Challenges on Peatland Restoration: From Oil Palm Plantation to Sustainable Peatland Ecosystem

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Keywords: Industry, Oil palm, Peatland, Sustainable development.

Abstract: Use of peatland for commercial estate crops such as oil palm triggers peatland fires, increases carbon emission, subsidences, and land-use conflicts. Oil palm expansion on peatland areas has been claimed to be a major cause of peatland ecosystem degradation. Massive damage on peatland ecosystem has motivated government of Indonesia to issue regulations and establish Peatland Restoration Agency. However, regulations which were created by different government institutions were not synchronized each other and often creates new problem. Development of sustainable peathydrological unitencounteroil palm industry which was claimed to have important contribution to the economy of Indonesia. Balancing economic growth and sustainable natural resource is the most challenging issues faced by nation-wide. The objective of this study is to assess prospects and challenges of peatland restoration in relation with palm oil industry. The study uses literatures and data from previous studies and documents from related institutions. The result shows that palm oilindustry which occupied large area of peatland is the most vulnerable and challenging sector in the present of peatland regulations. Development of oil palm plantation is a huge investment. Therefore, stopping oil palm plantation in peatland area will have impacts on oil palm investment, farmers' income, and people welfares. Collaboration amongst stakeholders together with establishing strategy and action plan are necessary to ensure the implementation of sustainable peatland ecosystem.

1 INTRODUCTION

Oil palm plantation area in Indonesia has achieved11,4 million hectares and produce 31 million ton of Crude Palm Oil (CPO). Indonesia has become world largest palm oil supplier which account for 52% of total world supply of CPO. Increasing demand for CPO in the last two decades has motivated investors and local people to develop new oil palm plantations. At the beginning, oil palm plantations have been expanded only in mineral soil.However, since mineral soil has become scarce, new plantations have been expanded to peat soilarea which isnot recommended for oil palm trees.

Oil palm expansion in peatland areas has been implemented by creating canals to reduce water level to improve soil condition for oil palm cultivation. It is often that land clearing has been done using fire (Simorangkir, 2007).Dry peatland is easy to burn but difficult to control since it contains high carbon. The fire in peatland could burn and create haze in long duration.

The worst of haze in Indonesia was recorded in the late 1990s, 2014 and 2015 which affected not only in Indonesia areas but also had negative impacts to some neighbouring countries such as Singapore, Malaysia and Brunei Darussalam. The haze had asignificant effects on people activities including health, education, and economic activities.

Use of peatland for oil palm plantation has been claimed to deteriorate peatland ecosystem in low land areas and threaten local people (Colchester, 2007; Kohne, 2014), deterioration of biodiversity (Edwards *et al*, 2011; Koh*et al*, 2008), and global climate change (Carlson and Curran, 2013).

It is crucial to increase water level in peatland area to rise humidity and to prevent fire by establishing canal blockings. Degraded peatland should be recovered by replanting peatland with its indigenous vegetation to improve peatland ecosystem. The Government of Indonesia has established The Peatland Restoration Agency (Badan Restorasi Gambut/ BRG) to find solution and recovering peatland ecosystem through hydrological and vegetation interventions.

Hutbarat, S.
Challenges on Peatland Restoration: From Oil Palm Plantation to Sustainable Peatland Ecosystem.
DOI: 10.5220/0009905400002480
In *Proceedings of the International Conference on Natural Resources and Sustainable Development (ICNRSD 2018)*, pages 512-520
ISBN: 978-989-758-543-2

Hydrological intervention was recommended to recover soil humidity by rewetting peat soil through canal blocking in the canals which were used as drainage system previously. Vegetation intervention was propositioned to restore peatland ecosystem by replanting native peatland vegetation.

Peatland restoration is the implementation of laws and regulations established by Government of Indonesia to restore peatland ecosystem. However, the regulations were claimed to threat existing oil palm plantations and other industries.The requirement to meet less than 3 (three) meters depth of peatland and less than 0.4 meter of water level have been the major issues. These peatland regulations could potentially stop the operation of oil palm business in most of plantation in peatland.

