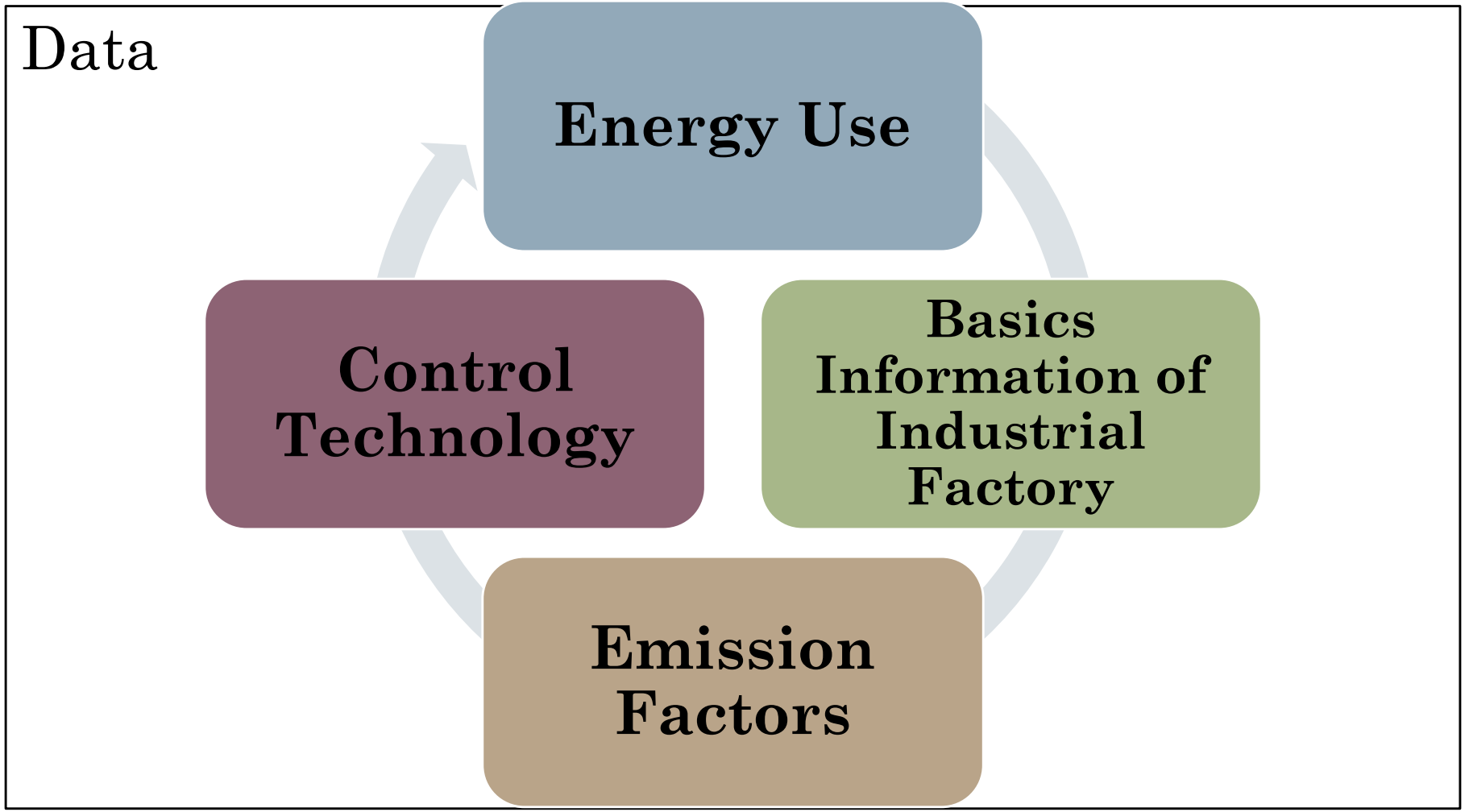
Steps

1. Collect data

2. Data conversion and extrapolation

3. Emission Estimation

3.Methodology



3.Methodology

Energy use data:

