

# Climate Change Impacts on Indonesian National Parks

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## Abstract

Indonesia is the third largest tropical forest country. There are about 125 million Ha of total Indonesian forests, in which 27 million Ha are conservation areas. Besides conserving species and ecosystem, national parks are also natural solutions for climate change problem. Despite its vital roles in mitigating climate change, national parks are affected by climate change. Changing in climate alters forest composition and structure, scenic beauty, cultural heritage, biodiversity, and ecosystem services. These impacts eventually could harm tourism, and national park development. National park is an interesting landscape to study climate change. It is a nature conservation area, has native ecosystem, managed using zoning system and mainly used for research, education, and nature tourism. Many of the national parks are protected from urbanization, timber harvesting, grazing, and other non-climate factors. Therefore, it can be said that human is one of the main causes of climate change. Taking into account the nature of national parks and inevitable impact of climate change, research needs to be done to assess how climate change affects national parks. Using literature review, this paper will explore to what extent the research on impacts of climate change in Indonesia national parks has been done and provide information regarding existing mitigation and adaptation actions.

**Keywords:** climate change, Indonesia, national park, tourism, adaptation, mitigation.

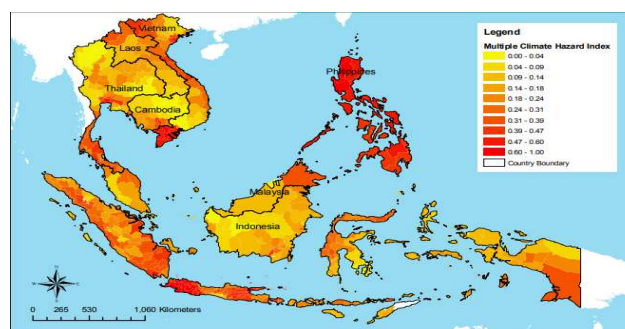
## Introduction

### Climate Change in Indonesia

Intergovernmental Panel on Climate Change summarized that changes in the atmospheric abundance of greenhouse gases and aerosols has altered energy balance of the climate system. It has increased surface temperatures, water vapour, and global ocean temperature. It also has reduced mountain glaciers and snow cover, and intensified drought. Greenhouse gases consist of aerosol ( $H_2O$ ), carbon dioxide ( $CO_2$ ), methane ( $CH_4$ ), nitrous oxide ( $N_2O$ ), and ozone ( $O_3$ ), are considered as the most important anthropogenic greenhouse gases (IPCC, 2007). These gases come from different sector such as energy, industry, agriculture, waste, land use, land-use change, and forestry (LULUCF). In general, Indonesian forestry sector (LULUCF, and Peat Fire) are the largest Green House Gases emitter and they contribute more than half (55 %) of Indonesia total emission. This high emission quantity from land use change and deforestation makes Indonesia become the top three GHG emitter in the world (World Bank, 2007). The other sectors which contribute for the emission are energy (32 %), Industrial process and product use (2 %), agriculture (6 %), and waste (5 %). Indonesia total Green House Gas Emission (Gg  $CO_2e$ )

is 1,808,305 (Ministry of Environment and Forestry Indonesia, 2017).

With a staggering 80,000 km of coastal line and 17,508 islands together with extremely high levels of biodiversity and high population density, Indonesia becomes of the most vulnerable countries to the impacts of climate change (Case, 2007). Figure 1 clearly describes that most Indonesia areas have high level of multiple climate hazard (drought, floods, landslides, sea-level rise) where Java island, Sumatera, North Sulawesi, and Papua are at the highest level.



**Figure 1.** Level of multiple climate hazard. (Sources: Yusuf and Franciso, 2009)

It is projected that Indonesia mean temperature will increase by 0.2-0.3° C, precipitation will increase, precipitation seasonality will change, and a 30-day delay in annual monsoon (GFDRR, 2011). This shifting will affect water availability, sea level, biodiversity, ecosystem services, and human health. Climate change impacts in Indonesia are evident of the severe impact of climate change and it even could be worsened in the future due to anthropogenic climate change. Research done by Case (2007) summarized some climate change impacts in Indonesia (table 1).