The objective of this study is to analyse the application of peatland regulations by the BRG to reduce peatland degradation and restore its ecosystem. Oil palm plantations have been expanded to peatland areas since 1980s. Do the plantations have to stop their business in peatland areas? Could oil palm plantations be operated with acceptable strategies to avoid peatland degradation?

2 METHOD

This study analyse issues of peatland use for oil palm plantations and peatland restoration program in Riau Province. The study was conducted by exercising qualitative and quantitative analysis and literature review using data available from previous studies, regulations and report documents at local government agencies such as Estate Crop Agency, Forestry Agency, Environmental Agency, and National Landuse Agency.

3 RESULT AND DISCUSSION

3.1 Oil Palm Plantation Development

Oil palm is one of Indonesian estate crops that has been massively expanded compared to other estate crops (World Bank & IFC, 2010b). CPO is an essential material used in various industries including food, non-food and biodiesel (May-Tobin *et al*, 2012). Palm oil is preferable because its availability and lower price compared to other vegetable oils (Teoh, 2012; Manggabarani, 2009).

Oil palm was introduced to Indonesia and planted at Buitenzorg Botanic Garden (Kebun Raya Bogor) in 1848 (Corley *et al,* 2004). Two seedling were from 'Bourbon or Mauritius' and the other two were from Amsterdam Botanical Garden (Gerritsma and Wessel, 1997). At the beginning, oil palm trees were introduced as decorative plants (Pamin, 1998). Oil palm has been planted as commercial plantation in Pulau Raja, Asahan, Sumatera Utara dan di Sungai Liput, Aceh since 1911 (Corley *et al,* 2004). However, oil palm plantations and industries have not developed significantly until 1960s because of power transition and political stability which was not conducive for plantation investment (Pahan, 2012).

The Government of Indonesia started to develop palm oil industry in late 1960s by establishing Government Estate Enterprises (Perkebunan Besar Negara/PBN) i.e., Perusahaan Negara Perkebunan (PNP)/Perseroan Terbatas Perkebunan (PTP) in 1969 [15,16]. The establishment of PNP was funded by The World Bank and The Asian Development Bank. Oil palm plantation areas in Indonesia was 131.298 ha in 1971 consisted of 84.640 ha Government Estate Enterprises (PBN) and 46.658 ha Private Estate Enterprises (Perkebunan Besar Swasta/PBS).

The development of estate crop industries was started from large-scale estate companies. However, the objective was not only for commercial objective but also to support the development of smallholder plantations to prepare farmersbecome oil palm planters. PNP/PTP was established to be enterprises that play a role as a nucleus estate which support smallholders plantation called 'kebun plasma' (Manggabarani, 2010). Two plantation models were developed in 1973 i.e., Project Implementation Unit (Pola Unit PelaksanaProyek/UPP) and Nucleus-Estate Smallholder (NES) or Perusahaan Inti Rakyat (PIR). PIR model was started in 1978 through NES I to NES VII projects. PIR was supported by Government Estate Enterprises and financed by the World Bank. In 1980, the oil palm areas achieved 294.560 ha consisted of 6.175 ha the plasma (smallholder plantations), 199.538 ha PBN and 88.847 ha PBS.

The PIR Project was developed with PIR TRANS Program in 1986 which was financed by National Domestic Banks.Then, PIR KKPA (KoperasiKredit Primer Anggota) or Credit Union for Member's Primaries, a type of scheme smallholders in Indonesia was launched which was financed by Cooperative Scheme. In the period of 1970-1990 the development of oil palm smallholders was dominated by the PIR models. In this period, PIR plantations have achieved 215.140 ha, i.e.

62.530 ha nucleus estates and 152.610 ha the plasma plantations (Manggabarani, 2009).

The PIR Project had succeeded to increase livelihood of farmers and the welfare of rural community. Farmers' income from oil palm plantation is on average higher than other estate crops. This condition triggered local people around the plasma to start cultivate oil palm tree in their owned land without any support from any party. The smallholders was later called "Independent Oil Palm Smallholders" (perkebunan kelapa sawit swadaya) (Rahadian, 2013).