- Obtained from Department of Alternative Energy Development and Efficiency(DEDE), Ministry of Energy, Thailand
- Consist of Name of factory, Address, TSIC (Thailand Standard Industrial Classification), Type of Industry, Type of product & capacities, Type of Energy use & amounts, Heat Value
- Have only data for about 4900 factories from about 100,000 factories in Thailand

3.Methodology

Energy use data:

- Example of data

Factory Name	Product	Fuel Type	Quantities	Unit
Tobacco company A	Dried Tobacco leaves	Fuel Oil	826,590	liter
Sugar Plant A	Raw and white sugar	Bagasse	544,389,760	Kg
Industrial Gases A	LPG	NG	387,539	M BTU
Chemical Company A	Synthetic chemicals	Fuel Oil	385490	liter

3.Methodology

Basics Information of Industrial Factory

Obtained from the Department of Industrial Works (DIW). The list contains ID, TSIC , address, capital investment, number of employee, and boiler/machine installed power capacity

Factory ID	Factory Name	Capital Investment (million baht)	Horsepower	Total Area(m^2)
3-1-18/15ชม	Tobacco company A	18.2	352.68	6400
3-11(3)-1/42กส	Sugar Plant A	345	228,690.3	798,400
3-89-1/21อค	Industrial Gases A	5.1	163.14	4,536
จ3-81(1)-1/38สป	Chemical Company A	20	184	6,400

3.Methodology

Control Technology

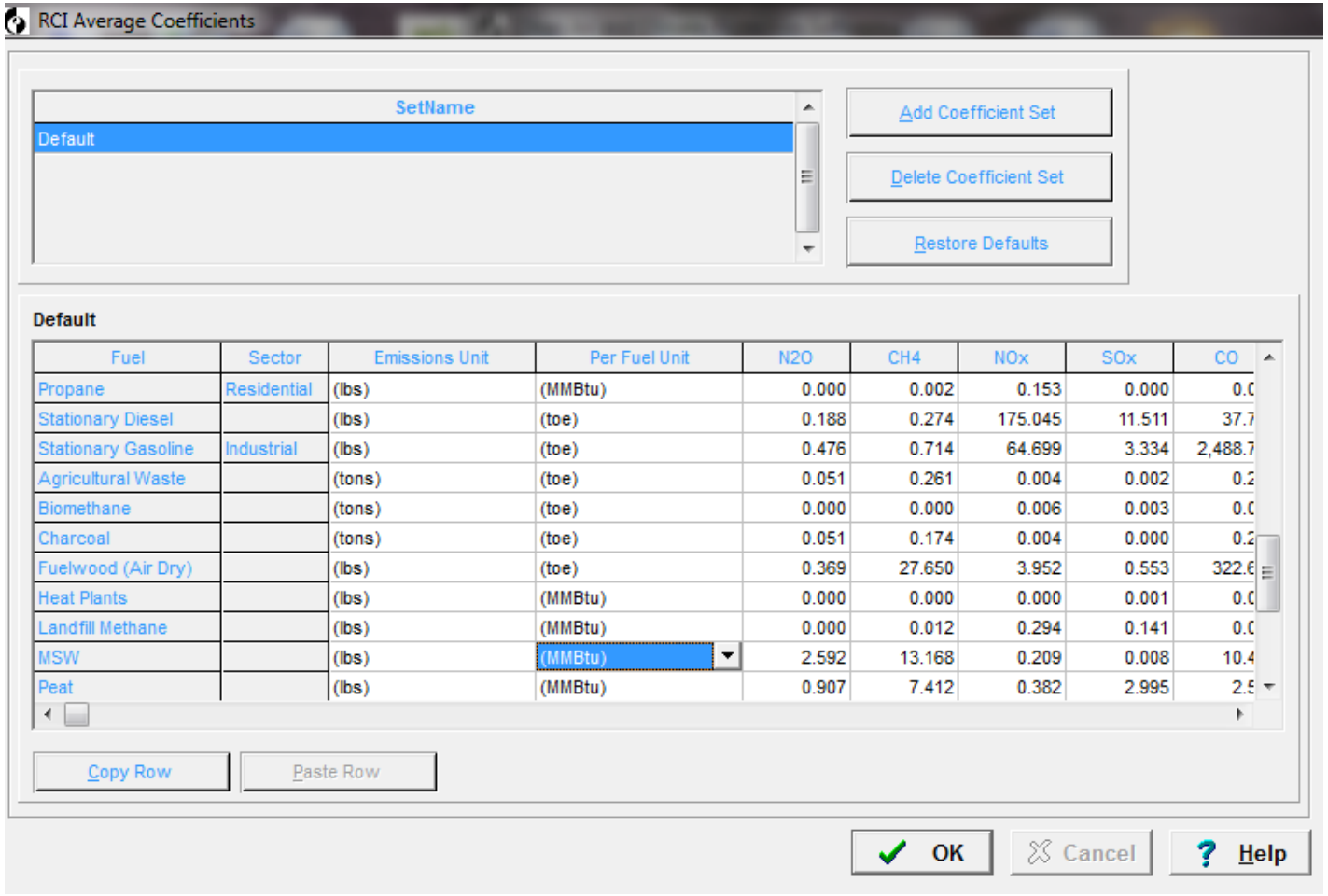
Obtained from Thi Bich Thao, Pham et.al, "Develop of an inventory and temporal allocation profiles of emissions from power plants and industrial facilities in Thailand", Sci Total Environ. 2008 Jul 1;397(1-3):103-18

