Biomass Burning and Air Quality in Indonesia

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Photo by PI: finding my own legend 2012

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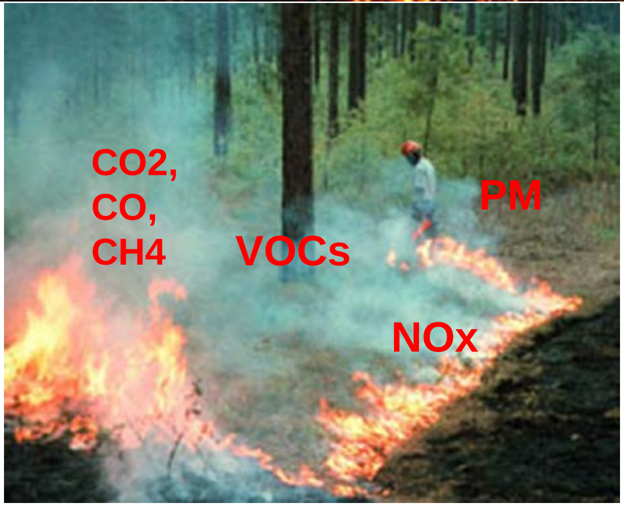
Why is Biomass Burning?

- The biggest contributor to Air Quality and GHGs in Indonesia
- Forest & Peat Fires occurs every year in Indonesia
- The Impact of Biomass is huge not only local and regional but also globally
- Biomass Burning emit Particulate & gaseous pollutants caused huge impact to Human & Environment
- According to the Global Fire Emissions Database (GFED), average PM2.5 emissions from fire (including deforestation, savanna, forest, agricultural waste, and peat fires) from 1997 to 2010 in Indonesia are accounting for 9.2% of global fire PM2.5 emissions and 62% of Southeast Asian fire emissions
- Peatland fire is a dominant source of PM2.5 emissions, accounting for 55% of all fire sources
- Biomass burning caused about 339,000 premature death per year (Johnston et.al 2015).
- Limited data exist regarding the chemical characteristics of these smoke aerosols

Source of Biomass Burning in Indonesia (Type of Biomass Burning)

- Forest and Peat Fire
- Agriculture Residue Open Burning
- House Hold Fuel (wood fuel burning)
- Others (Miscellaneous)

Forest & Peat Fire



- Indonesia has the largest tropical peatland in the world of which about 71% of its total area are located in Sumatra, Kalimantan and Papua (Ministry of Agriculture, 2011).
- Due to prolonged dry season coupled with human activities such as peatland clearing for agriculture and plantations, especially in Sumatra and Kalimantan by slash and burn resulted in severe peat fires
- Forest fire emit large amount of trace gases, both chemically active and green house gases, including non methane hydrocarbon and aerosol (Crutzen & Andreae, 1990).
- A very large Indonesian peat fire in 2015 was estimated to release about 1,043 million metric tons of carbon dioxide equivalent emissions (Mt CO_2eq) cumulatively (Harris et al., 2015).

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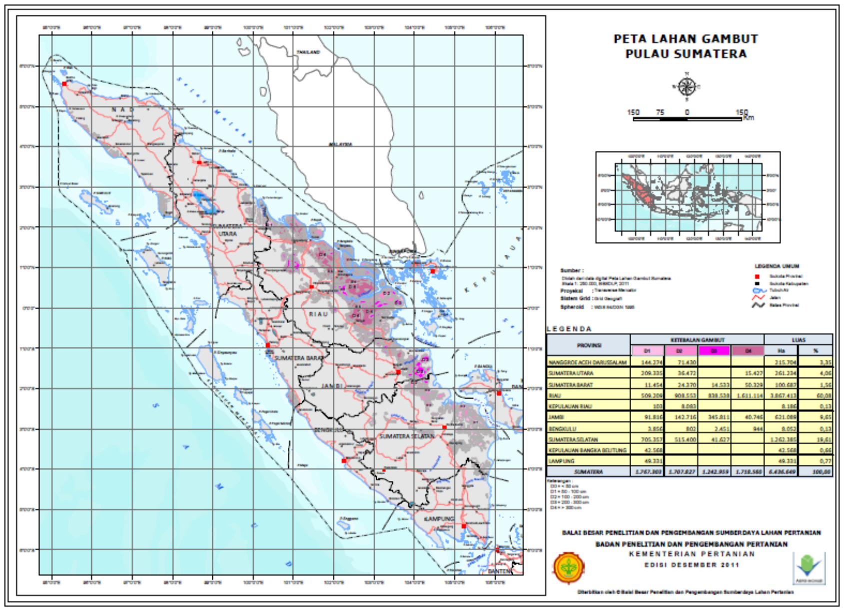
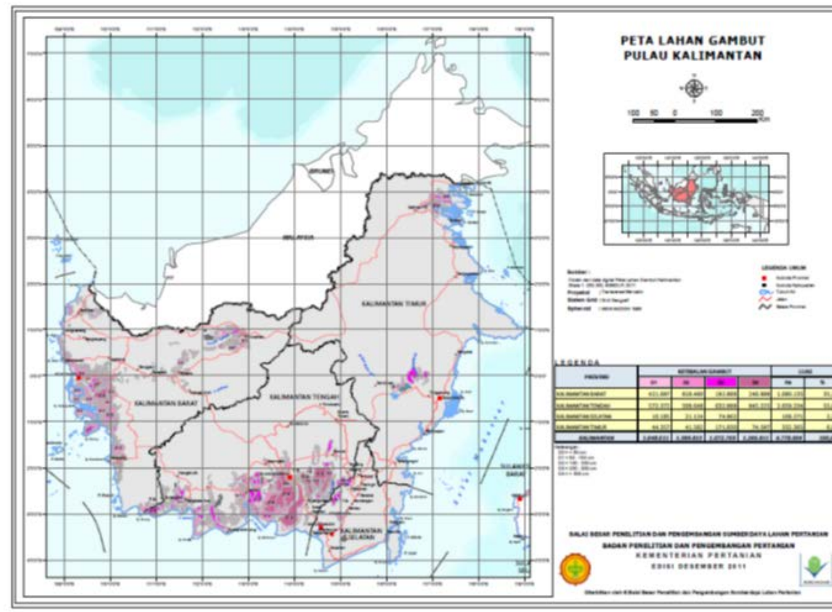
Peat Land Map: In Sumatra & Kalimantan

- Conted 70% of total Peatland





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Background Information:
Peat Land Area in Indonesia (MoA 2011)

Provinces	Area	
	Ha	%
Aceh	215.704	3,35
North Sumatera	261.234	4,06
West Sumatera	100.687	1,56
Riau	3.867.413	60,08
Kepulauan Riau Island	8.186	0,13
Jambi		
Bengkulu	8.052	0,13
South Sumatera	1.262.385	19,81
Kepulauan Bangka Belitung	42.568	0,66
Lampung	49.331	0,77
Sumatera	**6.436.649**	**100,00**
Kalimantan Barat	1.680.135	35,16
Kalimantan Tengah	2.659.234	55,66
Kalimantan Selatan	106.271	2,22
Kalimantan Timur	332.365	6,96
Kalimantan	**4.778.004**	**100,00**
Papua	2.644.438	71,65
Papua Barat	1.046.483	28,35
Papua	**3.690.921**	**100,0**
Total	**14.905.574**	

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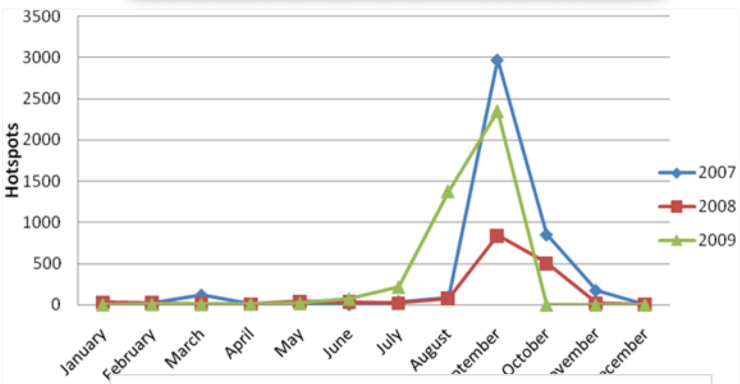
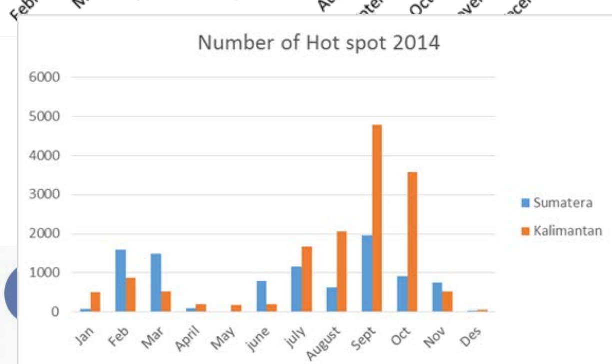
Why is Peat Fires?





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- Forest and Peat Fires occurs every year in Indonesia
- Central Kalimantan is one of the primary hotspots for peatland fire during the dry season, and the smoke aerosol generated there has caused haze in neighboring countries.
- Forest & Peat Fires emit Particulate & gaseous pollutants caused huge impact to air quality not only local & regional but also globally
- Peat land burning is a significant source of particulate matter ($PM_{2.5}$) in the Central Kalimantan
- Limited data exist on the emission characteristics from this source
- High Uncertainty

Problem

- The quantification of the emission from Forest and Peat land burning as well the monitoring of air quality from this source has high uncertainty due to lack of emission factors and emission measurement in this country
- PM2.5 Emission characteristic from this source is very limited in Indonesia

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Agriculture Residue Open Burning

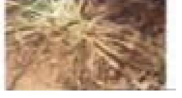
- Common practice of eliminating waste (crop residue)
- Contributed more than 80% of the total biomass open burning emissions (Permadi 2013).
- One of the major source of aerosol emissions. emits types of particulate matter (PM) (Andreaea and Merlet, 2001
- About 42 % farmer in West Java burn crop residue after harvesting
- Open crop residue burning emitted a great amount of pollutants to the atmosphere, which includes aerosols and hydrocarbons (Singh et all.,2010)

Crop residue Burning : Problem ?