In the beginning, the palm fruits from independent smallholders were sold to the nearest mills where their owned plantation production was still below the mill's capacity. Following rapid demand for palm oil, the investors responded by establishing new mills to meet the market demand. Larger capacity of new mills increased demand for FFB. Simultaneously, higher price of FFB has been responded by smallholders by expanding their oil palm plantation. Land expansion is a simple method when farmers have little information and knowledge about oil palm culture. Local farmers do not have awareness on efficient use of production factors. In period 1990-2000, smallholder plantation areas have increased fivefold to 1.166.758 ha. The oil palm areas continues to rise by threefold in 2000-2010. Independent oil palm smallholders have the highest contribution in the oil palm expansion areas after 1990.

3.2 Oil Palm Productivity

In general, independent smallholders have less knowledge on oil palm practices. Farmers use low quality of plant materials because of little information, knowledge, and less access to good seedling. These conditions have significant impact on oil palm productionparticularly for independent smallholders which is on average less than the plasma. Independent smallholders production ranging from 10 to 14 ton FFB/ha/year whereas scheme smallholders ranging from 16 to 22 ton FFB/ha/year. According to Molenaar*et al.*(2010) productivity of oil palm smallholder in Indonesia ranging 9-24 ton FFB/ha/year while in Malaysia 14-19 ton FFB/ha/year. Lee *et al* (2013) found that independent oil palm smallholder production for age 5-9 years in Sumatra was on average 14.8 ton FFB/ha/year compared to 17.8 ton FFB/ha/year for scheme smallholders. For palm age 9-17 years, independent smallholders productivity was 15.9 ton FFB/ha/year while scheme smallholders achieved 22.1 ton FFB/ha/year. Lack of knowledge on palm culture was identified as the main constraint for good agricultural practices. However, Molenaar *et al* (2010) found that low access to information, input, finance, and market could also be critical constraints for smallholders to improve farm management and production.

3.3 Positive Impacts of Palm Oil Industry

Palm oil industry has been claimed as a leading sector that support economic growth and people welfare in Indonesia. The industry has strategic role in economic, social, and environmental aspects. Development of palm oil industry provides basic food, creates job opportunity, increases farmers' livelihood, reduces poverty, promotes economic activities in rural areas, reduces urbanization, and become one of potential exchange earnings.

In Riau Province, farmers income from oil palm achieved IDR 36.1 million per household per year in 2013 while income from coconut and rubber were IDR 20.9 and 15.7 million per household per year, respectively (Dinas Perkebunan Provinsi Riau, 2015). Palm oil export value was also the highest among the estate crops. Palm oil export was 8.6 million ton equivalent USD 6.4 billion in 2014. Estate crops contributed 51.1% of PDB in Agricultural Sector and 14.4% of the Riau PDRB in 2012 (Dinas Perkebunan Provinsi Riau, 2015).

3.4 Negative Impacts of Palm Oil Industry

Rapid demand for FFB has been responded by investors and local people through land expansion. However, development of new plantationsis often conducted without adequate legality documents such as land ownership certificate (HGU or SHM), business registration and permits (IUP or STD-B), and statement of environmental management (AMDAL or SPPL). Development of oil palm plantations has been conducted rapidly and uncontrollable. This condition has been claimed by international consumers and NGOs to be worsen by traditional agricultural practices without adequate good agricultural practices and business management to reduce negative impacts on environmental and social aspects. Some studies show the negative impacts of oil palm expansion in Indonesia such as deforestation (Casson, 2012), land degradation (Fainhurst *et al*, 2009; World Resources Institute, 1994), biodiversity loss[5,24], GHG

emission (Smith *et al*, 2007; Fainhurst *et al*, 2009; Carlson *et al*, 2013), land conversion (Susanti *et al*, 2013), land and forest fires (Rowell and Moore, 2012), food security (Ewing and Msangi, 2010), land conflicts (Colchester, 2007; Kohne, 2014) and other environmental and social issues.

