Exercise 2016

1. สารมลพิษอากาศปฐมภูมิ (Primary air pollutants) ต่างจาก สารมลพิษอากาศทุติยภูมิ (Secondary air pollutants) อย่างไร จงอธิบายและยกตัวอย่างประกอบ (**3 คะแนน**)
2. จงระบุสารมลพิษอากาศหลัก (CAPs) ของประเทศไทย พร้อมระบุ (1) ประเภทหรือชนิดของแหล่งกำเนิดที่เกี่ยวข้องกับการปล่อยสารมลพิษ (2) กระบวนการที่เกี่ยวข้องกับการเกิดสารมลพิษ และ (3) ลักษณะการเกิดผลกระทบต่อสุขภาพจากการได้รับสัมผัส (**12 คะแนน**)
3. จงเปรียบเทียบชนิดของสารมลพิษอากาศที่มาจากแหล่งกำเนิดต่อไปนี้ (**6 คะแนน**)
   a) โรงไฟฟ้าถ่านหิน กับ โรงไฟฟ้าก๊าซธรรมชาติ
   b) รถยนต์ส่วนบุคคลที่ใช้ก๊าซธรรมชาติ กับ รถยนต์ส่วนบุคคลที่ใช้น้ำมันแก็สโซฮอล์
   c) รถบรรทุกที่ใช้ก๊าซธรรมชาติ กับ รถบรรทุกที่ใช้น้ำมันดีเซล
   d) โรงงานปูนซีเมนต์ กับ โรงกลั่นน้ำมัน
   e) เตาเผาขยะอุตสาหกรรม กับ การเผาชีวมวลในที่โล่ง
   f) กระบวนการสังเคราะห์แสงของพืช กับ การย่อยสลายสารอินทรีย์ในดินของแบคทีเรีย

Exercise 2017

4. You are asked to prepare an emission inventory for your city to conduct an integrated air quality management program (IAQMP). What kinds of approaches that you are going to apply for? Why? Which sectors, pollutant species, and based year? How will you plan to work on it? Could your prepared emission inventory database be an essential tool and give benefits for IAQMP in your city? How? Name your city and illustrate your answer.

Desktop Lab 1

Global Warming Potential Calculation (GWP)

Estimate Global Warming Potential (GPW) based 20-year and 100-year time scale from motorcycle emission by using following information: The number of total registered motorcycle (MC) in Thailand as of December 31, 2017 is 20,497695 fleets. Average Vehicle-Kilometer Travel for MC is 23,725 km/year while average fuel economy is 57 km/L. Types of motorcycle with each proportion and emission factors for greenhouse gases are given in Table 1.

Table 1 Types of motorcycle and its emission factors of greenhouse gases

Types of Motorcycle	Type Proportion	Emission Factors (g/km)		
		CO_2	N_2O	CH_4
Sml_Med_petrol 4-cycle, Carb catalyst	0.16	46.99	0.14	0.11
Sml_Med_petrol 4-cycle, FI catalyst	0.13	30.62	0.14	0.06
2-Cycle_Gasohol 95	0.03	37.54	0.14	0.09
4-Cycle_Gasohol_91	0.26	41.36	0.14	0.05
4-Cycle_Gasohol_95	0.44	45.79	0.14	0.08

Calculate the emission and GWPs for motorcycle emission in 2017 in Excel sheet and use Table 3 and Table 4 to report your results.

Calculation of Emission

Emission = Vehicle-Kilometer Travel (VKT) x Emission Factors (EF)

GWP = Emission x GWP_i

Table 2 Global Warming Potential (GPW) of Greenhouse gases for different time horizon

Gas name	Chemical formula	Lifetime (years)	Global warming potential (GWP) for given time horizon		
			20-yr	100-yr	500-yr
Carbon dioxide	CO_2	30–95	1	1	1
Methane	CH_4	12	72	25	7.6
Nitrous oxide	N_2O	114	289	298	153

Table 3 Emission inventory for motorcycle

Types of Motorcycle	Number of Vehicle	Total VKT (km)	Emission (Unit:)		
			CO_2	N_2O	CH_4
Sml_Med_petrol 4-cycle, Carb catalyst					
Sml_Med_petrol 4-cycle, FI catalyst					
2-Cycle_Gasohol 95					
4-Cycle_Gasohol_91					
4-Cycle_Gasohol_95					
Total					

