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2015 SEVERE PEAT FIRES AND AIR POLLUTION NEAR THE FORMER MEGA RICE PROJECT AREA IN CENTRAL KALIMANTAN, INDONESIA

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SUMMARY

Severe air pollution due to biomass burning occurred again in Indonesia during the 2015 super El Niño. In this report, air pollution data measured at Palangkaraya, near the northern part of the Mega Rice Project (MRP) area in Kalimantan, are analyzed in conjunction with fire and precipitation data, and satellite imagery. During super (very strong) El Niño conditions in 2015, the dry season lasted about 150 days from late May to late October, with low precipitation (=1.0 mm day^{-1}; average precipitation in dry season = 3.9 mm day^{-1}). Forest and peat fires became active around mid August, about three months after the onset of the dry season, followed by a period of severe air pollution (Hazardous level: PM10 > 420 × 10^{-6} g m^{-3}) starting in mid-September and lasting through late October. These time-lags between the dry season, fires, and air pollution period, suggest that biomass fuel needs about three months to become dry enough to start active fires, and that peat underground needs about four months to become ignitable dry peat. After severe peat fires began in late September, highest daily and hourly PM10 concentrations (3,010 and 3,760 × 10^{-6} g m^{-3} respectively) were observed on October 20, 2015. These fire and air pollution occurrence tendencies suggest that peat fires are a main source of air pollution.

Keywords: *Peat fire, PM10, MRP, MODIS, El Niño*

INTRODUCTION

In Southeast Asia (SEA), El Niño is typically associated with drought. This has helped fuel some of the worst wildfires on record in Indonesia in 2015 (OCHA 2015) during super (very strong) El Niño conditions. The total burnt area in Indonesia during the previous super El Niño in 1997–1998 was estimated at about 40,000 km^2 (Siegert and Hoffmann 1998). Thus, vegetation and peat fires in Kalimantan, Indonesia, were very active under El Niño and quasi-El Niño conditions, especially in recent years (2002, 2004, 2006, 2009, 2014, and 2015). These recent active fires may suggest vulnerable conditions in forests and peatlands in Kalimantan. The sources of particulate matter (PM) are mainly forest and peat fires. The Indonesian fires of 1997 released pyrogenic aerosols of around 55 × 10^{12} g PM10 into the atmosphere, the equivalent of around one-third of the global annual anthropogenic emissions of primary particles (Heil *et al.,* 2006). Indonesia also formally admitted to releasing a very large amount of CO2 emissions from fires and deforestation (Yulianti 2013). From 2001 to 2010 in Palangkaraya, maximum peak concentrations of particulate matter (PM10), SO2, CO, and O3 were observed on October 14, 2002 during a moderate El Ni–o event, and their values reached 1905, 85.8, 38.3, and 1003 × 10^{-6} gm^{-3}, respectively. Photochemical smog also occurred (Hayasaka *et al.,* 2014).

In this report, air pollution data (PM10) measured at Palangkaraya, near the northern part of the MRP area in Kalimantan, are analyzed in conjunction with fire and precipitation data, and satellite imageries, to discuss precipitation during the dry season under El Ni–o conditions, fire (hotspot) occurrence tendency during the dry season, occurrence tendency of PM10, and air pollution sources.

METHODS

Study area

Figure 1 shows a detailed map of the study area in the Mega Rice Project (MRP), called ―MRP+" in this paper. MRP+ covers the MRP area and its vicinity, including the Sebangau National Park (1.75Ð3.5°S, 113.5Ð115°W). MRP+ was chosen as the study area simply because MRP+ is major peatland in Central Kalimantan, and is the highest hotspot density area in Indonesia. Deforested peatlands, abandoned after the MRP, became major sources of air pollution because of the large accumulation of peat.

Palangkaraya is located in Central Kalimantan, as shown by a circle (2.207°S, 113.917°E) in Figure 1. The distance from the nearest coastline is about 100 km, and the average altitude is only around 10 m. The MRP was built on tropical swamp forest areas on the eastern and southern sides of Palangkaraya. Before the disturbance, the tropical swamp forest could hold enough water to stay wet even in the dry season. However, the newly constructed 4,000-km-long MRP canal system built for irrigation facilitated not only illegal logging, but also loss of water through drainage from most of the peatlands in the MRP area. This is one of the reasons for severe fire occurrence in the MRP area.

