Impacts of land cover change on climate trend in Padang Indonesia

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Abstract
The purpose of this study was to analyze the trend of climate change through changes in the elements of Green House Gases (GHGs), includes the trend of CO2, N2O, and CH4. The change of the extreme rainfall and temperature indices due to land cover change into developed area in Padang. Identification and analysis trends of climate change and extreme climatic events were analyzed by using RclimDex the Expert Team for Climate Change Detection and Indices (ETCCDMI) technique. Where as the analysis and interpretation of land cover changes into developed area used Landsat TM 5 and Landsat 1985 7 ETM + of 2011 by ERDAS 9.2 GIS with the supervised classification method and GIS Matrix. The results of the study provide informations of land cover changes into developed area at forest land (11,758.9 ha), shrub (3,337.3 ha), rice fields (5,977.1 ha), and garden (5,872.4 ha). It has an implication on increasing of the elements of GHGs concentration such as CO2 (14.1 ppm), N2O (5.4 ppb) and CH4 (24.8 ppb). This condition lead to an extreme temperature and precipitation indexes trends in Padang.

Keywords: Climate Change; Green House Gases; Land Cover Changes

Land cover change is an urban development phenomenon that is difficult to solve. This is due to the urban development which directly change natural land functions. In line with the urban development caused the pressure on forest land conversion into developed area. The land cover changes will lead to the increasing of CO2 concentration in the atmosphere. The changes in agricultural and farm land into developed area will produce an increasing trend of N2O and NH4. That would affect the changes of climatic conditions in the region directly [Hermon, 2012a]. CO2, N2O, and NH4 are included in green house gas (GHG) which naturally can adsorb the heat radiation in the atmosphere. The change in GHGs concentration will impact unstable climatic conditions both on extreme temperature and rainfall. GHG emissions have been increasing due to the increased of fossil fuels (FF) consumption since the industrial revolution in the mid 1980s. In the last decade, CH4 emissions have declined by 22 million tons/year from 37 million tons/year in the previous decade and N2O emissions also decreased slightly from 3.9 to 3.8 million tons/year. The CO2 emissions increased by more than double from 1.400 million tons/year to 2.900 million tons/year. The CO2 emissions rising by 0.50 °C compare to pre industrial. In the long term, earth temperature will tend to be higher than the current temperature [IPCC, 2001; Hermon, 2010].

Padang is the capital city of West Sumatra Province. that has a flat to hilly relief in general, primary forest located on the eastern and southern city. It continues over the time. Land cover change into developed area covered 3,044.20 ha in 1980 and increased to 8,288.28

I. Introduction

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Padang is the capital city of West Sumatra Province. that has a flat to hilly relief in general, primary forest located on the eastern and southern city. It continues over the time. Land cover change into developed area covered 3,044.20 ha in 1980 and increased to 8,288.28
ha in 1995, 12,444.21 ha in 2005 compared to 69,496 ha of Padang area [BPS Padang, 1981; BPS Padang, 1995; BPS Padang, 2006]. Land cover changes into developed area generally occur in the Lubuk Kilangan, Bungus Teluk Kabung, Koto Tangah, and Padang Selatan district. Those are belong to the hills with forest vegetation [Hermon, 2009; Hermon, 2012a; Hermon, 2012b]. The objectives of this study was to analyze the climate trend caused by land cover changes in Padang.

2. The Methods
   According to Zain [2002], Hermon [2009], and Hermon [2012b], the dynamics of land cover changes into developed area by interpretation of Landsat TM + 5 (1985) and Landsat ETM + 7 (2011) using ERDAS 9.2 as analysis tools. The analysis of land cover classification used supervised classification techniques on each images. This formulated six patterns of landcover, ie: (1) forest, (2) garden, (3) shrub, (4) open land, (5) paddy field, and (6) developed area. The analysis of area change (ha) for each land cover in 1985 and 2011 used ERDAS 8.6 and tools Interpreter (GIS Analysis-Matrix). Reclimdex with Expert Team for Climate Change Detection and Indices (ETCCDMI) technique had used for climate change and climatic extreme events.

3. Result and Discussion
   The result of Landsat 5 TM + (1985) and Landsat ETM + 7 (2011) shows that land cover changes into developed land generally occurs in the eastern part of Padang. The area was converted from forest, gardens, shrubs, and rice paddies into developed area (Table 1).

The land cover changes leads to increasing trend of GHG concentration for CO₂, N₂O, and NH₃. It will impact the change in temperature and rainfall patterns in Padang. The concentrate of CO₂, N₂O, and NH₃ from 1985 to 2011 showed an increasing trend. The concentrate of CO₂ increased by 14.1 ppm, N₂O increased by 5.4 ppb, and CH₄ increased by 24.8 ppb. Nahas and Setiawan [2009] explained that the increase of CO₂ concentrate in the air causes the increase of radiative forcing. The average of CO₂ radiative forcing was 0.04 ± 1.634 Wm⁻², radiative forcing of CH₄ was 0.509 ± 0.003 Wm⁻², and radiative forcing of N₂O was 0.168 ± 0.005 Wm⁻².

Table 1. The Land Cover Area in 1985 and 2011

| No | Type of Land Cover         | 1985   | 2011   |
|----|----------------------------|--------|--------|
| 1  | Developed Area             | 3,157.0| 28,573.2|
| 2  | Open Land                  | 513.4  | 1,709.9|
| 3  | Shrub                      | 4,901.6| 1,917.5|
| 4  | Mixed Garden               | 13,767.2| 7,539.7|
| 5  | Forest                     | 40,879.5| 29,375.7|
| 6  | Paddy Field                | 5,897.3| 1,997.5|
| 7  | River and Sea              | 380.0  | 380.0  |
|    | **Total**                  | **69,496.0**| **69,496.0**|

Source: Result of GIS Matrix Analysis of Landsat TM+5 (1985) and ETM+7 (2011) using ERDAS 9.2 (2013)

An increase of CO₂ concentration in Padang was generated due to conversion of large area of forest into developed area. This conditions also supported by shrub and garden which converted into developed area due to the urgent needs of community settlements and public facilities. Carbon stock from forest land, shrub
and garden have removed and emitted as CO₂. The increasing trend of N₂O and NH₄ concentration due to paddy field, fish pond and husbandry farms converted into developed area (Figure 2).

The increasing trend of GHG concentration had a direct effects on the temperature and the extreme rainfall index in Padang. Trend of extreme temperature indices (TX10p) declined followed by incline of TX90p trend. This condition will make high temperature during day and night (Figure 3).

This is one of indicator that Padang already experiencing global warming. According to the IPCC [2001] that global warming is an indication of climate change has been caused by increasing greenhouse gases in the atmosphere.

The Trend of extreme rainfall occurred in Padang was characterized by an increasing of Rx5day compare to Rx1day. It has implication on high rainfall intensity in a relatively short time. The dominant developed area will have an accumulation of surface run off. The high volume of surface-run off will lead to flooding event, flash flooding and landslides [Hermon, 2009; Hermon, 2012]. The high rainfall intensity in relatively short time will caused the declining CWD trend and inclining CDD trend. These conditions will lead unstable hydrological phase in the region.

4. Conclusion

Land cover changes into developed area land especially in forests, gardens and shrubs lead into the increasing of GHG concentrations. The increasing of GHG concentration will have direct effect on global warming and climate change. It had been marked that higher temperatures during the day and night and trends of extreme rainfall where high rainfall intensity in relatively short time.

Figure 2. Trend of GHG Concentration Changes in Padang
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