Table 4 Global Warming Potential for Motorcycle Emission

Types of Motorcycle	GPW_{20} (Unit:)			GWP_{100} (Unit:)		
	CO_2	N_2O	CH_4	CO_2	N_2O	CH_4
Sml_Med_petrol 4-cycle, Carb catalyst						
Sml_Med_petrol 4-cycle, FI catalyst						
2-Cycle_Gasohol 95						
4-Cycle_Gasohol_91						
4-Cycle_Gasohol_95						
Total						

Desktop Lab 2

Emission Inventory of Biomass Open Burning

Instruction: Read this information and answer following questions

Pathumthani locates in the North of Bangkok and is a part of the Bangkok Metropolitan Region (BMR) and has the total area of 1,525.9 km^2. The province lies on the low alluvial flats of the Chao Phraya River that flows through the capital. Many canals cross the province and feed the rice paddies as seen in Figure 1.

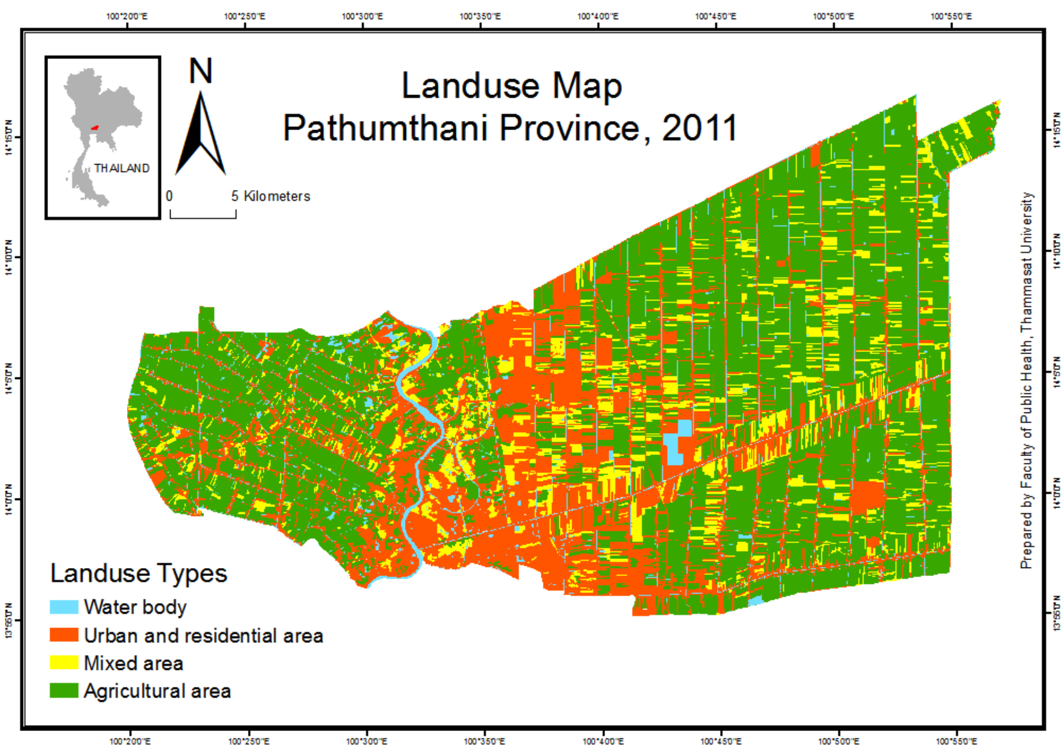

Figure 1 Landuse map of Pathumthani

Rice is the major crop of Pathumthani. The province is ranked as one of the main rice producers of the country. Statistically, the monthly rice production and plantation area of Pathumthani in 2010 are presented in Figure 2.

