# Mangrove Loss Drives Global Warming

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Abstract: Mangroves distributed along tropical and sub-tropical tidal coast areas and most of them grow in Indonesia coastal areas. However, Indonesia contributed as highest level of the mangroves loss and degradation. This paper discussed the impact of mangrove degradation and lost on global warming and livelihoods. Degrading and losing of mangroves caused increasing atmospheric greenhouse gases (GHGs), mainly carbon dioxide and methane and Southeast Asia was responsible for more than half of the emission. Conserving mangroves could be more economically, socially and ecologically beneficial, both regional and global. Therefore, mainstreaming mangrove in coastal development should be implemented properly.

## 1 INTRODUCTION

Global warming as one of the climate change impacts, triggered mainly by an increased in the atmospheric greenhouse gases (GHGs), is one of the major environmental issues globally (Rosentreter et al., 2018) in recent decades. In addition to energy and transportation sector activities, land use activities, such as agriculture, forestry and other (AFOLU) generate GHGs (Crutzen et al., 2016) by released carbon dioxide ($CO_2$) and methane ($CH_4$) that is significant impact to global warming. Therefore, the management of AFOLU that is environmentally friendly is one of the keys in mitigating climate change as well as global warming.

Mangroves are one of the most productive ecosystems, globally (Alongi, 2012) and recorded as higher carbon storage compared than terrestrial forests (Donato et al., 2011, Murdiyarso et al., 2015). It means mangroves have important role in mitigating global warming as sink of carbon storage, however, emissions occurred even worse by mangroves loss and degradation. Therefore, global and local effective actions should be done to realize well management of mangroves as part of climate change mitigation.

Due to easy access and high value of mangrove uses (biodiversity and land), it has made mangrove resources that are highly threatened (Valiela et al., 2001, Onrizal, 2013). However, mangrove conversion continues to increase to become agricultural land or fish/shrimp ponds (Valiela et al, 2001, Ilman et al., 2016, Thomas et al., 2017) has caused degradation of ecosystem productivity (Cunha-Lignon et al., 2011, Satyanarayana et al., 2012, Atwood et al., 2017).

Degradation of mangroves on the east coast of Langkat, North Sumatra has caused the Island of Tapak Kuda to disappear (Onrizal and Kusmana, 2008, Onrizal, 2010). Therefore, the degradation and loss of mangroves is very detrimental both ecologically and socio-economically, from local to regional and global scale. This paper mostly asessed and discussed the impact of mangrove loss on GHG emissions, mainly $CO_2$ and $CH_4$ based on relevant publication in recent years.

## 2 MATERIALS AND METHODS

Peer-reviewed of global mangrove inventory from 1980 until recent years (FAO, 2007, Giri et al., 2011, Hamilton and Casey, 2016) was compiled to know the mangrove forests area change. Subsequently, publications on capacity of mangroves in storing carbon (Donato et al., 2011, Murdiyarso et al., 2015, Alongi, 2014) as well as $CO_2$ (Murdiyarso et al., 2015) and $CH_4$ (Rosentreter et al., 2018) emissions driven by mangroves loss were used to calculate the global $CO_2$ and $CH_4$ emissions by declining world mangrove forests.



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# 3 RESULTS AND DISCUSSION

## 3.1 Change of Mangrove Forests

Mangroves distribute in tropical and subtropical coastal (Thomas et al, 2017) and their global distribution has been control by climatic factors (Osland et al., 2017a, 2017b). During 1980-2014 periods, almost 30% of world mangrove forests were loss (Figure 1). The highest mangrove loss rate was occurred between 1900-2000 periods with 2,947.3 km$^2$ per year, followed by 1980-2000 periods (1,869 km$^2$ per year) and the lowest rate was in period of 2000-2014 (560.4 km$^2$ per year). Most of the mangrove forests were converted to fishponds and plantations.

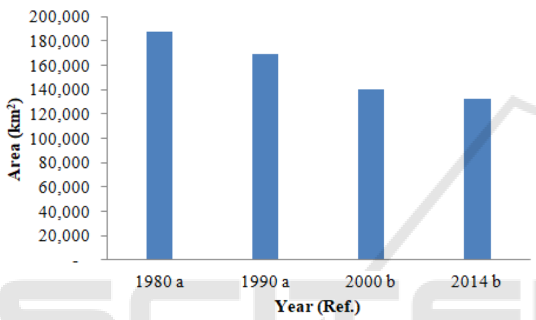


Figure 1: World mangrove area from 1980 until 2014. Ref: a (FAO, 2007), b (Giri et al., 2011).

Half of the global mangroves grow in Southeast Asia and Indonesia has widest mangrove forests in world (Hamilton and Casey, 2016). In 2000, Indonesia has circa 33.37% of world mangrove forests (139,777 km$^2$) and the proportion of Indonesian mangrove has relatively decreased in 2014, i.e. 32.05% of 131,931 km$^2$ of world mangrove forests (Hamilton and Casey, 2016). It means Southeast Asia and mainly Indonesia were very important for sustaining mangroves, globally.