Pollutants	Control Technology	Efficiency (%)
CO	-	-
NO_X	Low NO_X burner	75
SO_X	Scrubber	87.50
VOCs	-	-
PM_{10}	ESP	90

3.Methodology

Emission Factors

- Obtained from **International Council for Local Environmental Initiatives (ICLEI) Clean Air and Climate Protection (CACP) Software**



3.Methodology

Steps

1. Collect data

2. Data conversion and extrapolation

3. Emission Estimation

3.Methodology

Data Conversion

Fuel Type (Unit)	TOE/10^6UNIT
Gasoline (liter)	745.07
Coal (kg)	624.19
NG (cu. ft)	24.57
Charcoal(kg)	683.64
biogas (cu.m)	495.39

3.Methodology

Data Extrapolation Methodology

- DIW data
  1. filter data only name, address, TSIC, and installed HP
  2. Calculated energy use per TSIC type for factory without energy use by using mean ratio energy per HP from DEDE * installed HP of each factory
  3. Sum each type of energy use for all 107 classes
  4. Check the total amount of energy use with energy usage in industrial sector from Energy Statics of Thailand, Ministry of Energy
  5. If the total amount of estimated energy use was not match with national statistics, apply an adjusted factor until the difference of two datasets was less than 5%

3.Methodology

Data Extrapolation Methodology

- DEDE data
  1. Matched name in DEDE data to name in DIW data to get installed HP information from DIW data
  2. Merged installed HP to DEDE data and calculated ratio of energy use/installed horse power
  3.Sorted calculated energy ratio for each TSIC classification(107 classes) and calculated mean for each group

3.Methodology

Steps

1. Collect data

2. Data conversion and extrapolation

3. Emission Estimation

4.Results

Group of Industries	emissions(ton/yr)				
	NO_X	SO_X	CO	VOCs	PM_{10}
Construction materials	23,213	1,511	5,406	2,004	1,722
Food & Beverage	89,597	128,118	355,171	43,355	23,600
Textiles	25,815	16,296	60,724	8,058	4,344
Wood	21,865	1,858	47,059	9,022	6,238
Paper	32,150	31,390	24,641	3,725	3,612
Chemicals	41,532	44,497	149,771	15,754	10,383
Non-Metal	31,622	23,209	145,871	4,160	7,785
Basic Metal	24,221	9,449	5,476	1,663	1,714
Metal products	26,698	5,166	9,443	2,477	1,786
Others	22,095	3,639	5,143	2,048	1,825
Utilities	22,380	3,551	3,476	1,767	1,849
Total	361,186	268,684	812,181	94,033	64,858