Residu Padi
(Jerami)

Residu jagung
(Batang dan Daun)

Residu Tebu
(Daun dan pucuk)



The quantification of the emission from agriculture residue burning as well the monitoring of air quality from this source has high uncertainty due to lack of emission factors and emission measurement in this country .

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Wood Fuel for Household Cooking

- Biomass fuel, especially solid fuel, is still an attractive for rural people in developing countries as an energy source for daily household cooking
- About 730 million tons of biomass fuel is burned annually by households in developing countries (IBRD, 2011). It is estimated that biomass fuels are used in as many as 70% of rural households in Asia (Aunan et al., 2009
- In Indonesia about 66% of rural household are still using fuel wood as main source of fuel at home (BPS 2011).
- Poverty and economic condition caused the used of solid fuel in rural area

Others (Miscellaneous)

- Biomass Waste as AFR
- Co firing with coal or MSW in Power station or incinerator plants and Cement Industries can be used to assess the biomass waste
- Relieve shortage of energy
- Substitution rate in Cement industries in Indonesia could reach 15% of total energy demand

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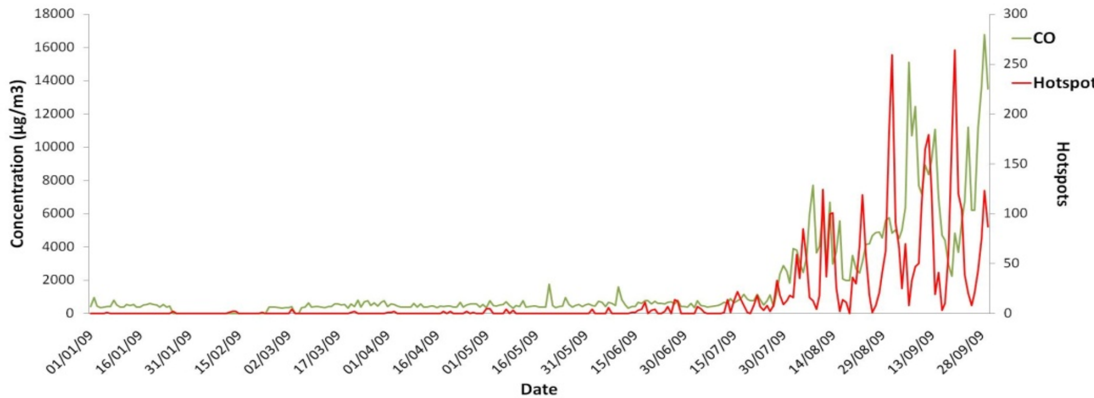
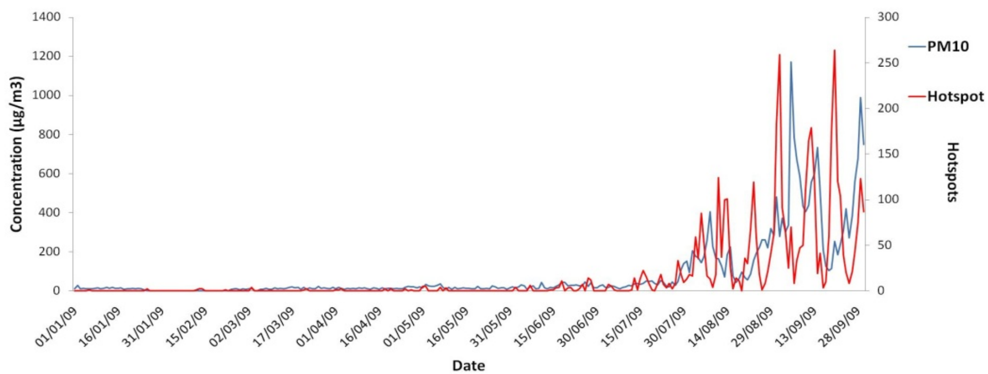
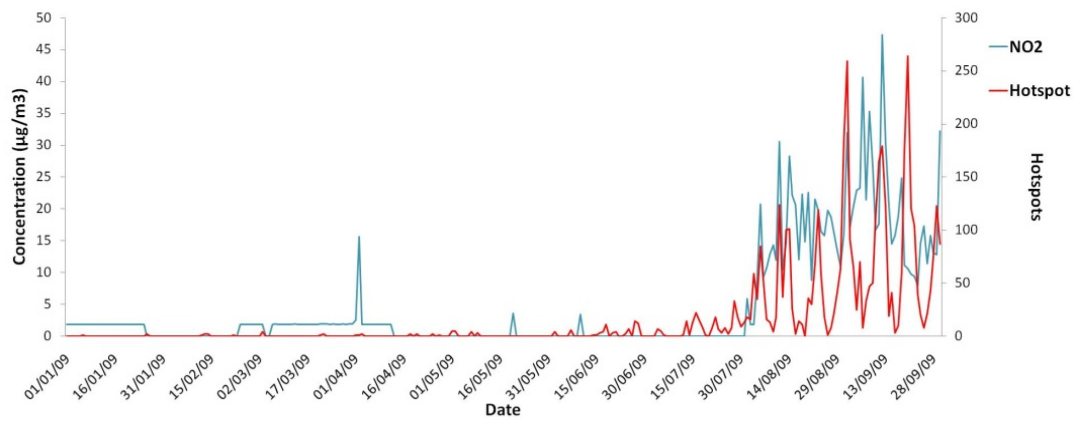
Biomass waste as Energy Alternative

Impact to Air Quality in Palangkaraya (Peat Fire in 2009)







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Impact of Peat Fire in Palangkaraya (2015)

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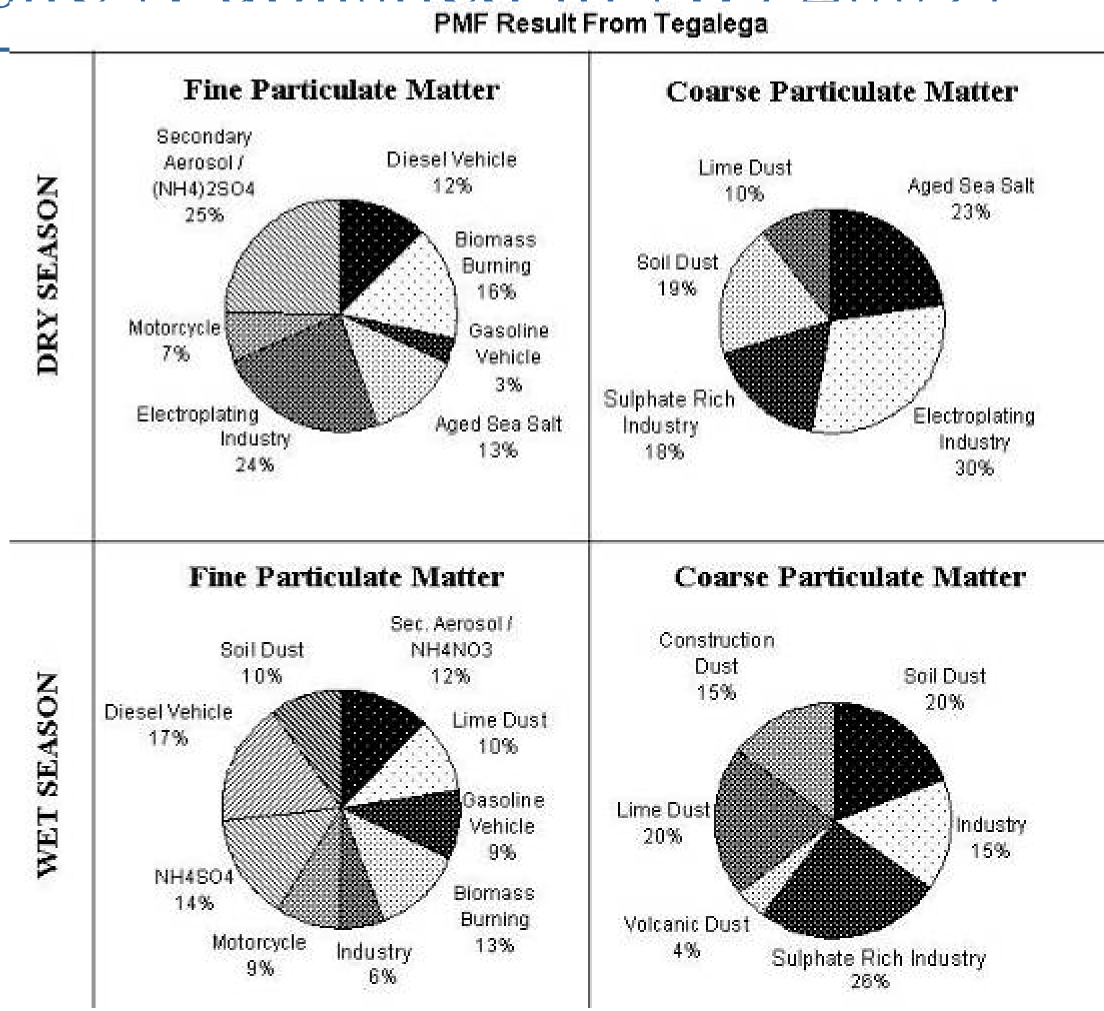
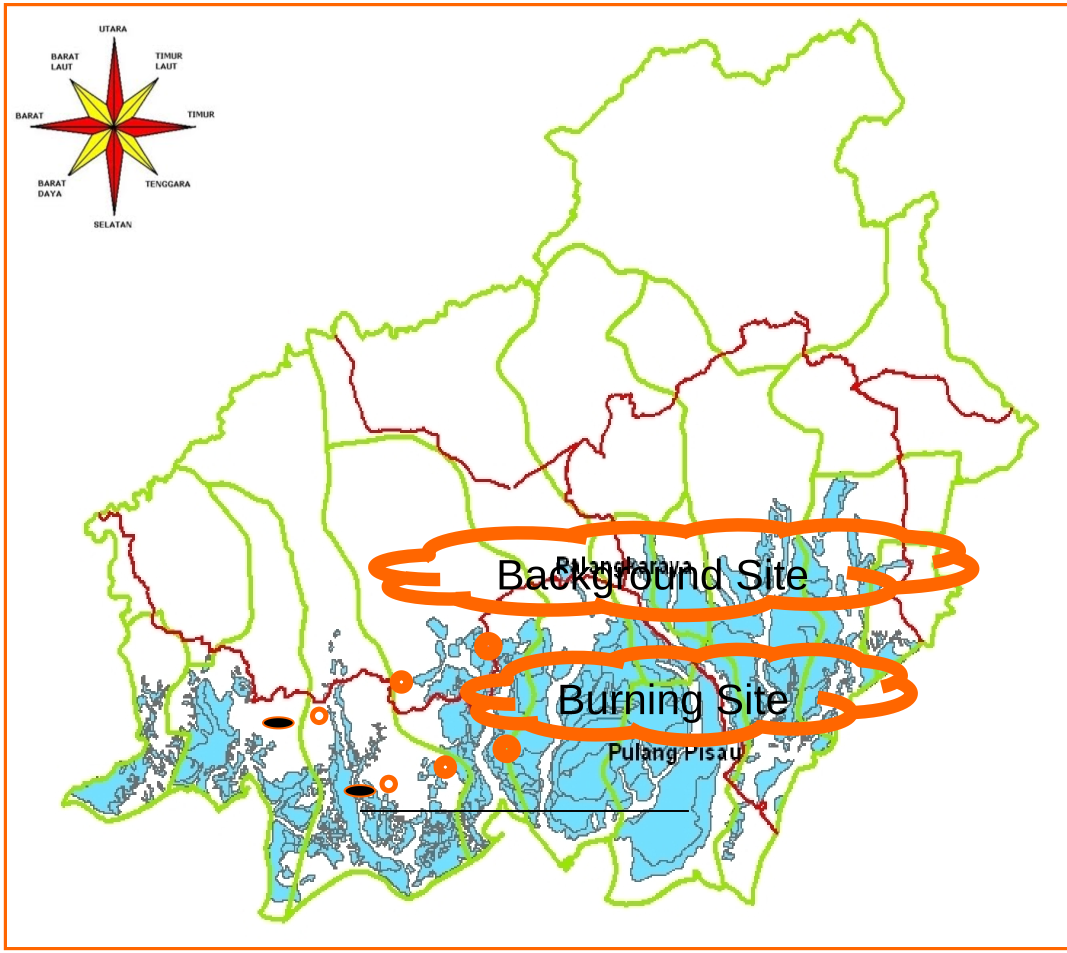
Source Apportionment results from Urban Mixed site (Published in AE 2009)