**Table 1.** Climate change impact in Indonesia.

No	Aspects	Impacts
1	Water availability	<ul style="list-style-type: none"> <li>Decrease rainfall affect agricultural production, economic development, hinder poverty alleviation, and food security programs</li> <li>Increase rainfall brings flood</li> <li>Stronger and more frequents El Niño will worsen drying and/or flooding</li> <li>Delayed monsoon could reduce rice production</li> </ul>
2	Sea level rise	<ul style="list-style-type: none"> <li>Asia sea level has increased 1-3 mm/year and will be worse in the upcoming years</li> <li>Number of population who are affected by flood increase from 13 million to 94 million</li> <li>Sea level rise negatively impact aquaculture and coastal infrastructure</li> </ul>
3	Biodiversity and ecosystem service	<ul style="list-style-type: none"> <li>Almost half of the Asia's biodiversity is threaten</li> <li>88 % of coral reefs in Asia will loss</li> <li>Fish habit will change, fish regeneration will decline</li> <li>Massive coral bleaching lead to coral reefs and biodiversity loss</li> <li>Sea turtle will be affected by sea level and temperature rise</li> <li>Forest fire will negatively affect wildlife habitat and biodiversity</li> </ul>
4	Human health	<ul style="list-style-type: none"> <li>Injury, illness, and death increase due to heat waves, and other climatic change</li> <li>Water-borne diseases, infectious disease, respiratory problem and vector-borne diseases increase</li> <li>This situation could increase mortality</li> </ul>

Source: Case, 2007

## Indonesian National Park: The Last Home of Forest and Biodiversity

Indonesia is the third largest area of tropical forest and impressive biodiversity is mostly contained in those forests (Josef Leitmann et al. 2009). According to Convention on Biological Diversity, Indonesia is home of 10 % of world's flowering plants, 12 % of world's mammals, 16 % of the world's reptiles, and 17 % of world's total species. For this reason, Indonesia belongs to one of the 17 "megadiversity countries". There are about 120 million Ha of total Indonesian forest that can be divided into four main groups, those are production, conversion, protection, and conservation. However, one third of the production forest, and half of the conversion forest were deforested. Protection and conservation are the only categories that remain sustain by 2000 (Leitmann et al. 2009). Therefore, their existence must be preserved to maintain biodiversity.

Indonesian national parks comprise of upland, lowland, coastal, mangroves, swamp, savanna, evergreen forest, mountain range, and aquatic ecosystem. They have unique ecosystem and magnificent scenery that attract tourists to come. In 2016, Indonesia national parks were visited by 2,961,331 visitors (domestic and international tourists) (Directorate General of Ecosystem and Natural Resources Conservation, 2017). Besides conserving species and ecosystem, sustaining development, protected/conservation forests are also "natural solutions" in helping communities to cope with climate change problem (IUCN 2016).

In 2016, Indonesia has 556 conservation area with the total area of 27.257.128,20 ha. This conservation area consists of 54 national parks (Taman Nasional), 118 nature recreation parks (Taman Wisata Alam), 28 Grand Forest Park (TAHURA), 72 wildlife sanctuary (Taman Suaka Margasatwa), 219 strict nature reserves (Cagar Alam), game hunting parks (Taman Buru), and 54 are sanctuary reserves-nature conservation area (KSAs-KPAs). There are six national parks appointed as Ramsar site, nine parks as Biosphere Reserves, six parks are World Heritage Sites, and four parks are ASEAN Heritage Parks (Directorate General of Ecosystem and Natural Resources Conservation, 2017). This international acknowledgement symbolizes the importance of the parks and its protection.

Despite its vital roles in mitigating climate change, forests including national parks are affected by climate change (Purnomo, 2011). Changing in climate alter forest composition and structure, relieve biodiversity and reduce ecosystem services (GFDRR, 2011). It also alters scenic beauty, cultural heritage, and national park experience. Rises of 1,5°C temperature will cause the extinction of 20-30 % of flora and fauna, and rises of 3°C temperature will cause the extinction

of 40-70 % of species (House of Representatives of the Republic of Indonesia, 2011). Increasing of CO<sub>2</sub> and sea temperature threaten coral reefs. Rise of sea level may affect sea turtle, and mangrove forest conservation (UNESCO, 2007).

### Impact of Climate Change on National Parks

In terms of climate change, national park is an interesting landscape to study. It is a nature conservation area which has native ecosystem, managed using zoning system and mainly used for research, education, and nature tourism (Harjadi, 2016). Many of the national parks are protected from urbanization, timber harvesting, grazing and other nonclimate factors. Therefore, it is also easier to tell if human is the main cause of climate changes and reducing carbon pollution is the solution to protect the future of the national parks (Gonzales, 2016). Seddon et al (2016) also concluded that forest is one of the most vulnerable ecosystems in facing climate change. Taking into account the nature of national parks and inevitable impact of climate change, research needs to be done to assess how climate change affect national parks.

Researches on climate change impacts on national park have been done in U.S. Some results have shown severe impact of climate change on national park. For example, trees are dying across Yosemite and Yellowstone national parks, melting of glacier in Glacier Bay National Park, heating ocean temperature in Channel Islands National Park, shifting of subalpine forest subslope into subalpine meadows, shifting of wildlife in Yosemite and Shenandoah National Park, increasing of wildfire and tree mortality in Sequoia and Yosemite National Parks, and bleaching of corals in Virgin Islands National Park. These conditions are mainly caused by human activities (Gonzales, 2016).