4.Results

Type of Energy	emissions(ton/yr)				
	NO_X	SO_X	CO	VOCs	PM_{10}
Natural Gas	4,084	3,478	2,875	355	309
LPG	5,133	1,016	2,122	305	170
Kerosene	1,196	1,121	58	91	75
Gasoline	1,705	588	65,580	2,196	605
Diesel	228,815	16,256	53,250	19,618	15,816
Fuel Oil	13,860	66,218	7,216	1,154	3,931
Coal	84,521	169,061	17,060	1,578	9,974
Bio Fuel	21,874	10,948	664,019	68,736	33,977
Total	361,188	268,686	812,180	94,033	64,857

4.Results

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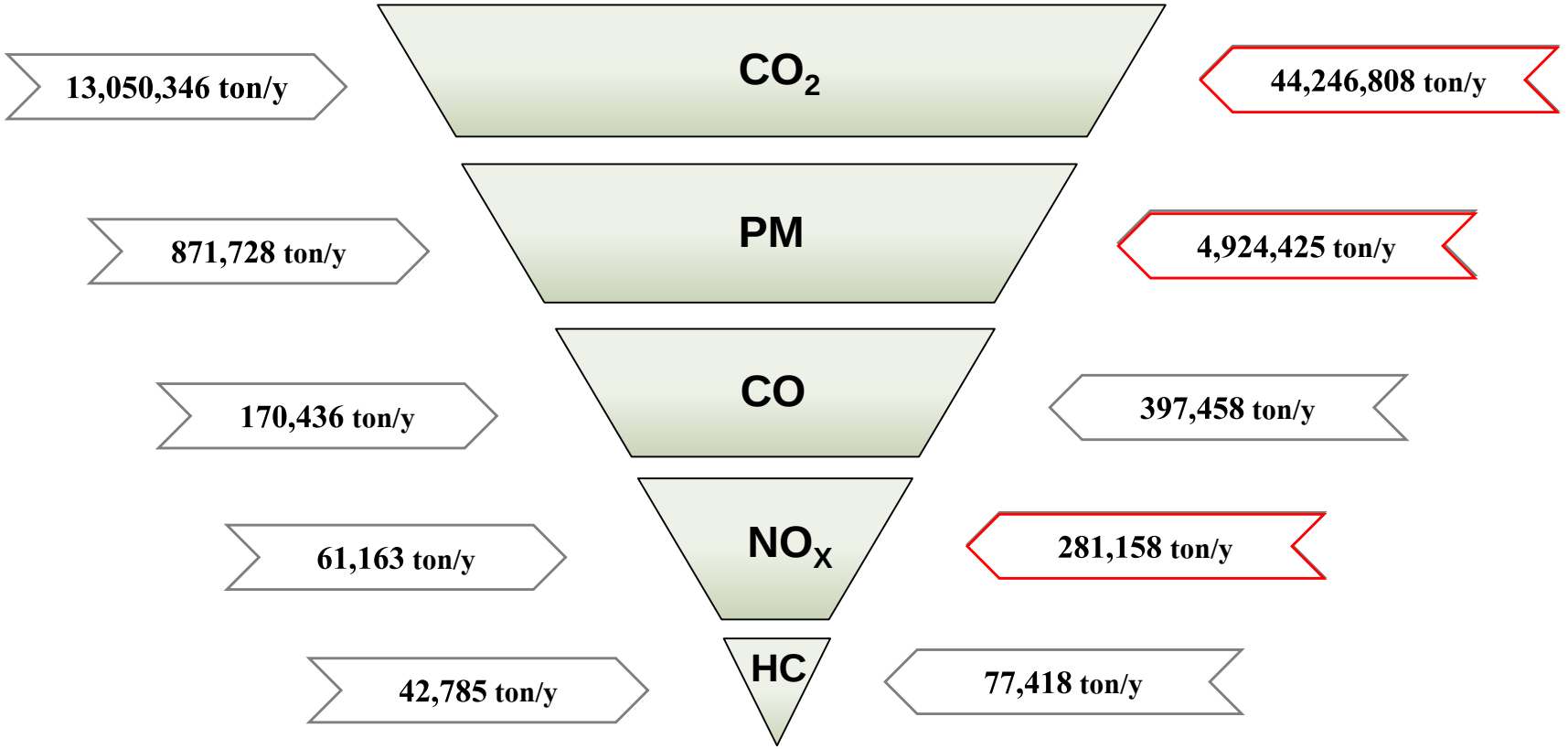
4. Results