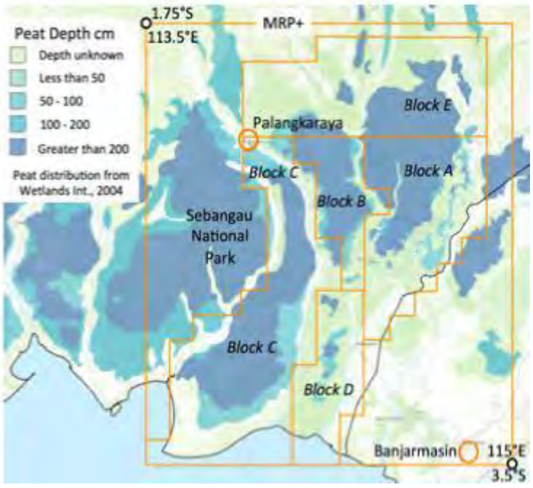

Figure 1: Peatland distribution in study area (MRP+) (Original Map from Global forest watch and Wetland Int. 2004

Air pollution, PM10 data, and weather data

The air pollution (PM10), precipitation, and visibility were measured hourly by the Palangkaraya weather station of the Indonesian Agency for Meteorology, Climatology, and Geophysics (BMKG) at Palangkaraya International Airport (Tjilik Riwut, 2.224°S, 113.946°E). In our previous paper, we used air pollution data from the Air Quality Management System and Regional Center at Palangkaraya. Unfortunately, most of their gas analyzers were broken in 2011. In this paper, we used PM10, precipitation, and visibility data from BMKG to evaluate air pollution.

RESULTS AND DISCUSSION

Peat fires in 2015 during super El Niño

The number of daily hotspots (NASA EARTHDATA) in Kalimantan and the study area (MRP+), and the precipitation at Palangkaraya, are shown in Figure 2 using double Y-axes. Only a few precipitation events were observed from August to late October. Average daily precipitation during the dry season (Day Number (DN) = 154–298) in 2015 was 1.0 mm day^{-1}. September was a rainless month.

Under the very dry (drought) conditions created by a super El Niño, the number of hotspots began to increase in mid-August (Figure 2). The two-month time lag between late May (beginning of dry season in 2015) and August (beginning of active fires) suggests that the biomass needs a drying period after the wet season to become combustible biomass. From mid-September, the number of daily hotspots exceeded 2000. The maximum number of daily hotspots observed in October 14, 2015 (DN = 287) was 2890. This fire activity suggests that the biomass becomes highly combustible in mid-September. In particular, deep peat fires could begin because the underground water level becomes lowest just before the rainy season begins in October, when the amount of ignitable peat becomes largest. The number of hotspots in MRP+ also increased from around mid-August (see Figure 2). The ratio of number of hotspots in MRP+ to those in Kalimantan also gradually increased, as seen in Figure 2. One of large ratios was 0.573, at one of largest hotspot peaks at DN = 266. The large ratio suggests peat fire activity in MRP+ due to a large peat area in the MRP. After the rainy season started in late October, the number of hotspots in MRP+ became nearly zero (Figure 2). This suggests only a large amount of precipitation could suppress peat fires.

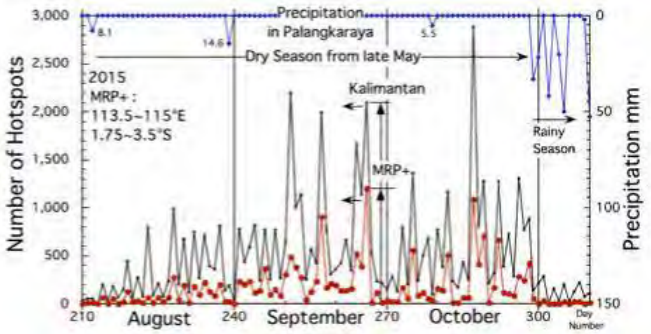

Figure 2: Number of daily hotspots and precipitation in Kalimantan and study area (MRP+)

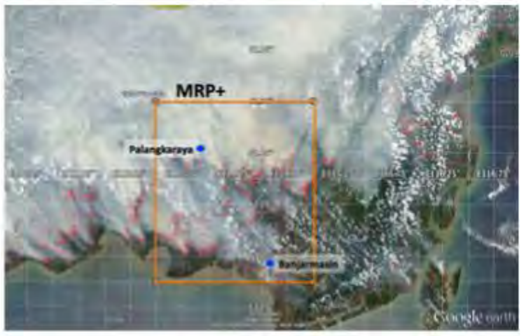

Figure 3: Satellite imagery (MODIS on Aqua) for daily hotspot peak day (DN = 287, October 14, 2015)

Satellite imagery in Figure 3 clearly shows the fire situation in Central, South, and East Kalimantan on a hotspot peak day on October 14, 2015 (DN = 287, Figure 2). A strong southeasterly wind in Figure 3 activated fires on the peatlands. In particular, fires southeast of Palangkaraya emitted a dense haze (Figure 5). Most of these fires were located on peatlands in Block A, B, and C of the MRP (Figure 1). In contrast, the number of fires in the pristine forests in the northern part of Sebangau National Park (south of Palangkaraya, Figure 1) was nearly zero.

Severe air pollution in 2015 during super El Nibo

PM10, and minimum and average visibility measured at Palangkaraya are plotted in Figure 4. Minimum and average visibility gradually decreased with fire activity in MRP+ (Figure 2). The daily maximum PM10 was 3245 × 10^{-6} gm^{-3}, observed on October 21, 2015 (DN = 294). The hourly maximum PM10 was 3761 × 10^{-6} gm^{-3} and was also observed on the same day (DN = 294). The minimum and average visibility on this day (DN = 294) were nearly zero (hourly data varied from 10 to 150 m). A severe air pollution period (Hazardous level (API > 300): PM10 > 420 × 10^{-6} g m^{-3}) began in mid-September (about four months after the dry season started) and lasted until late October. Very severe air pollution (>1000 × 10^{-6} gm^{-3}) occurred beginning in late September. This severe air pollution just before rainy season also suggests that the main source of air pollution was peat.