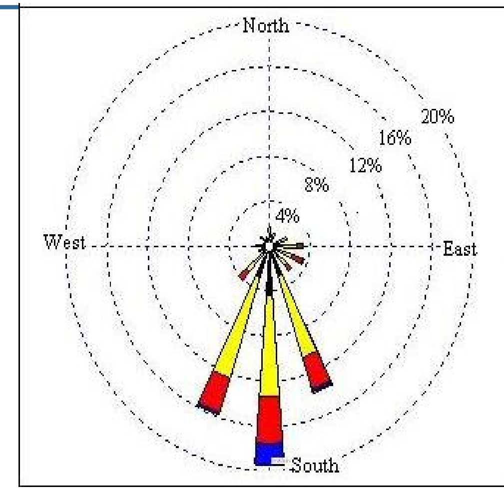


Research Activities

- 2009- conducting direct emission measurement of PM2.5 and PM10 from peat land burning in Kalimantan during the forest and peat fire episode in 2009. Emission characterization of Particulate Matter were conducted
- 2011-2012 : conducting direct emission measurement of PM2.5 and PM10 as well as gaseous pollutants from peat land burning in Sumatra during the forest and peat fire episode in 2011 and 2012. Emission characterization of Particulate Matter gaseous pollutants were conducted. Chemical speciation of particulate matter were analyze to include OC/Ec and carbon fractions.
- 2015 : Field observation and lab scale observation using peat;land samples from Kalimantan were conducted to develop emission factor of CH4 and CO2. The Emission factor for particulate matter and OC/EC is still on going.
- 2015- now : Agriculture residue open burning: study were conducted to measure the emission of PM2.5 and BC from different crop residue open burning in West Java. (Emission Factors of BC and PM2.5)
- 2008-2009 : Evaluating Characteristic of indoor air pollution in the rural household using traditional cook stove and wood fuel.

Forest & Peat Fire :
Sampling Location: Central Kalimantan





Peat land area

Provincial Road

Administrative Border

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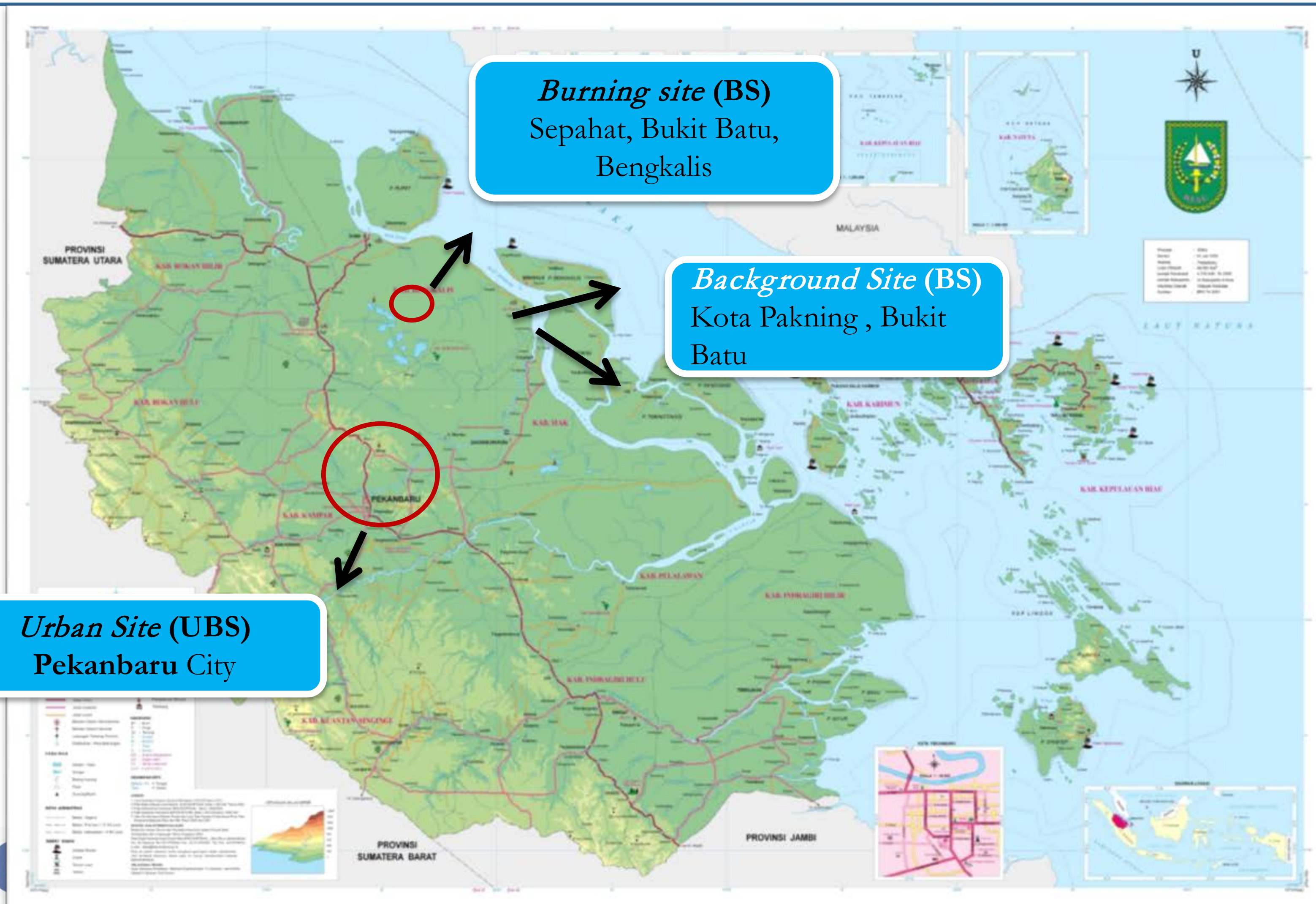
Central Kalimantan – Indonesia (30-40km)

Sampling Locations: Riau Sumatra



***Burning site* (BS)**
Sepahat, Bukit Batu, Bengkalis

***Background Site* (BS)**
Kota Pakning , Bukit Batu

***Urban Site* (UBS)**
Pekanbaru City

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Sampling Method

Mini-Vol portable air samplers

- collected near source of peat burning, directly adjacent to the plume and at a nearby regional residencial area
- A major peat fire episode in Sept - October 2009
- Sampling time 4-8 hours to obtain sufficient PM mass for chemical analysis
- Two different filters47 mm pre-fired quartz fiber and teflon membrane (PTFE)