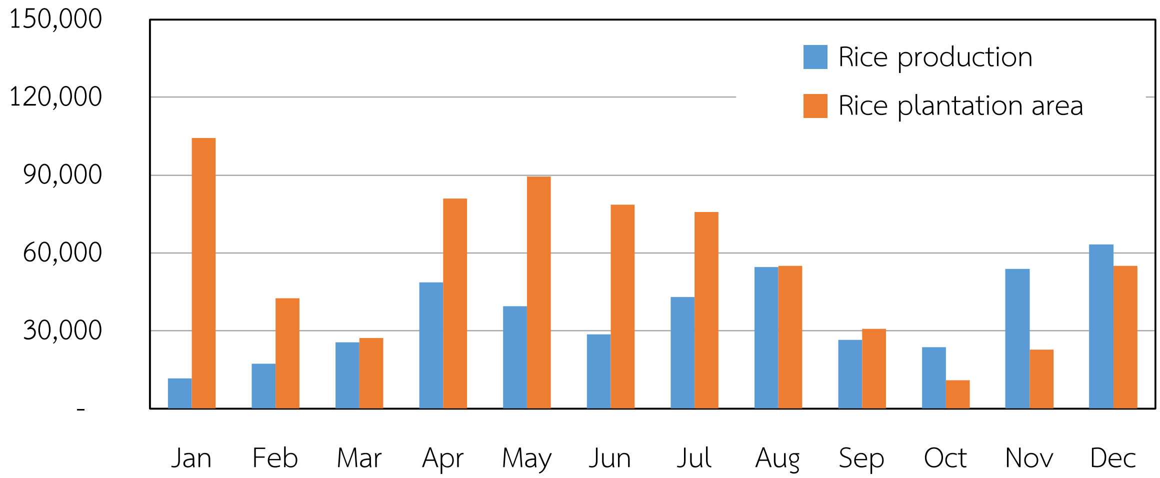

Figure 2 Rice production (ton) and plantation area (rai) in Pathumthani, 2010

Annually, rice residues are burnt in the field with huge amount of air pollutant emissions emitted to the atmosphere. To estimate this emission, according to Kanabkaew and Kim Oanh (2010), the emission of rice residue open burning can be calculated from Equation 1:

$$E_i = M \times EF_i \qquad \text{Equation 1}$$

Where,

i	=	Pollutant species
E_x	=	Annual emission of species i (g)
M	=	Amount of burned rice residues in a year (kg dry mass of residue)
EF_i	=	Emission factors of species i (g/kg dry mass of residue).

The amount of field burned rice residues can be estimated from the total annual rice production data which can be calculated from Equation 2:

$$M = P \times N \times D \times B \times \eta$$ Equation 2

Where,

P = Rice production (kg)

N = Rice specific residue-to-production ratio

D = Dry-matter-to-rice residue ratio

B = Fraction of dry matter residues that are burned in the field

η = Rice specific burn efficiency ratio (fraction oxidized during combustion).

Scientifically, Kanabkaew and Kim Oanh (2010) found that farmers in Pathumthani normally burn rice residue in the field after harvesting. Their findings on farmers' activities for rice residue open burning in Pathumthani can be presented in Table 1, and the emission factors for rice residue burning (g/kg dry mass of residue) can be presented in Table 2.

Table 1 Finding of farmers' activities on rice residue open burning in Pathumthani

Factors	Values
Total annual production (ton/year) (P)	**416,467**
Residue to rice ratio (N)	1.19
Dry matter to rice residue ratio (D)	0.85
Fraction burned in fields (B)	0.90
Burn efficiency fraction (η)	0.89

Table 2 Emission Factors *(EF)* Used for Rice Residue Burning (g/kg dry mass of residue)

Pollutant species	EFs (g/kg) in different confidences of estimation		
	Low	Best	High
PM_{10}	3.46	9.1	9.1
CO	64.2	93	179.9
NO_x	1.81	2.28	2.84
NMVOCs	7.0	7.0	7.0

Source: Thongchai and Kim Oanh (2010)

Questions:

Congratulations!! You are now the Head of Environment Health Department of Pathumthani.

You are asked to

1. Estimate emission of PM10, CO, NOx, and NMVOCs from rice residue burning in Pathumthani for the year 2010 using "low" "best" and "high" emission factors.
2. Estimate emission of PM10, CO, NOx, and NMVOCs from rice production of Thailand in 2016/2017 using below information

Regions	Rice production (ton/year)
Central part	8,261,445
Northern Region	12,768,145
Northeast Region	36,193,410
Southern Region	840,476

3. Suggest possible solutions on emission control measures for reducing emission from rice residue open burning

Estimation Guideline

Estimation of amount of burned rice residues ***(M)*** in a year

Rice production (P) (kg)	Residue to rice ratio (N)	Dry matter to rice residue ratio (D)	Fraction burned in fields (B)	Burn efficiency fraction (η)	Amount of burned rice residues in a year $\boldsymbol{M}$ (kg)

Estimation of emissions ***(E)***

Pollutant species	Emission factors $\boldsymbol{EF}$ (g/kg)			Amount of burned rice residues $\boldsymbol{M}$ (kg)	Emission $\boldsymbol{E}$ (kg)		
	Low	Best	High		Low	Best	High
CO	3.46						
PM_{10}	64.2						
NO_x	1.81						
NMVOCs	7.0						

Summary

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