3.5 Oil Palm Plantation in Riau

Oil palm plantation in Riau achieved 3 million ha in 2016 which accounted for 31.5 million tons of FFB and 6.5 million tons of CPO. Riau Province contribute more than 60% of the total oil palm areas in Indonesia. However, there are many oil palm plantations that have been operated with traditional agricultural practices and without adequate legal documents. Special committee of House of Representative in Riau Province for monitoring plantation recorded 513 oil palm enterprises operate in Riau and most of them have land certificate (HGU). However, in practice, plantation areas of the enterprises have expanded more than the permitting areas (Tanjung, 2017). This finding indicates that the oil palm plantations areas in the field are larger than what has been recorded officially by government agencies. This study found that the majority of independent smallholders did not have adequate land ownership certificate. They also do not have business registration or permit and statement of environmental management. Therefore, the area of oil palm plantations is predicted based on the production of mills.

Based on Provincial Regulation No. 10/1994 regarding Regional Spatial Planning (Rencana Tata Ruang Wilayah/RTRW) inRiau Province,areas allocated for oil palm plantation development is 3.133.398 ha (33.14%) of the total area of Riau Province (9.456.160 ha). However, the oil palm plantation has achieved 3,543,714 ha in 2013 which consisted of 2,439,750 haoil palm smallholders, 90,447 haGovernment Estate Enterprises and 1.013.517 haPrivate Estate Enterprises (Dinas Perkebunan Provinsi Riau, 2015).

Riau Province has 4.03 millions ha peatland which is about 56% of the total land in Riau where the largest peatland areas is in District of Indragiri Hilir followed by Bengkalis and Pelalawan(BKSDA Riau, 2014).The data indicates that part of oil palm plantations must be located in peatland areas.

BKSDA Riau (2014) recorded 25% of forest fires in Riau occurred in oil palm plantation areas. Silvius *et al* (2016) claimed that about 99% of land and forest fires occurred in oil palm plantation areas located in peatland. Massive haze occurred in the last two decade in Riau caused by fires in peatland areas and most of it located in oil palm areas. Negative impacts of land and forest fires have motivated Government of Indonesia to establish regulations related to the use of peatland including Minister of Environment Decree No.5/2000, Presidential Instruction No.1/2007, Minister of Agriculture Regulation No.26/2007, Government Regulation No.26/2008, Laws No.32/2009, Minister of Agriculture Regulation No.14/2009, Presidential Instruction No.10/2011, Presidential Regulation No.61/2011, Presidential Regulation No.61/2011, Presidential Regulation No.71/2011, Minister of Agriculture Regulation No.19/2011, Law No.39/2014, Government Regulation No. 71/2014 which revised by Government Regulation No. 57/2016, Minister of Agriculture Regulation No.11/2015, Government Regulation No.1/2016, Minister of Forest and Environment Regulation No.P.15/2017, P.16/2017, and P.17/2017, Minister of Forest and Environment Decree No. 129/2017 dan 130/2017.

Government Regulation No. 57/2016 which was revised from Government Regulation No. 71/2014 was published to protect and manage peatland ecosystem as a systematic and integrated effort to prevent degradation and conserve function of peatland ecosystem. Peatland ecosystem is peatland system as an integrated unit which create equilibrium, stability, and productivity.Peatland Ecosystem is Peat Hydrological Unit (Kesatuan Hidrologi Gambut/KHG) located between two rivers or between river and sea or in peat areas. KHG consists of protected and cultivated functions.

Protected function of peatland ecosystem was delimited to 30% of the KHG located in peat dome. Protected function could be larger if the depth of KHG is 3 (three) meters or more, has specific vegetation (plasma nutfah and/or endemic), endangered species, and other protected area (Figure 1). Cultivated function is area in peatland ecosystem outside protected function areas that can be used for crop cultivation.

Based on Minister of Forest and Environment Decree No. 129/2017 regarding Map of National Peatland Ecosystem, there are 59 KHGs which account for 5,067,909 ha in Riau Province where two of the KHGs are next to North Sumatera and Jambi Provinces. Minister of Forest and Environmental Decree No.130/2017 regarding Map of National Peatland Ecosystem Function determined that 2,468,058 ha (48.1%) are protected function areas and 2,658,849 ha (51.9%) are cultivated function areas.