Burning Site

Background Site

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Sampling Conditions : Smouldering

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Analysis

- PM2.5 were analyzed using gravimetric
- OC/EC carbon fraction (OC1, OC2, OC3, and OC4, as well as EC1, EC2 and EC3) were analyzed at Desert Research Institute's Laboratory (DRI) using a thermo-optical technique
- The IMPROVE_A temperature defines temperature plateaus for thermally-derived carbon fractions as follows: 140 C for OC1, 280 C for OC2, 480 C for OC3, and 580 C for OC4 in helium (He) carrier gas; 580 C for EC1, 740 C for EC2, and 840 C for EC3 in a mixture of 98% He and 2% oxygen (O2) carrier gas (Chow et al., 2007).
- BC were analyze using EEL type Smoke Stain Reflectometer
- OC, EC, and total carbon (TC) were calculated from the eight carbon fractions as follows:

$$OC = OC1 + OC2 + OC3 + OC4 + OP \quad (1)$$

$$EC = EC1 + EC2 + EC3 - OP \quad (2)$$

$$TC = OC + EC$$

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Results :
Filter from Peat Burning

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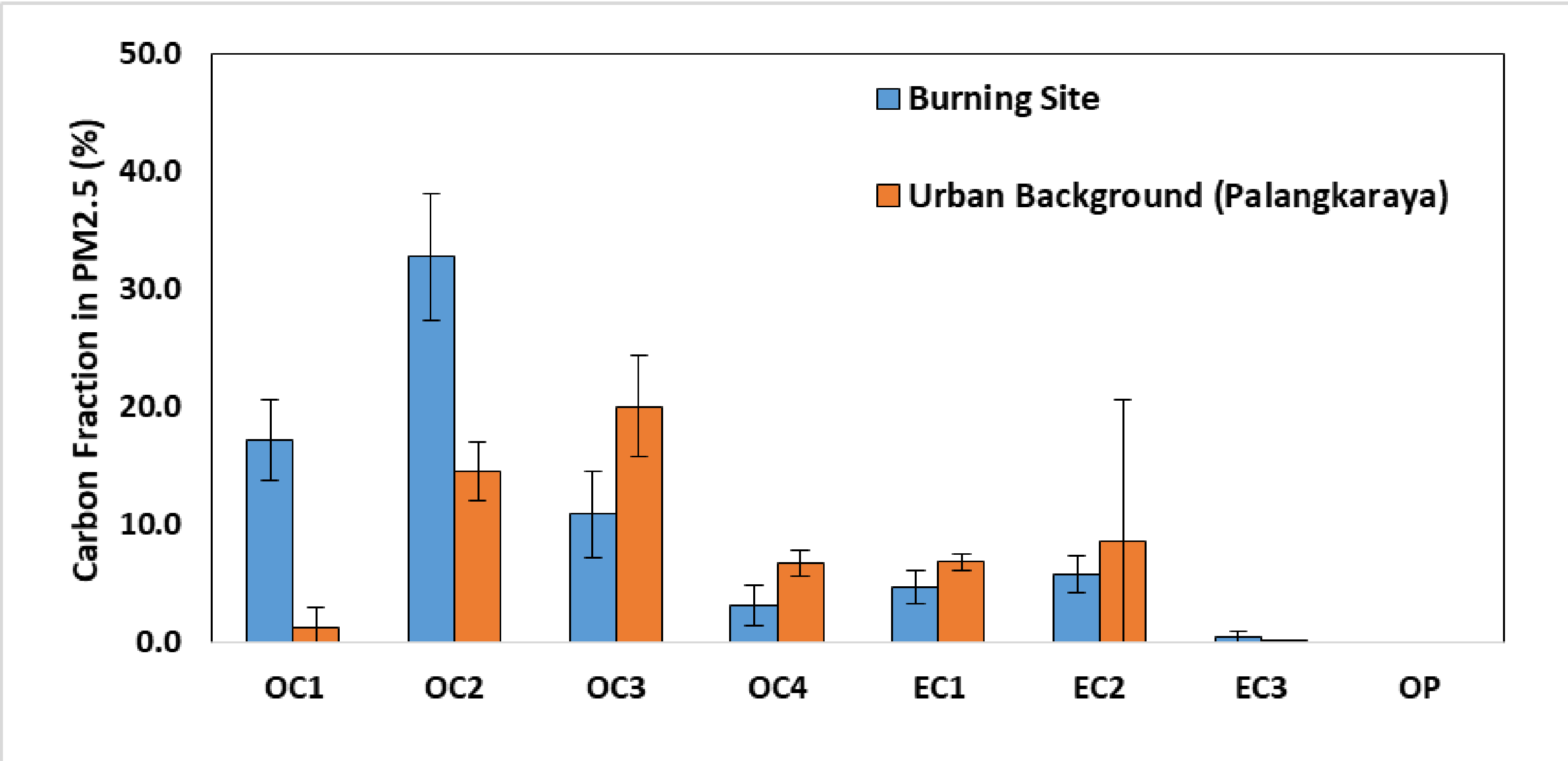
Carbon Fraction in PM2.5

Abundances of eight thermally-derived carbon fractions differ by carbon sources



OC1 normally rich in biomass burning
OC3 and OC4 relatively came from road dust
OC2 was found in samples of coal combustion (decay plants)

EC1,EC2 and EC3 mainly emitted by motor vehicles

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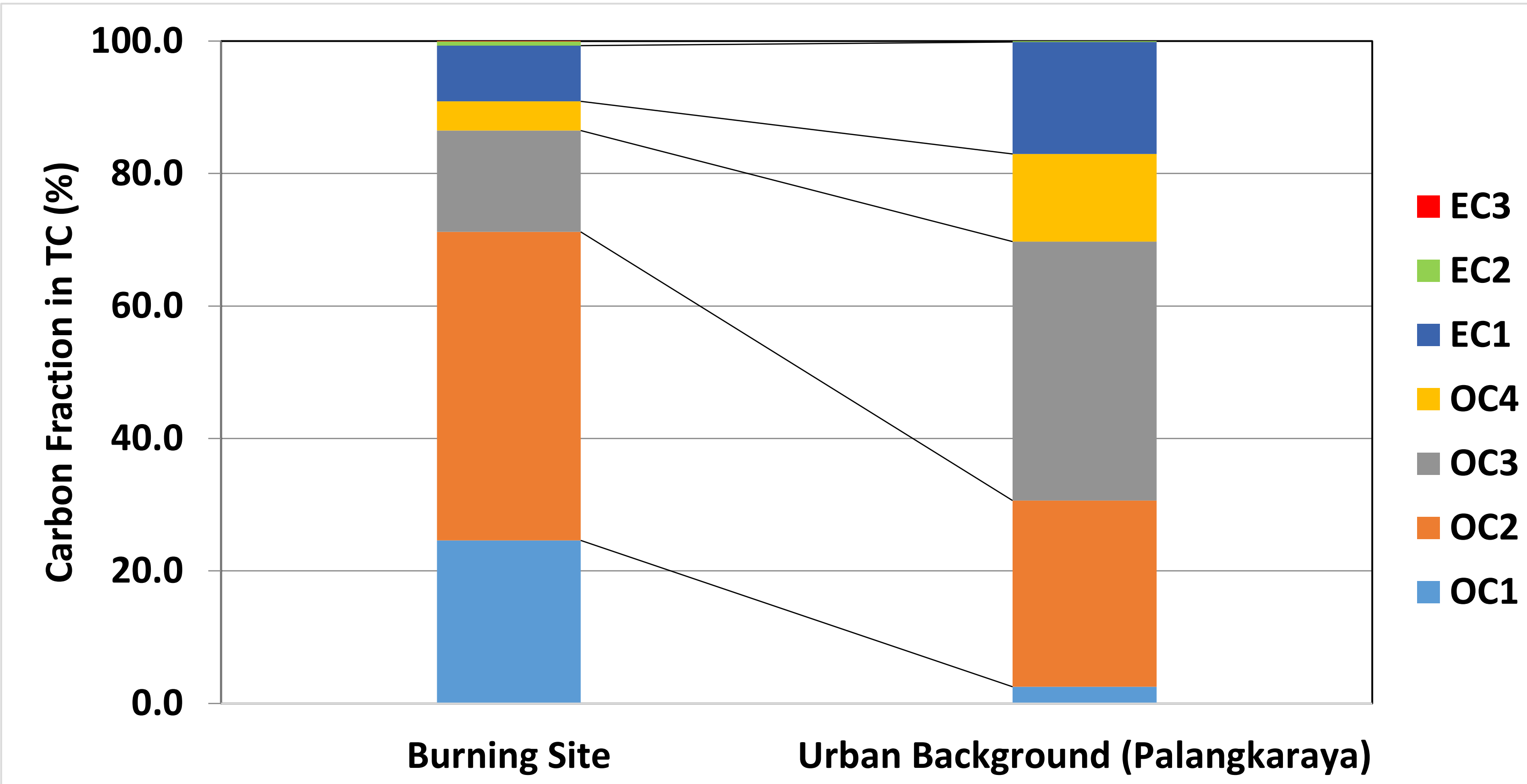
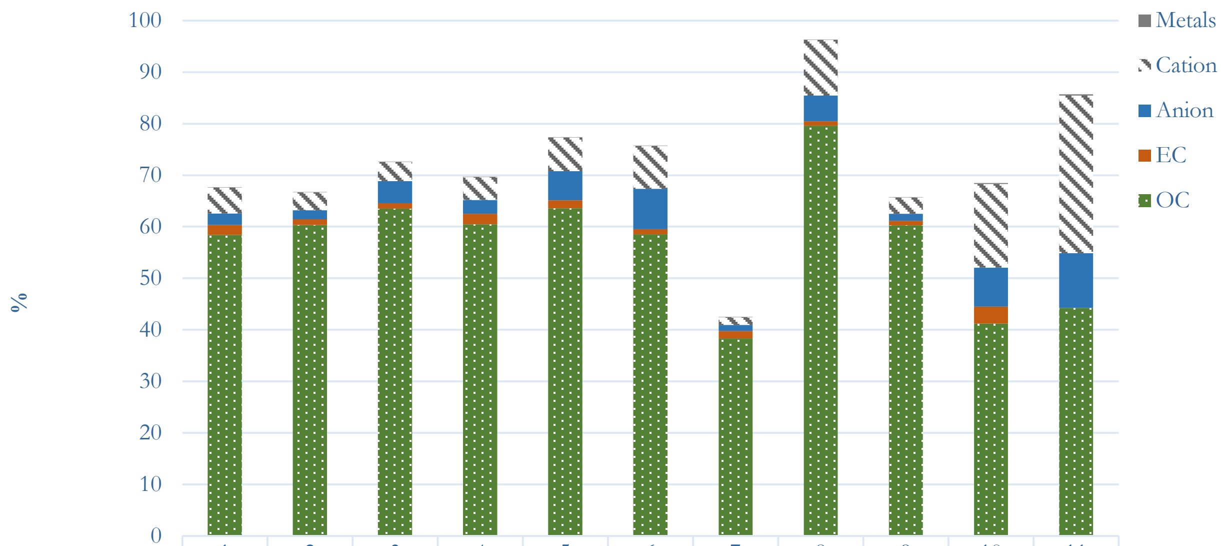
Carbon Fraction in the Total Carbon



