RELATIONSHIPS BETWEEN GROUND WATER LEVEL AND CO2 EMISSION TROPICAL PEATLAND IN INDONESIA

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ABSTRACT: As a cause of global warming, CO_2 is most effective green house gas. And many countries are trying to reduce emission of that. However, the report of quantitative description is few still because the amount of CO_2 emission is difficult to estimate for their complex process. One of the main reasons of CO_2 emission is from peatlands in natural. The peat land is known as the carbon sink as there is much Carbon that wasn't decomposed. This carbon is increasingly released to the atmosphere due to drainage and fires associated with plantation development and logging. These two reasons of CO_2 emission are associated with ground water level. If the ground water level declined, CO_2 is released more than before by promoting decomposition and fire from the peatland. The purpose of this study is to assess the interrelationships between CO_2 emission and dryness in the peatland by using remote sensing data and ground water level assumption. CO_2 emission from peat soil is estimated by calculating CO_2 flux model. And ground water level assumption as dryness of peatland is estimated with KBDI (Keetch-Byram Drought Index) which calculated by using GSMaP for daily precipitation data and MTSAT for land surface temperature data as source of evapotranspiration. KBDI is validated with soil moisture products from AMSR-E (Advanced Microwave Scanning Radiometer for EOS) images. Current distribution of Asian tropical peatland is extracted by MODIS images.

1. INTRODUCTION

CO_2 is the most effective green house gas. And many countries are trying to reduce emission of that (IPCC,2007). One of the main reasons of CO_2 emission is from peatlands in natural. The peat land is known as the carbon sink as there is much Carbon that wasn't decomposed. Lowland peatlands in Southeast Asia cover 27.1 Million hectares (Mha) of which over 22.5 Mha are in Indonesia where they make up 12% of the land area and over 50% of the lowland area (Hooijer et al., 2010). In Indonesia, CO_2 is increasingly released to the atmosphere due to drainage and fires associated with plantation development and illegal logging from Mega Rice Project in 1999(Sundari et al., 2012). These two reasons of CO_2 emission are associated with ground water level. The ground water level is the major factor of promoting CO_2 emission in peatlands (Limpens et al.,2008; Page et al., 2009). If the ground water level declined, CO_2 is released more than before by promoting decomposition and fire from peatlands (Couwenberg et al ., 2010; Dommain et al., 2012). Therefore, the purpose of this study is to assess the interrelationships between CO_2 emission and dryness in peatlands by using remote sensing data and ground water level assumption.

2. METHODS AND EQUATION

2.1 Ground water level assumption

CO_2 emission is associated with local hydrology for example fluctuation of ground water level in peatlands. In this study the Ground Water Level (GWL) is calculated by the Keetch-Byram drought index(KBDI). The Keetch-Byram drought index (KBDI) is a continuous reference scale for estimating the dryness of the soil and duff layers. The index increases for each day without rain (the amount of increase depends on the daily high temperature) and decreases when it rains. The scale ranges from 0 (no moisture deficit) to 800. The range of the index is determined by assuming that there is 8 inches of moisture in a saturated soil that is readily available to the vegetation (Keetch, 1968). This study used GSMaP precipitation data and MTSAT air temperature data to calculate KBDI. The data period is about 5years from Oct. 2006 to Oct. 2012(as this writing).

$$mKBDI = mKBDI0 - 3.94 \times r + \frac{(1800 - mKBDI0)(0.968exp(0.0875T + 1.5552) - 8.30)}{1000 \times (1 + 10.88exp(-0.001736R))} \quad (1)$$

$$GWT = -0.0045 \times mKBDI \quad (2)$$

2.2 Soil respiration

Then the soil respiration(RS) is simulated for estimation of CO_2 emission. The empirical equation of the soil respiration(RS) was proposed in Sundari(2012) same study site. This equation(3) is based on situ observed soil respiration data.

$$RS=4.03+2.41\times(GWL(m))+1.69\times(GWL(m)^2) \quad (3)$$

3. RESULTS

The RS(soil respiration) shows seasonal fluctuation obviously because that is closely affected by local hydrology such as ground water level. According previous paper(Sundari,2012), the RS of DF(drained forest) and ground water level is in quadratic relationship. For that reason, the range of RS fluctuation is not radical. However, the response of RS become large in case of low or high GWL. And Sundari(2012) revealed the inflection point is -0.71m from daily observation data analyzing. As shown in Figure.1, Minimum RS is 3.17(DOY231/2008) Maximum RS is 4.64($gCm^{-2}d^{-1}$)(DOY294/2010). The average RS during five years, from 2007 to 2011, was about 1340($gCm^{-2}y^{-1}$). GWL of 2006 and 2012 has excluded because these years data are not exist full of day.