Indonesia and Malaysia in Southeast Asia and Brazil in Latin America were recorded as highest mangrove area loss in period of 2000-2014, respectively (Figure 2a). In the period, Indonesia has loss of 4,364 km$^2$, followed by Malaysia (1,112 km$^2$) and Brazil (881 km$^2$). Subsequently, the highest rates of mangrove area loss in the same period were Malaysia (0.92%), Myanmar (0.72%) and Thailand (0.70%) as shown at Figure 2b. In this case, Southeast Asia and others of top ten of mangrove area loss in the world should be more aware and need to provide well manage of their mangrove.

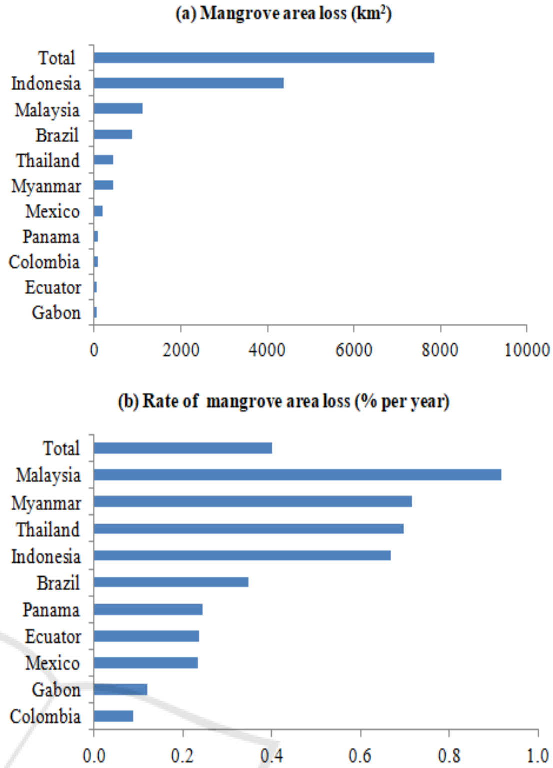


Figure 2: Top ten of mangrove area loss in period of 2000-2014 (a) and rate of mangrove area loss in the period (b).

## 3.2 $CO_2$ and $CH_4$ Emissions

According to Hamilton and Casey (2016), almost 7,846 km$^2$ of mangroves was loss in period 2000-2014, resulting emission of 85.78-344.26 Tg C or 314.82-1,263.43 Tg $CO_2$ with an average of 789.13 Tg $CO_2$ (Figure 3a) from mangrove soil as impact of mangrove area change in the period. Subsequently, the $CH_4$ emission ranged of 62.96-252.69 Tg $CH_4$ with an average of 157.83 Tg $CH_4$ (Figure 3b). This is significant contribution of mangrove loss in increasing atmospheric-GHGs as well as driving the climate change.

Indonesia mangrove alone contributed around 55% of the emission, followed by Malaysia (14.3%) and Brazil (11.2%). This estimate is mostly consistent with Danoto et al. (2011) and Murdiyarso et al. (2015) for $CO_2$ emission and Rosentreter et al. (Rosentreter et al., 2018) for $CH_4$ emission and higher than Duarte et al. (2005). Therefore, Indonesia should inhabit the rate of mangrove loss and degradation as well as preserving the good stand of mangrove forests.

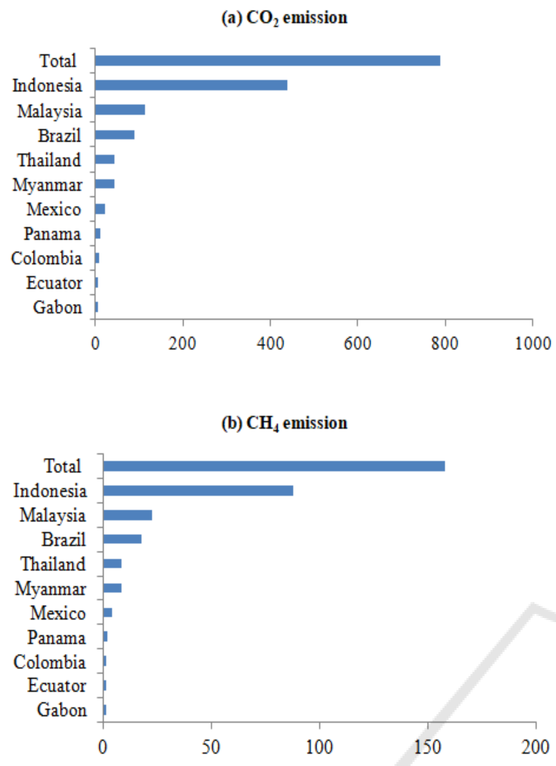


Figure 3: Top ten of GHGs emitted by country due to mangrove loss in period 2000-2014, carbon dioxide (Tg $CO_2$) (a) and methane (Tg $CH_4$) (b).

## 4 CONCLUSIONS AND RECOMMENDATIONS

Mangrove loss caused increasing GHG significantly, such as $CO_2$ and $CH_4$ and contributed to global warming as well as climate change. Southeast Asia and Latin America accounted high store of carbon storage, however, they also high responsible for GHG emission due to high mangrove forests lost in the region. According to Ilman et al. (2016) and Richards et al. (Richards & Friess, 2016), the expansion will still be the major driver of mangroves conversion in the next two decades, along with the palm oil plantation development. In country level, Indonesia must do extra work to manage mangrove forests to be better and then reducing the mangrove forest loss as well as restoring the degraded mangrove forests. To achieve this goal, the policy and action based on scientific evidence are required.

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