Contribution of OC, EC, ions and metals to total PM10 concentration in individual samples



	1	2	3	4	5	6	7	8	9	10	11
Metals	0.01	0.01	0.03	0.01	0.07	0.09	0.01	0.09	0.02	0.19	0.25
Cation	5.04	3.44	3.68	4.43	6.51	8.31	1.48	10.77	3.17	16.21	30.55
Anion	2.22	1.77	4.29	2.67	5.68	7.80	1.18	5.00	1.42	7.56	10.67
EC	1.97	1.08	1.06	2.10	1.54	1.00	1.45	0.84	0.83	3.33	0.00
OC	58.40	60.36	63.53	60.44	63.56	58.56	38.31	79.62	60.29	41.19	44.23

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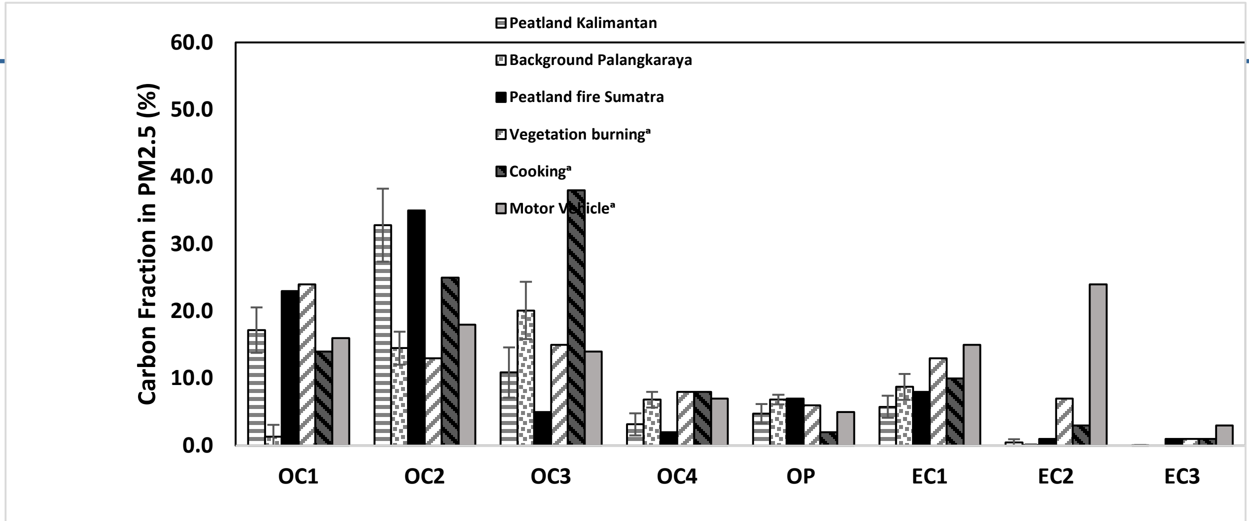
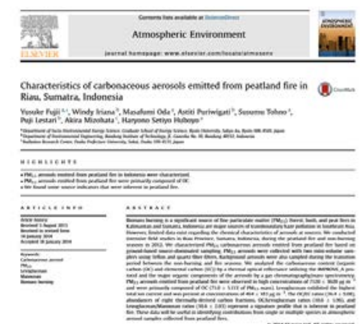
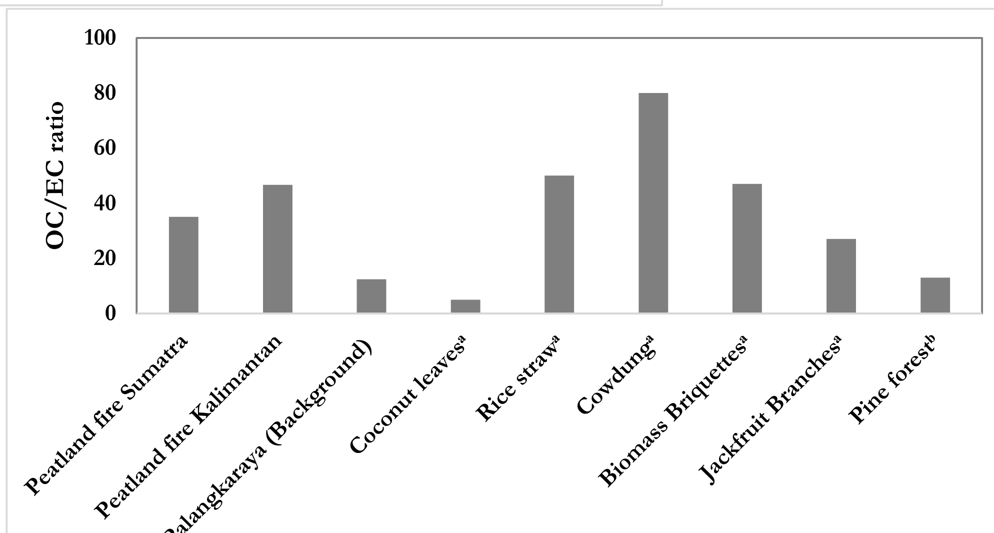
OC/EC ratio from PM2.5 emitted from Peat land and other burning sources (Fujii et al. AE 87(2014) 164-169.




Atmospheric Environment

Characteristics of carbonaceous aerosols emitted from peatland fire in Riau, Sumatra, Indonesia

(OC/EC) provide some indication of the origins of carbonaceous PM2.5



[a] data from Sheesley and Schauer, 2003, [b] data from Lee *et al.*, 2005.

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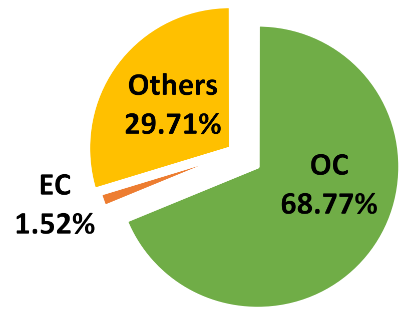
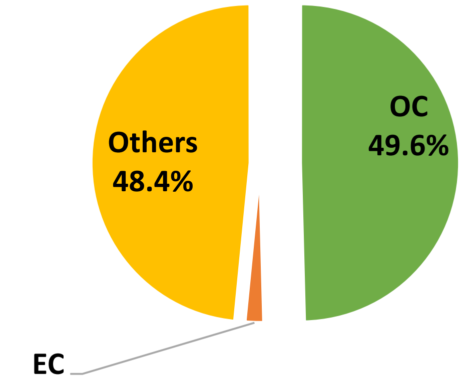
Laboratory Experiment: PM2.5 Measurement & Emission Factor Development

Peat samples collected from Kalimantan

OC/EC Average contribution to $PM_{2.5}$



Burning Site (Pulau Pisang)



Urban Background (Palangkaraya)

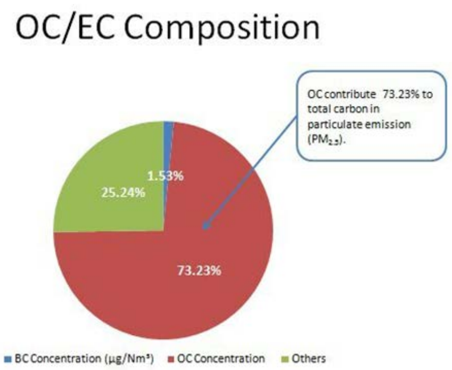


Figure 8. The OC/EC composition of each sample's particulate matter

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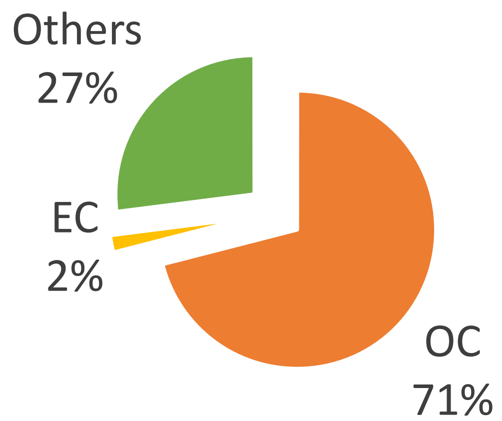
Lab experiments



Burning site -Sumatra

Emission Factors From Peatland Burning (Wiwiek et al, IOP, 2017)