Estimated emissions

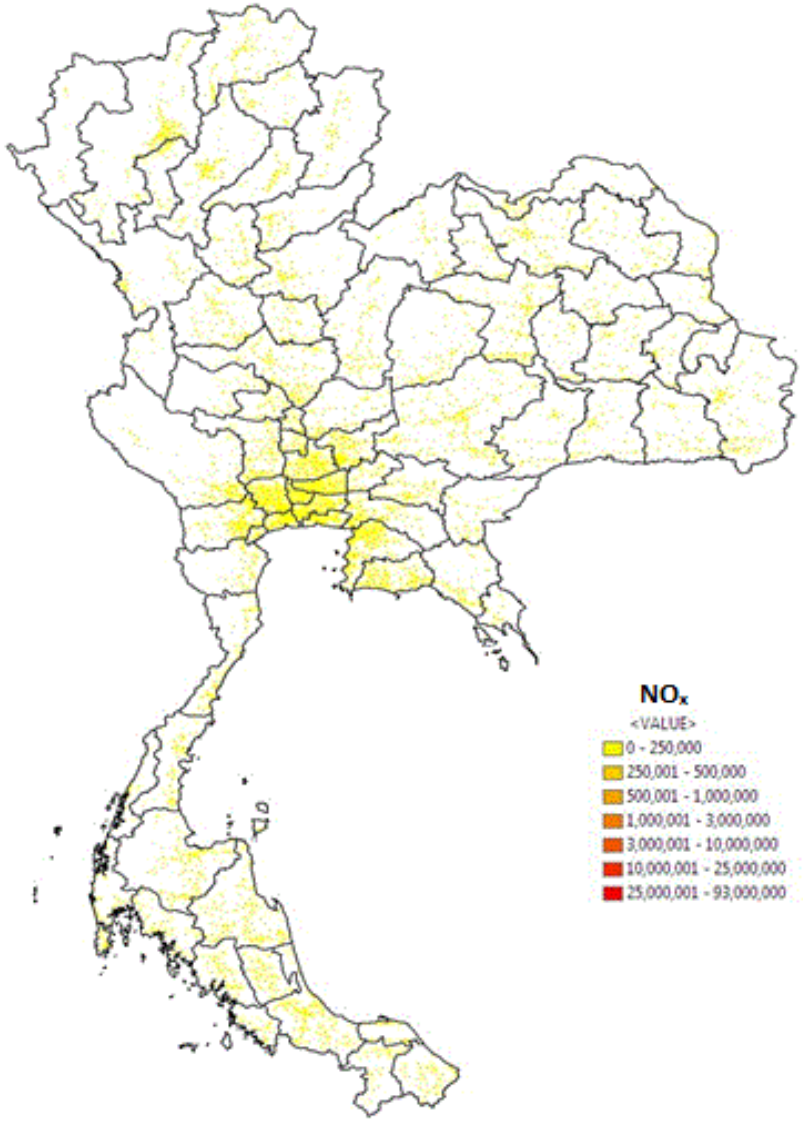
Emissions from Traffic Statistics

* Calc from 50% of road length

Emissions from Registered Vehicles



4.Results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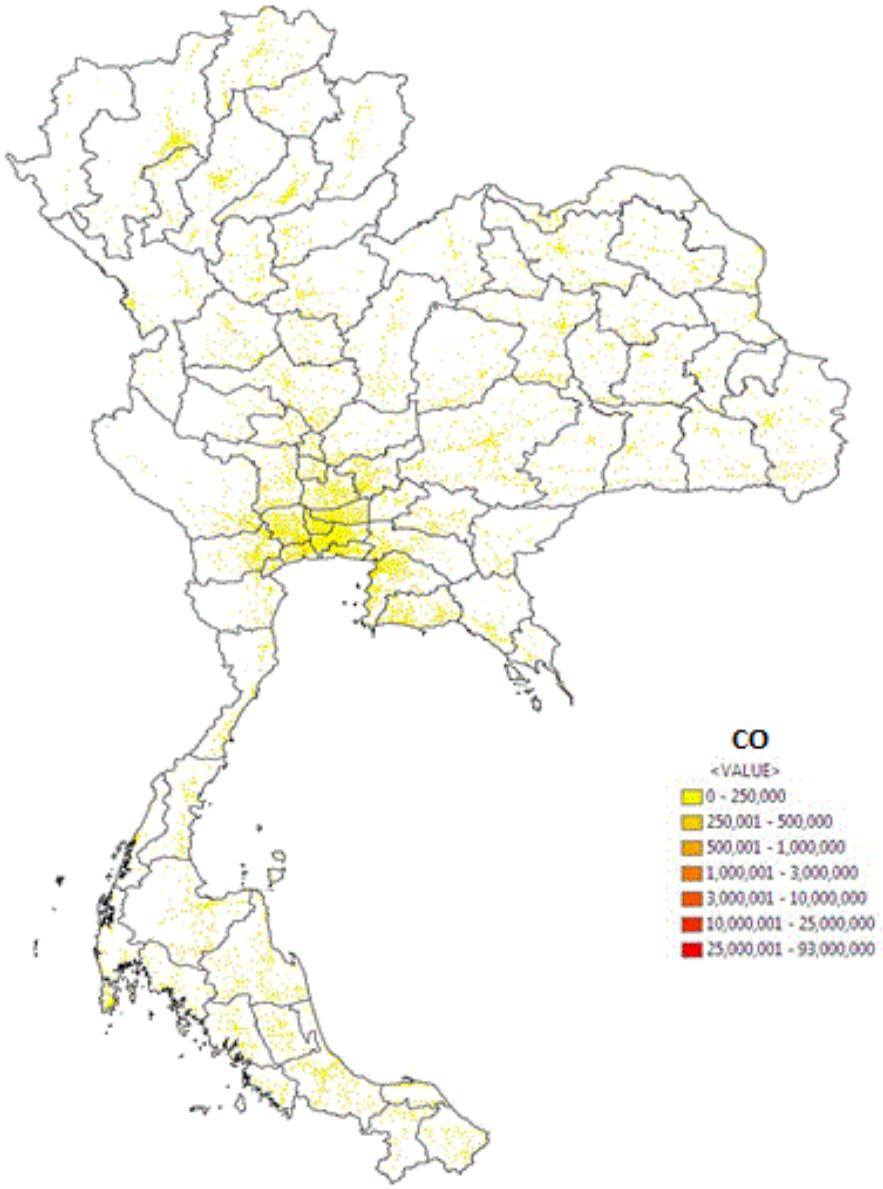
10,000,001 - 25,000,000
25,000,001 - 93,000,000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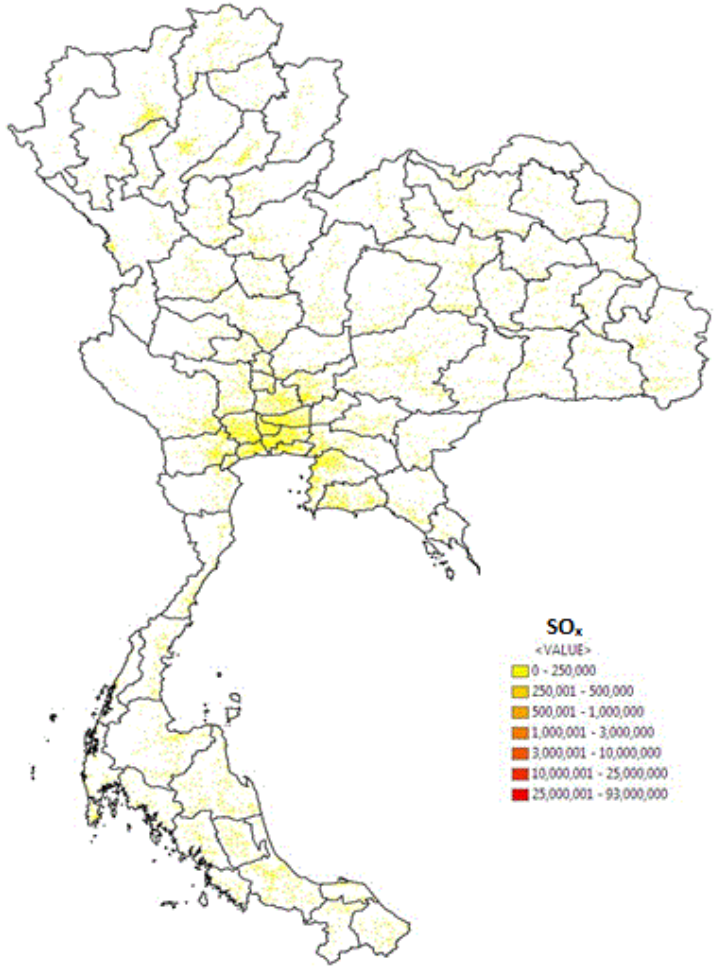