Markham et al (2016) released a publication about World Heritage and Tourism in a Changing Climate. Some of the world heritage sites discussed on the paper were national parks, for example: Bwindi Impenetrable National Park in Uganda, Lake Malawi National Park in Malawi, Komodo National Park, in Indonesia, Sagarmatha National Park in Nepal, Yellowstone National Park and Mesa Verde National Park in United States of America, Huascarán National Park and Rapa Nui National Park (Easter Island) in Peru. This report noted that climate change is on the most significant risk for World Heritage sites and its impact could harm all of these iconic places. In addition, it could alter tourism development, one of the world's largest and fastest-growing economic sectors, which contributed 9 percent of global gross domestic product.

Impact of climate change is different among continents, countries, and regions. It is also different

between individual and group (EPA, 2017). Therefore, impact measurement must be done at specific area.

**Table 2.** Existing research on climate change impact on National Park.

No	Locations	Key Information	Sources
1	Ujung Kulon National Park	Participatory approaches can be used to assess Indonesia Javan rhino National Park vulnerability to climate change	Purnomo, 2011
2	Komodo National Park	<ul style="list-style-type: none"> <li>▪ Increase in rainfall could alter breeding areas and vegetation</li> <li>▪ Ocean acidification and warming temperatures damage coral reef and sea level risk mangrove ecosystem</li> </ul>	Markham et al. 2016
3	Baluran National Park	Calculating vulnerability of an ecosystem can be done by calculating Constant Vulnerability (CV), and Dynamic Vulnerability (DV).	Harjadi, 2016
4	Kayan Mentarang National Park	Climate Change alters fruit trees phenology which affect orangutan population	Wulffraat, Tatenkeng, and Salo, 2006 in Case, 2007 Suhud & Saleh, 2007
5	Tanjung Puting National Park	Burned peat swamp increase tree mortality	Yeager et al, 2003
6	Bukit Barisan Selatan	Phenological pattern of flowering of Dipterocarpaceae in the park was correlated with maximum temperature which tended to increase during 15 years	Winarni et al., 2016
7	Sebangau National Park	Climate change will have an impact on orangutan conservation in Sebangau National	Suhud dan Saleh, 2007

Table two above summarizes existing researches on climate change impact on Indonesia national park. It can be seen that only very few study relate climate change and national park. Most of the studies were done in Kalimantan Island (Kayan Mentarang, Tanjung Putting, and Sebangau National Park). The island is one of the world's most diverse rain forest and the largest remaining tropical forest in Indonesia. The other national parks such as Bukit Barisan Selatan, Ujung Kulon, and Komodo National Park belong to World Heritage Sites. According to Yusuf and Franciso (2009), one of the most multiple climate level hazards is northern Sulawesi. Despite this area has one aquatic national park, Bunaken National Park, data on climate change impact on these regions could not be found.

### **Adaptation and Mitigation Program**

Indonesia actively develops program and policies to combat climate change. Indonesia commits to reduce 26 percent and 41 percent (with international support) of its GHGs by 2020 compared to a business-as-usual (BAU) scenario. Presidential Regulation (PERPRES) No.61/2011 on National Action Plan to Reduce Greenhouse Gas Emissions regulates this target. This target also has been incorporated with The National Medium-Term Development Plan for 2015–2019 (RPJMN 2015-2019) that established GHG emissions reduction will be done in five priority sectors (forestry and peat lands, agriculture, energy and transportation, industry, and waste). The plan has two target for forestry, land and forest restoration and social forestry target. The others national policies which regulate climate change mitigation are Presidential Decree No 16 Year 2015 on Ministry of Environment and Forestry (MoEF) about incorporation of National Council of Climate Change and National REDD+ Agency under Directorate General of Climate Change within the MoEF; Presidential Instruction No. 6 Year 2017 on Forest Moratorium; Presidential Regulation No. 1 Year 2016 on Peat Restoration Agency; Government Regulation No.79 Year 2014 on National Energy Policy (Wijaya et al, 2017). Indonesia also has established Indonesia Climate Change Trust Fund (ICTF), Indonesia Adaptation Strategy, Indonesia Climate Change Sectoral Roadmap (ICCSR). ICCSR contains mitigation and adaptation strategies of difference sectors (agriculture, forestry, energy, marine and fisheries, water, health, transportation, Industry, and waste). Mitigation in forestry sector aims to support Sustainable Forest Management and emission reduction from forestry sector. The key mitigation measures are Sink enhancement, and Emission reduction with three key field activities: plantations for rehabilitation, plantations for wood production (HTI or HTR), and development of forest management units (KPHs) (Republic of Indonesia, 2009).