Tabel 2. Emission factor for Pontianak peat combustion

Combustion stages	EF CO_2 (g/kg)	EF CO (g/kg)	EF CH_4 (g/kg)	MCE
Flaming	$1938^a - 2174^b$ $2088^c \pm 21^d$ 17^e	$0.002^a - 23.542^b$ $3.104^c \pm 7.173^d$ 17^e	$0.011^a - 0.490^b$ $0.143^c \pm 0.132^d$ 17^e	$0.982^a - 1.000^b$ $0.998^c \pm 0.005^d$ 17^e
Smoldering	$1558^a - 1998^b$ $1831^c \pm 131^d$ 17^e	$15^a - 304^b$ $138^c \pm 72^d$ 17^e	$3^a - 44^b$ $17^c \pm 12^d$ 17^e	$0.774^a - 0.988^b$ $0.894^c \pm 0.055^d$ 17^e
Smoldering[1]	1703^c 1^e	210.3^c 1^e	20.80^c 1^e	0.838^c 1^e
Smoldering[2]	- $1637^c \pm 204^d$ 3^e	- $233^c \pm 72^d$ 3^e	- $12.8^c \pm 6.6^d$ 3^e	- $0.816^c \pm 0.065^d$ 3^e

Superscript a = minimum, b = maximum, c = average, d = standard deviation, e = number of sample
EF = Emission factor, MCE = Modified Combustion Efficiency
Source: 1 Christian et al., 2003; 2 Stockwell et. al (2014)

Emission factor from laboratory scale of smoldering combustion from studies of Stockwell et al. (2014) [12] and Christian et al. (2003) [6] were shown in Table 2. Emission factors from three peat samples taken from the Mega Rice Project area in Central Kalimantan for CO_2, CO and CH_4 were 1637 ± 204 g/kg (dry basis), 233 ± 72 g / kg (dry basis) and 12.80 ± 6.6 g/kg (dry basis). The average MCE was 0.816 ± 0.065 [2]. Combustion of one peat sample taken from Teluk Pulau, South Sumatera had average CO_2, CO and CH_4 emission factors of 1703 g/kg (dry basis), 210,3 g/kg (dry basis) and 20.80 g/kg (dry basis) [6]. One-sample t test two-way with a significance level (α) = 0.05 and

Summary Key Finding Peatland Fire:

- PM2.5 carbonaceous aerosols collected at a peatland fire had very high concentration of more than 100 times of that colected at an urban background site.
- PM2.5 aerosols emitted from peatland fire were primarily composed of OC (69. ± 9 % of PM2.5 mass), this finding is similar to Study in Sumatra in 2012 (71 ±5.11%).
- PM2.5 from peat fire emissions is characterized by abundance of OC1 and OC2 fractions
- The OC/EC ratios (36 - 50 for peatland fire), abundances of eight thermally-derived carbon fractions,
- Emissions on burning site produces more volatile compounds with low molecular weight compared to the background site

Crop Residue Open Burning

- Emission Measurement for PM2.5 and BC from crop residue Open burning (Rice straw, corn straw and sugar cane)
- Emission Factor Development for BC and PM2.5 field and lab scal observation
- Emission Inventory of BC & PM2.5 (on going)

Field Measurement

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Lab Scale : Burning in the Chamber

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Key Finding : Emission Factors (Hafidawati et.al, 2017)

Emission Factor

International Journal of GEOMATE, Aug. 2017, Vol.13, Issue 36, pp.126-130

(Model 43D, Diffusion Systems Ltd, London) at the Laboratory of air quality environmental engineering Institute Technology of Bandung.

Analysis of Black Carbon by optical methods, by comparing the transmission of light through a filter that contains suspended particles with the transmission of light through a filter that is still clean. It is possible to estimate Black Carbon (BC) concentrations in the atmosphere by simply measuring light absorption or reflectance.

Air is drawn through the filter and then the density of the particles retained on the filter was measured using a reflectometer. Particulate density can be converted using a calibration curve to obtain the mass concentration of Black Carbon.

2.5. Calculating Methods

The emission BC were measured in form of concentration (mg/m^3 BC). The concentrations of BC on $PM_{2.5}$ from the smoke emision were calculated as the following equation :

1). Calculation of carbon black weight per unit area of filter

$$BC = 4.37638 \times (-\ln(\bar{R})) + 21.199 \quad (1)$$

3. RESULT AND DISCUSSION

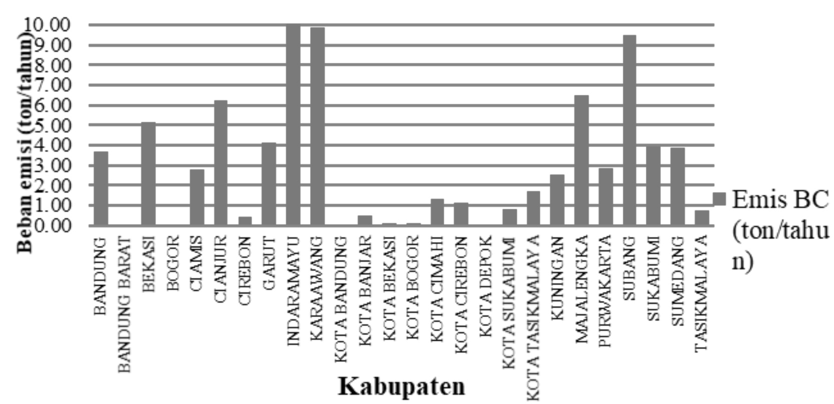
In this research, estimation of emission factor BC from open burning in the rice field is the target. Other pollutants ($PM_{2.5}$, CO_2, and CO) are also considered to investigate combustion characteristics and efficiency combustions (EC).

Emissions of BC from open burning of rice residues were measured in form of concentration (µg/m^3 BC) by real time monitored equipment. Emission factor of BC in form of gr/kg (dm). Emission factor from open burning of 8 varieties of rice straw results are presented in Table 1.

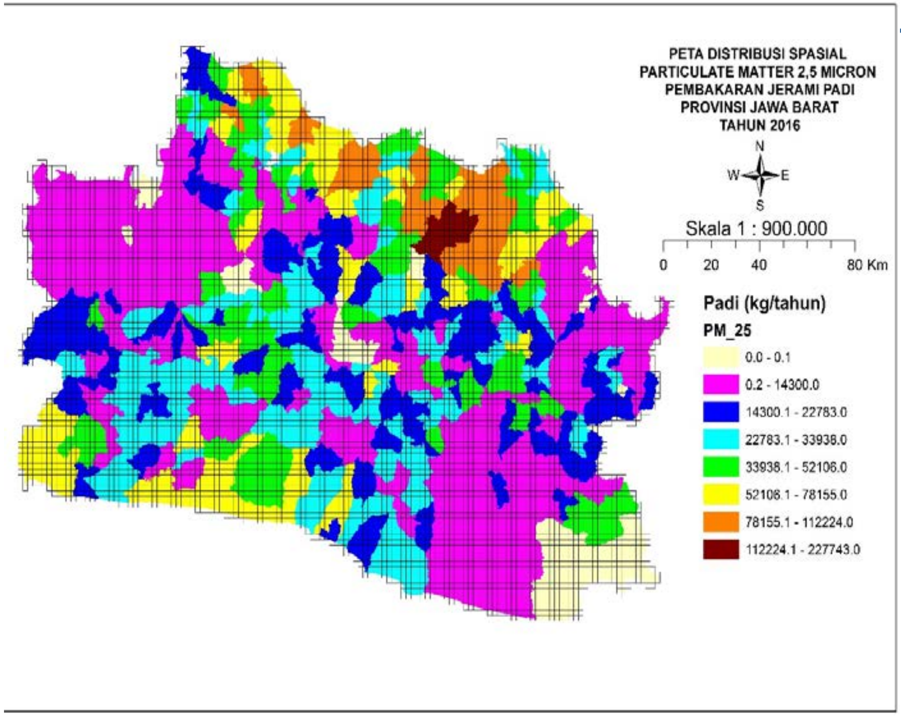
Table. 1 Emission factor of BC from Field Open Burning of Rice Straw.

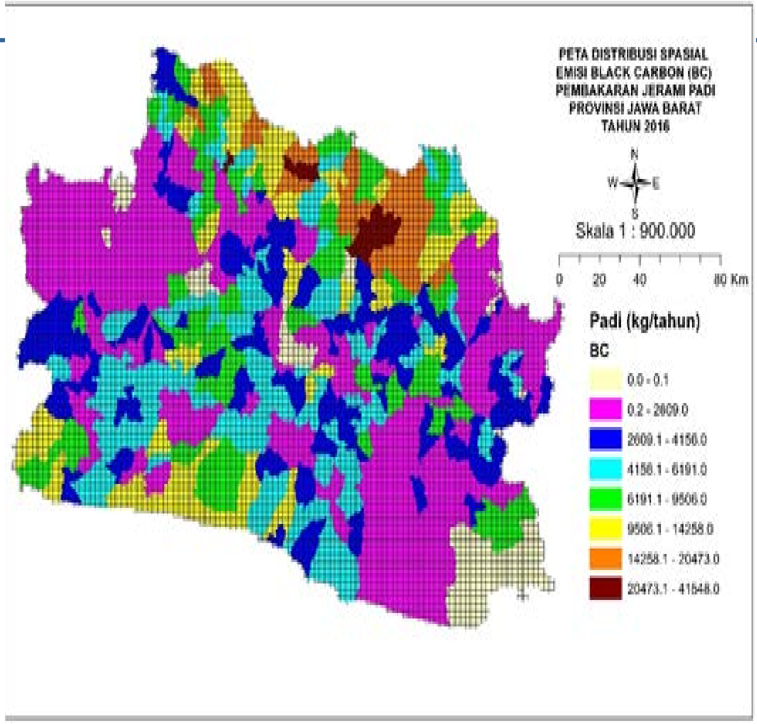
Rice Straw Varieties	EF BC (g/kg)dm
Mekongga	0.501
Ciherang	0.749
Hibrida	0.817
Inpari	0.973
Cintanur	0.794
Inul	0.928
Sarangue	0.847
Pandan Wangi	1.099