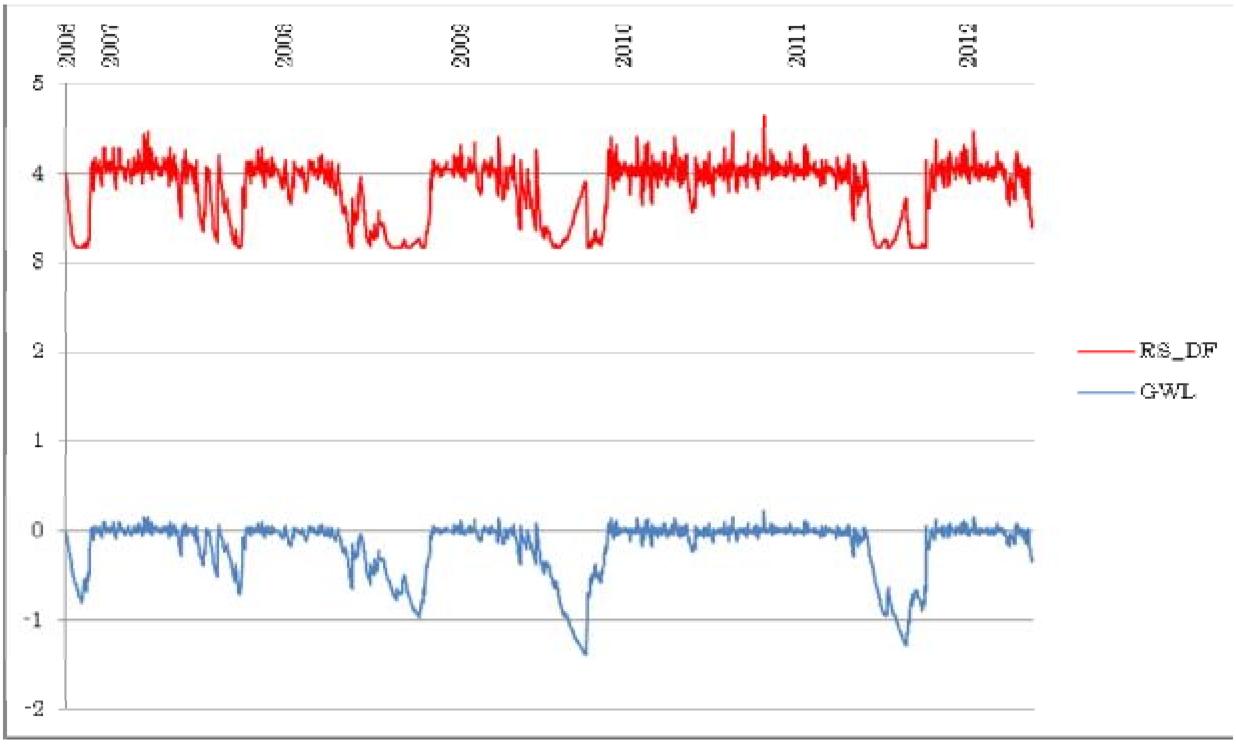

Figure 1: Estimated Soil respiration($gCm^{-2}d^{-1}$) and Ground water level(m) from Oct 2006 to Oct 2012 on Drained Forest(DF) Palankaraya, Central Kalimantan, Indonesia(2.35S,114E)

4. DISCUSSION

From the result the five years(2007-2011) average of CO_2 emission, RS(soil respiration), was about 1340($gCm^{-2}y^{-1}$). And two years (2007-2008) average of CO2 emission is 1358.5($gCm^{-2}y^{-1}$). This number is larger than previous paper Sundari(2012)'s result. In that result, the average of RS was 1237($gCm^{-2}y^{-1}$) during 2007-2008. This overestimated RS result is caused by low GWL estimation. Especially in dry season a modeled GWL is estimated lower than measured data. Because the modeled GWL is sensitive to precipitation (Takeuchi et al.,2010).

Table 1 : The average ground water level and soil respiration comparison in this result (Figure.1) and in previous study (Sundari,2012). The DF(drained forest) site is in Palankaraya, Central Kalimantan, Indonesia(2.35S,114E).

year	Average Ground water level (m)		Soil Respiration ($gCm^{-2}y^{-1}$)	
	From Figure.1	Sundari(2012)	From Figure.1	Sundari(2012)
2007	-0.07	-0.4	1386	1238
2008	-0.26	-0.4	1331	1236

5. CONCLUSIONS

This study revealed the relationship between ground water level and CO_2 emission in the peatland of Indonesia. Through KBDI-drought Index calculated by GSMaP and MTSAT data, the ground water level was assumed. And CO_2 emission from the peatland was estimated by Sundari(2012)'s empirical soil respiration equation. As the result five years, 2007-2011, of average CO_2 emission was about 1340($gCm^{-2}y^{-1}$). This is larger than measured data result in previous paper. This over estimated RS difference is caused by under estimation of GWL in dry season. Especially 2007 was estimated more lower GWL because of El Nino year. Therefore this study can suggest KBDI-drought index by remote sensing data is useful to estimate CO_2 emission from global peatlands.

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