In addition, Indonesian Government published National Action Plan on Climate Change (RAN-PI), which contains the initial guidance and multi-sector coordination effort to address mitigation and adaptation to climate change. The implementation of this action is supported by 18 regulations. There are five sectors included in the action plan, namely economic resilience, life system resilience, ecosystem resilience, special area resilience, and support system. Conservation areas (national parks, wildlife sanctuaries, hunting parks and nature reserves) become one of the priority ecosystems where action plans aimed at ensuring conflict and pressure on the area. However, despite Indonesia has many good policies and legislation, its implementation and enforcement are weak (PEACE, 2007).

Tabel 3 shows adaptation and mitigation strategy done at several national parks. It can be seen that very few data described role of national parks in mitigating climate change at national park level. This is might be caused by uncertainty about climate vulnerability and forests. Tropical forests have a small role in adaptation strategies, even in most National Adaptation Action Programs (Locatelli et al., 2009). In addition, Ministry of Tourism and Creative Economy Industry Republic of Indonesia has developed Destination Management Organization (DMO) at several national parks to ensure sustainability of tourism development. In Tanjung Putting National Park, DMO supports conservation efforts, applies and monitors Green and Fair criteria in ecotourism development. Furthermore, in Komodo National Park DMO conducts coaching and training related to conservation, and waste management. Some local governments in Indonesia have initiatives such as Bali Green Province – BGP, and Aceh Green which are climate resilience actions. There is also Tree Adoption Program which is joint venture initiatives between Green Radio and Gunung Gede National Park (Nirwandar, 2013).

Study on climate change adaptation on national park has been done in U.S. From the study it can be concluded that institutional aspect such as unclear mandates from superiors and bureaucratic rules and procedures had greater barriers in climate change adaptati (Jantarasami et al., 2010). Another study done in industry showed that there were several aspects which hinder climate change adaptation such as lacking of knowledge and uncertainty about future impacts of climate change; lacking of qualified human resources and economic benefit; lacking of inspiration by good practices; managerial and institutional problems (Meinel and Höferl, 2017). Ampaire et la. (2017) stated that policies, lack of coordination among from central and local government, technical and financial shortage, and political interference hamper climate change adaptation.

**Tabel 3.** Existing adaptation and mitigation done at National Park level.

Location	Name of the program	Highlight	Source
Bali Barat National Park	"Friends of the Reef"	"strengthening the livelihoods of coastal Communities"	Case 2007 Bali Barat Climate Chang
Bukit Duabelas National Park in Jambi and in Tesso Nilo National Park in Riau	REDD +	"Improved management of land-related conflicts"	Ministry of Environment and Forestry Indonesia, 2015
Bukit Tigapuluh	Environmental education for Bukit Tigapuluh	"Minimize conflicts between people and wild animals in the national park's Buffer zone and to de-stress and improve their co-existence"	BFN, 2011
Meru Betiri National Park	Community Based-Medicine Plantation Conservation	"Rehabilitating critical land in the buffer zone of the Park using medicinal plant agroforestry"	Suyanto et al., 2005
Gunung Leuser, Kerinci-Seblat and Barisan Selatan, and Ujung Kulon National Park	WWF's Asian Rhino and Elephant Action Strategy (AREAS)	<ul style="list-style-type: none"> <li>▪ "Conducted community-based initiatives, environmental education and environmentally sound ecotourism with benefits to local inhabitants in Kerinci Seblat National Park"</li> <li>▪ "Reduced encroachment through designation areas for conservation, agriculture and resource extraction, and the introduction of alternative sources of income for people in Ujung Kulon National Park"</li> </ul>	Suyanto et al., 2005
Berbak National Park (Jambi Province), Sembilang National Park	Community-based peatland management	"promote the sustainable management of peatland in Indonesia in order to increase its forest functions to sequester and store carbon"	Suyanto et al., 2005
Komodo National Park	Komodo National Park Collaborative Management Initiative"	"encourage local communities to switch from the current destructive fishing practices to sustainable livelihoods based on the rational use of park resources"	Suyanto et al., 2005
Gunung Halimun National Park	"Community Based Ecotourism Package in Gunung Halimun National Park	"Share ecotourism revenue from ecotourism was collected and is channelled back to local communities through community development and conservation funds"	Suyanto et al., 2005
Sebangau National Park	Kalimantan Forests And Climate Partnership (Kfcp)	peatland rehabilitation	Australia Indonesia Partnership, 2009

## Conclusion

Researches revealed negative impacts of climate change and some examples of adaptation and mitigation actions. Indonesia still lack of data regarding climate change and national park. Therefore, study

needs to be done to avoid more severe impact. Existing adaptation and mitigation can be used as a role model for the other national parks. In general, Indonesia has adequate regulation on climate change. Challenges are more on its implementation and enforcement. Limitation of this research is mainly from

data. As research is done using existing studies that are available online, some necessary information might not be accommodated in this research.

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