Emission Inventory



Spatial Distribution of Emission from Rice Straw Open Burning





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Fuel Wood Burning

- Identify PM size distribution generated from wood burning with traditional cook stove in Lembang
- Measure indoor and out door pollution from cooking activies at rural household
- Identify exposure of woman and children
- Jattropha Curcas seed Cook Stove development

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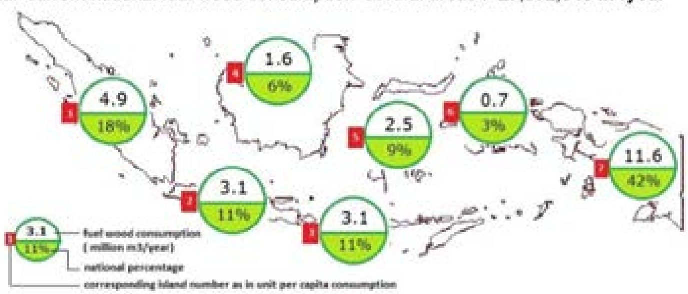
Wood Used as Main source of Fuel

Island	Per capita consumption (m^3/capita/year)	Sources
1.Sumatra	1.63	national average
2.Java	1.11	**this study**, Tampubolon 2008 and Sumardjani et al., 2007
3.Bali-Nusa Tenggara	1.63	national average
4.Kalimantan	3.75	Sumardjani et al., 2007
5.Sulawesi	1.61	NFP, 2012
6.Maluku	1.63	national average
7.Papua	10.9	Rachman et al., 1996

Note: Papua was excluded from national average calculation due to the considerable high value compared to the others, some units are converted from kg to m^3 using secondary data

Total current national fuel wood consumption at rural areas : **27,572,043 m^3/year**



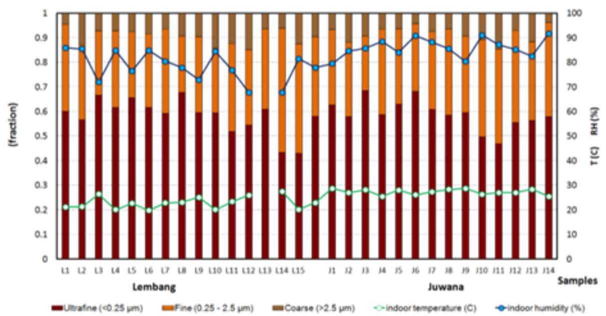
Papua island has high fuel wood consumption due to the large fraction of poor people as well as high unit consumption per capita of fuel wood

Indoor Sampling activities

Key Finding (Huboyo et.al, 2014)

COMPOSITION OF INDOOR ULTRAFINE, FINE AND COARSE PARTICLES RELATED TO STOVE EMISSIONS

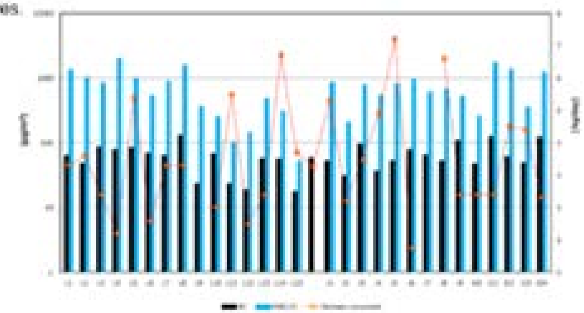
Average compositions of ultrafine, fine, coarse particles related to the stoves emissions were 57.9%,32.3%,9.8% and 58.8%, 32.8%,8.4% for Lembang and Juwana respectively. During the cooking period, the indoor temperature as well as indoor humidity were higher at Juwana site rather than in Lembang site



Zero-Carbon Energy 2012
The 4th International Symposium: Kyoto University Global COE Program
(Specially Jointed with JGSEE, King Mongkut's University of Technology Thonburi)
"Energy Science in the Age of Global Warming – Toward CO2 Zero-emission –"
22 – 23 May 2012, Bangkok, Thailand

BLACK CARBON (BC) PROPORTION AND FUEL CONSUMPTION

The BC proportions at ultrafine particles ($PM_{0.25}$) at both sites were almost comparable indicating comparable performance of the stove operation even using different type of wood and stoves.

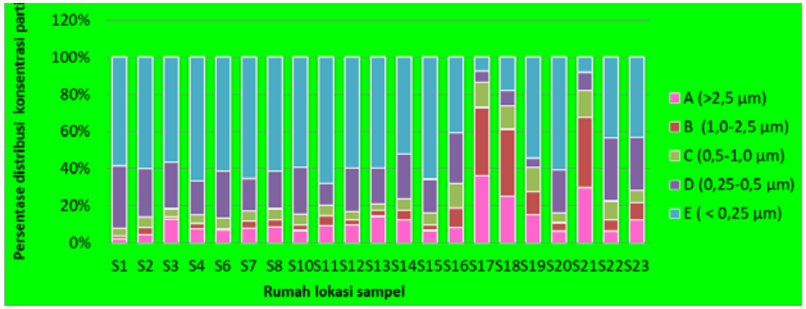


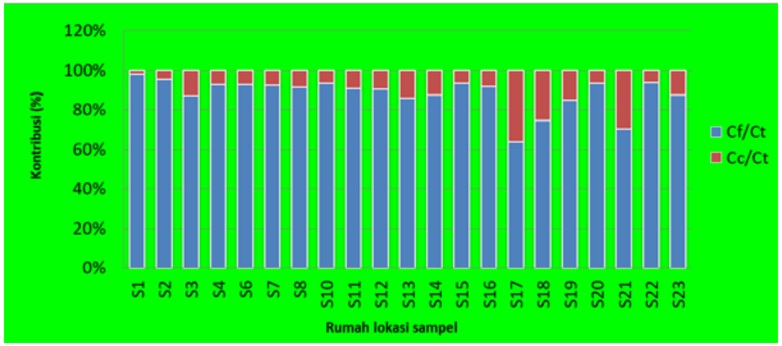
Key Finding

Emission Factors

No.	Jenis kayu	massa kayu (kg)	Lama memasak (menit)	konsentrasi partikulat (μg/m3)	Faktor emisi (g/kg)	Faktor emisi (mg/kg)	Faktor emisi (g/menit)	Faktor emisi mg/menit)
1	Pinus	3,6	178	1281,3	0,00057	0,56815	0,00001	0,01177
2	Bambu	5,6	166	1511,2	0,00033	0,33395	0,00001	0,01172
3	Alpukat	2,7	141	1741,3	0,00131	1,30923	0,00002	0,01681
	Standar deviasi	1,5	19	230,0	0,0	0,5	0,00001	0,00292

Concentration & Size distribution





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Several Publications

Biomass fuel use in Indonesian rural households: the indoor aerosol of ultrafine (and its BC), fine, coarse particles related to cooking emission and a rough estimate of its biomass fuel consumption at nationwide

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ABSTRACT

After national fuel switching program was launched in mid-2007 across Indonesia, people in remote rural areas seem to have dual cooking fuels (wood and LPG) for daily cooking. They prefer to use wood for heavy-daily cooking. It is therefore important to know the impact of indoor air pollution and the fuel consumption relevant to the cooking. Field measurements of the cooking activities related to energy use and indoor air pollution episode were accomplished in 29 rural Indonesian households i.e at Lembang, West Java and Juwana, Central Java Indonesia during December 2010 – January 2011. The averages of 3.54 ± 1.4 kg and 3.8 ± 2.2 kg wood were consumed at each cooking period for Lembang site and Juwana site respectively. Indoor aerosol related to cooking emission of ultrafine particles (<0.25 μm), fine particles (0.25 – 2.5 μm) and coarse particles (2.5 – 10 μm) were quantified with Sioutas impactor. The average PM_{10} concentrations were 1132 ± 900 μg/m^3 and 1375 ± 883 μg/m^3 for Lembang site and Juwana site respectively.
The mass proportions of ultrafine, fine and coarse particles in PM_{10} were 58 ± 8%, 32 ± 7%, 9 ± 8% at Lembang site, while at Juwana site those were 59 ± 6%, 33 ± 5%, 8 ± 3% for ultrafine, fine and coarse particles respectively. While the proportions of black carbon (BC) in ultrafine particles, which is important to evaluate the health impact on the cooker, showed 13.39 ± 8.8% and 10.9 ± 4.7% at Lembang site and Juwana site respectively. Combining with the previous fuel wood consumption studies in Indonesia, we roughly estimated the rural household fuel wood consumption at nationwide.

Keywords: indoor air pollution, cooking, energy, PM10, size distribution, wood

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journal homepage: www.elsevier.com/locate/atmosenv

Characteristics of indoor air pollution in rural mountainous and rural coastal communities in Indonesia

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HIGHLIGHTS

- We monitored the indoor $PM_{2.5}$ and CO concentrations in rural Indonesian households.
- The mountainous area has higher indoor air pollutions than those in the coastal area.
- The wood burnings in coastal area show more flaming than those in mountainous area.