4.Results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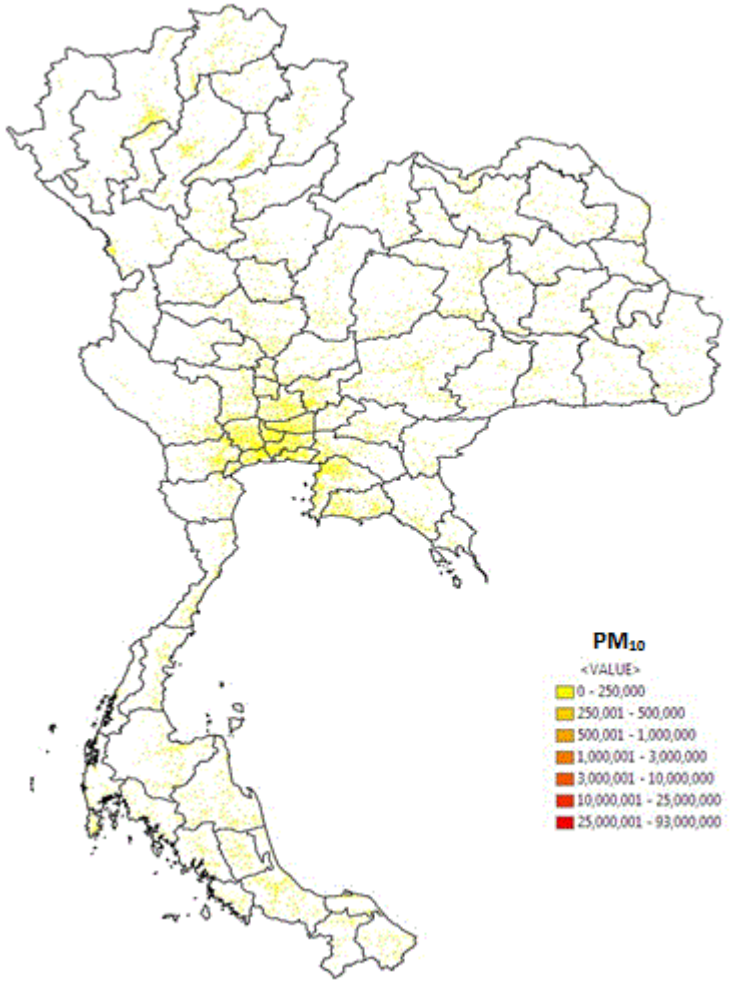
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1,000,001 - 3,000,000
3,000,001 - 10,000,000
10,000,001 - 25,000,000
25,000,001 - 93,000,000

5. Conclusions

- Estimated Emissions from Industrial sector based on energy consumption revealed that Food & Beverage, Chemicals, and non-metal industries are major sources.
- For controlling strategies in Industrial sector
  - NO_x -> use clean Diesel
  - SO_2 -> use clean Coal
  - Others -> installed control technology for bio fuels
- Recommendation: need a model validation for EI improvement

- Thanks You
- Q&A