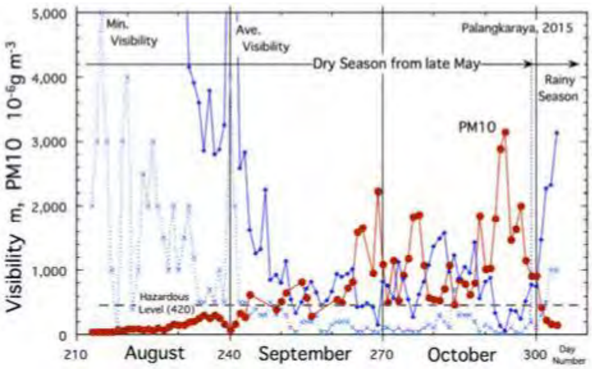

Figure 4: PM10, minimum and average visibility measured at peak Palangkaraya.

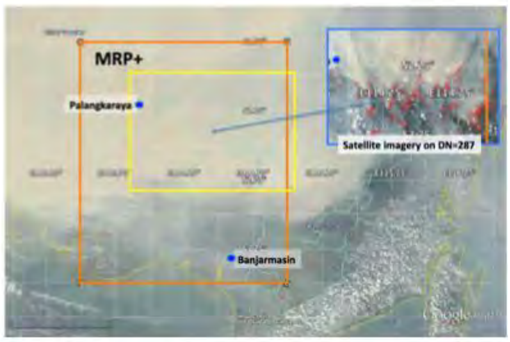

Figure 5: Satellite imagery (MODIS on Aqua) for daily hotspot day (DN = 294, October 21, 2015)

To explain the several days difference between the hotspot peak day (DN = 287 in Figs. 2 and 4) and PM10 peak day (DN = 294 in Figure 4), satellite imagery on DN = 294 is shown in Figure 5.

The satellite imagery in Figure 5 clearly shows that a thick haze covers more than 60% of the northern part of the MRP+ area. Because of the thick haze and underground peat fires, the number of hotspots in Kalimantan and MRP+ was small, 724 and 101 respectively. The worst air pollution occurring at the end of the dry season or just before the rainy season suggests that the air pollution source is peat because the underground water level becomes lowest at the end of the dry season, and this makes deep (<40 cm) peat highly combustible (Usup A *et al.,* 2004). This tendency was also found in the 2002 air pollution at Palangkaraya. Previous studies reported that the worst air pollution in 2002 occurred on October 14, 2002 during a moderate El Niño event, and about 10 days before the onset of the rainy season.

CONCLUSION

In this report, air pollution data measured at Palangkaraya, near the northern part of the Mega Rice Project (MRP) area in Kalimantan are analyzed in conjunction with fire and precipitation data, and satellite imagery. The analysis results clearly showed: (1) In 2015, MRP area has about five months of dry weather, from late May to

October. (2) The dry season during an El Niño event becomes very dry compared with average precipitation (=3.9 mm day^{-1}). (3) During the 2015 super El Niño, the dry season was longer and very dry. The dry season lasted about 150 days, from late May to late October with lower precipitation (=1.0 mm day^{-1}, ratio to average = 1/3.9). (4) Forest and peat fires became active around mid-August, about three months after the dry season started. The number of daily hotspots in MRP+ exceeded 200 beginning in mid-August. (5) Severe fires began around mid-September, about four months after the dry season started. Although hotspot detection was interrupted by dense haze from fires, the number of daily hotspots in MRP+ exceeded 500 several times beginning in mid-September. (6) A period of severe air pollution (Hazardous level (API > 300): PM10 > 420 × 10^{-6} g m^{-3}) also began in mid-September (about four months after the dry season started) and lasted until late October. (7) The second largest hotspot peak (1,100 hotspots) was observed on October 14, 2015. (8) Several days after the second largest hotspot peak day, the highest daily and hourly PM10 concentrations (3,010 and 3,760 × 10^{-6} g m^{-3} respectively) were observed 0n October 20, 2015. (9) In our previous report (Hayasaka H *et al.,* 2014), a maximum peak in PM10 concentration in the ten-year period from 2001 to 2010 was 1905 × 10^{-6} g $_{m}{}^{-3}$, and was observed on October 14, 2002 during a moderate El Niño. (10) Both PM10 peaks in 2002 and 2015 occurred in October simply because the amount of ignitable dry peat increased at the end of dry season, when the underground water level reached a deepest level.

From the above results and discussion, we recommend strong conservation measures of peatlands in the MRP+ area in Central Kalimantan. In particular, we suggest limiting the construction of irrigation canals, which contribute to further development and subsequent drying of the land. Drastic land use/land management planning, including re-wetting, should be developed based on scientific knowledge, and carried out using modern technology.

ACKNOWLEDGEMENT

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