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ABSTRACT

The increased use of biomass fuel use among rural Indonesian households for years despite national program on subsidized LPG fuel distribution pose threat of indoor air pollution for the householders. Indoor air pollution levels of $PM_{2.5}$ and CO in the kitchen of 40 households using the fuelwood as the main cooking fuel were measured in the same season in mountainous and coastal areas in Indonesia. The temporal variations of $PM_{2.5}$ and its size distributions were simultaneously measured using photoelectric UCB monitor and personal cascade impactor, respectively. While carbon monoxide (CO) concentrations were measured using USB-CO monitors. Household indoor air pollution in the mountainous area was generally higher than that in the coastal area. This is because the households in coastal area have higher kitchen volume (about three times), smaller ventilation area (about 1.7 times) and shorter cooking duration with wood fuel (0.6 times) than those in mountainous area. Yet, during cooking with fuelwood, the indoor $PM_{2.5}$ concentrations at the cook site showed almost comparable results for both sites. The wood stove burning in coastal area tended to be in flaming combustion than in mountainous area. This can be indicated by a higher fraction of finest particles in $PM_{2.5}$, a higher fraction of EC in $PM_{2.5}$ and a higher fraction of K^+ and Cl^- ions in $PM_{2.5}$ mass concentrations. The time-averaged CO concentrations for 22-h measurements at the mountainous area were higher than those in coastal area. The mountainous area showed higher positive correlation relationship between the measured concentrations of CO and $PM_{2.5}$ than those in the coastal area. The use of cleaner fuel, e.g., subsidized LPG fuel in rural area should be promoted and managed intensively in mountainous area than in coastal area to avoid people exposure of health damaging indoor air pollutants.

Contents lists available at SciVerse ScienceDirect

Energy for Sustainable Development

Comparison between *Jatropha curcas* seed stove and woodstove: Performance and effect on indoor air quality

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ABSTRACT

Jatropha curcas has been introduced and sold as cook stove fuel in Indonesia since late 2010, after the progressive phasing-out of the subsidy for kerosene started in 2007. To review the reliability and probable health impacts of *J. curcas* Seed (JCS) stoves used for cooking, the standard water boiling test (WBT) was used to evaluate the stove's basic performance (thermal efficiency and specific fuel consumption) and the indoor air quality associated with its emissions and these parameters were compared with those of a traditional wood stove (WS). The emissions were analyzed using a CO monitor, photoelectric PM (particulate matter) monitors and the Sioutas Cascade Impactor to characterize the CO (carbon monoxide) concentration, temporal variations in PM mass concentrations and the mass size distributions from the stove emissions respectively.

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Government Commitment on Emission Reduction

- During G-20 in Pitttsburg, USA, Indonesia Commit to reduce its emissions by 26% against 2020 BAU scenario or 41% if international assistance is available
- President Joko Widodo during his speech at COP 21 in Paris last December. ", Indonesia commits to unconditionally reduce its emissions by almost a third (29 percent) against 2030 business-as-usual (BAU) scenario or more (41 percent), provided that international assistance is available.
- Kerosene to LPG conversion in 2007

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Government Intervention (Kerosene Conversion Program)

- In Indonesia in 2007, The Government launched Kerosene conversion program , where the each housedhold requiring Kerosene would receive .. free LPG stove. The program aim to complete nationwide in 2011. However, fuel wood user were also receiving the LPG stoves due to their low income. Although they received subsidy, some of rural people keep continue using fuel wood as their primary cooking fuel. In sequence, rural people will still be exposed to indoor air pollution. The reduction seems very difficult and the impact to reduce the indoor air pollution may not be achieved. When this research was conducted in 2009 -2011. Rural People were still been exposed by high fine particulate matter concentration. Alternative solution for cook stove with better combustion efficiency were also important.
- There is no specific regulation or government intervention on agriculture residue open burning. However, the local government only provide some suggestion not to burn the crop residue and instead they may used for cow feed.


The basic performance of Jatropha curcas seed stove
and its indoor air pollution over traditional wood stoves
Manchester, September 4th – 9th 2011
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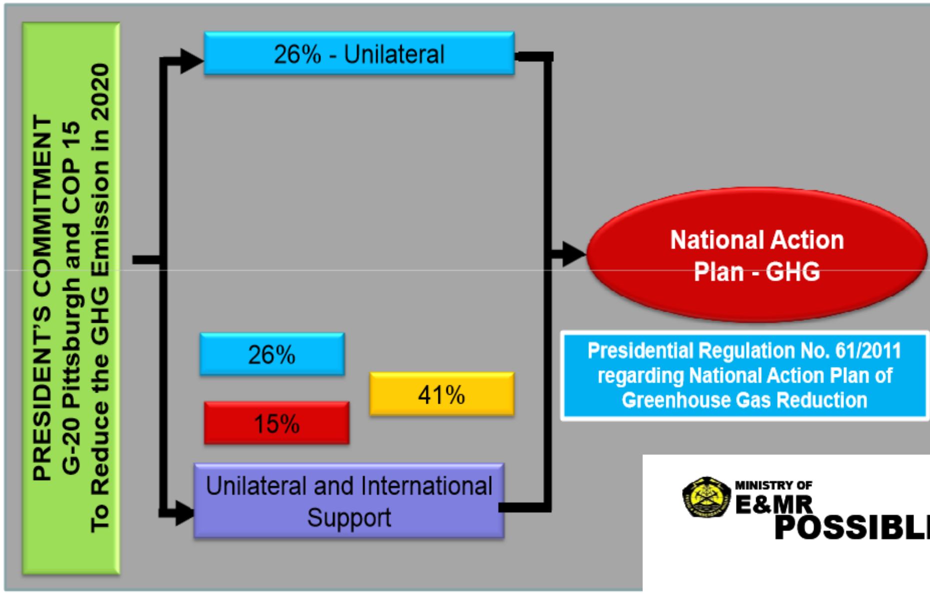
National Program Policy on kerosene to LPG conversion since 2007 (Indonesia)
In rural area...
An innovative biomass stove which rural people are accustomed to using desirable. Moreover, the stoves should be pretty safe, clean emission and energy efficient. We evaluated performance and its indoor air pollution of Jatropha curcas seed (JCS) stove fabricated by local stove craftsmen over traditional stoves using simple water boiling test.
-clean? √
-cheaper? ?
-safe? ?
-efficient? √
-tasty? X
-env friendly? X
-clean? X
-cheaper? ?
-safe? √
-efficient? X
-tasty? √
-env friendly? ?

Solutions Needed

- Less Burning Program : converting Biomass to Energy conversion… EFB as a source of Energy
- Converting the Biomass to animal feed
- Converting solid fuel to clean fuel (gas)for low income people.. (may not be easy)
- Introduce Better Cook stove for rural household and Provide recommendation on house ventilation to reduce indoor air pollution
- Raising public awareness

MINISTRY OF E&MR

INDONESIAN COMMITMENT IN GHG EMISSION REDUCTION



- And by 29 % for 2030

MINISTRY OF E&MR

POSSIBLE DISTRIBUTION AND TARGET OF GHG EMISSION REDUCTION

Sector	Emission Reduction (Giga Ton CO_2e)		Action Plan	Institution
	26%	+ 15%		
Forestry and Peatland	87.61% (0.672)	86.97% (0.367)	Forest and land fire control, water and hydrology management on peat land, forest and land rehabilitation, illegal logging control, avoiding deforestation, community development	Ministry of Forest, Ministry of Public Works, Ministry of Agriculture, Ministry of Environment
Waste	6.26% (0.048)	7.11% (0.030)	Sanitary landfill development, 3 R and sewerage system in urban areas	Ministry of Public Works, Ministry of Environment
Agriculture	1.04% (0.008)	0.71% (0.003)	Introduction of low carbon rice variety, irrigation efficiency, organic fertilizer utilization	Ministry of Agriculture, Ministry of Public Works, Ministry of Environment
Industry	0.13% (0.001)	0.95% (0.004)	Energy efficiency, renewable energy development	Ministry of Industry, Ministry of Environment
Energy and Transportation	4.95% (0.038)	4.27% (0.018)	Biofuel development and utilization, fuel efficiency improvement, mass transportation, demand side management, renewable energy, energy efficiency	Ministry of Transportation, Ministry of Energy and Mineral Resources, Ministry of Public Works, Ministry of Finance

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NATIONAL COMMITMENT IN EMISSION REDUCTION

1994

Indonesia ratified UNFCCC Convention;

Act No. 6/1994

2009

President SBY pledge to reduce emissions by 26% (own efforts) and up to 41% with international supports by 2020;

Presidential Decree No. 61 /2011

2015

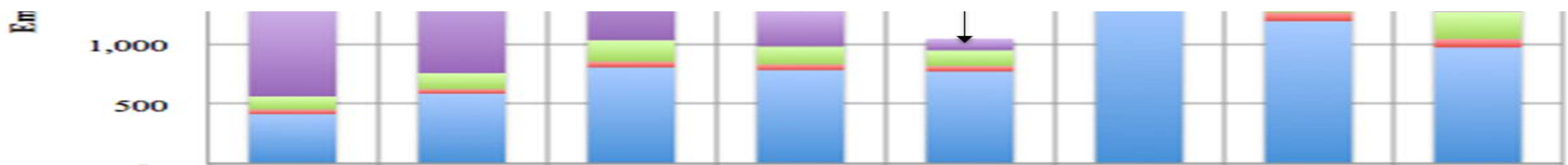
Indonesia's INDC: 29% of emissions reduction (own efforts), and up to 41%, with international supports by 2030;

Revised of Presidential Decree No. 61 /2011

2016

Indonesia ratified Paris Agreement;

Act No. 16/2016



	2010	2015	2020	Fair (26%)	Ambisius (41%)	2030	Fair (29%)	Ambisius (41%)
AFOLU	875	855	738	330	97	1,084	539	418
Limbah	108	133	178	149	130	275	244	227
IPPU	38	38	48	48	45	79	76	73
Energi dan Transportasi	415	586	806	783	772	1,444	1,191	972

Note :
AFOLU : Agriculture, Forest, and Other Land Use systems
IPPU : Industrial Processes and Production Use

Source : MOEF

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Thank you