In general, cultivated function has met the criteria regulated in the Minister of Agricultural Regulation No.14/2009 regarding Guideline on utilization of peatland for oil palm cultivation, i.e., peatland can be use for oil palm cultivation if (a) oil palm plantation located around local community and cultivated areas, (b) the depth of peatland less than 3 (three) meters, (c) substratum of mineral soil below peatland is not kuart and acid sulphate soil, (d) level of peat maturity is sapric, and (e) level of peat soil fertility is eutrophic. Cultivated areas could previously be free state-lands (tanahnegara yang telahdibebaskan) or other land use (area penggunaan lain/APL). Oil palm plantations spread must be in areas where peatland with depth less than 3 (three) meters is at least 70% of the total oil palm plantation.

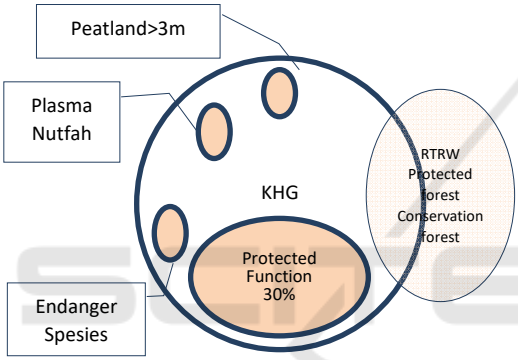

Figure 1: Protected Function of KHG.

The difference that criticized in the Government Regulation No.57/2016 is the height of water table which is regulated less than or equal to 40 cm below the surface of peatland while it is regulated 60-80 cm in Minister of Agriculture Regulation No.14/2009. High water table could be an important constraint for the root of palm tree that could cause death (Pahan, 2012; Corley *et al*, 20013). In contrast, Wawan (2017) stated that the change in physical and biological characteristics in peatland with water table 60-80 cm is still tolerable for palm tree.According to Wawan [34], peatland area in Riau with depth less or equal to 3 (three) meters is 2,667,581.1 ha (61.17%) and based on Minister of Agricultural Regulation No.14/2009, this peatland area can be used for oil palm cultivation. However, based on Government Regulation No.57/2016 this area cannot be cultivated for oil palm plantation.Even though, the area of plantation located in peatland with less than or equal to 3 (three) meters but the standard of water table less than or equal to 40 cm could be a serious problem for oil palm plantations that have been planted before the publication of Government Regulation No.57/2016.

3.6 Peatland Restoration Agency

Peatland Restoration Agency (BRG) was established in 2016 based on Government Regulation No.1/2016 to coordinate and facilitate peatland restoration in 7 (seven) provinces in Indonesia (Riau, Jambi, South Sumatera, West Kalimantan, Central Kalimantan, South Kalimantan, and Papua). The BRG functions are to coordinate and support the implementation of peatland restoration policy which includes (1) planning, mapping and zonation, (2) construction, operational and maintenance, (3) institutional capacity building, (4) socialization, monitoring and evaluation, and (5) research and development, network of research and international relations. The BRG has to prepare planning dan implementation of peatland ecosystem restoration for 5 (five) years in two million hectares which is 8% of the total area of KHG in Indonesia.

The task of BRG to implement Government Regulation No.57/2016 might be a big challenge. Peatland has been occupied by many parties particularly oil palm and pulp industries. The regulation was established to stop all activities that degrade peatland ecosystem. There are parties which do not agree with the regulation. Oil palm and pulp industriesclaimed that their industries create benefits to Indonesia including provides job opportunity, improves people livelihood, accelerates rural development, source of foreign exchange and provide basic material for food and downstream industry. Oil palm become one of leading sectors and the driver of Indonesian economy. Therefore, the role of oil palm industry in Indonesia economy is very important.In contrast, other parties claimed that there are negative impacts of oil palm activities on social and environmental issues. Palm oil cultivation in peatland has been claimed to destroy peatland ecosystem, land fires and haze which create loss to local, national and international community.

3.7 Sustainable Agriculture

Sustainable agriculture entails that all parties in the economy have to bear equal but proportional risks and benefits. The gainer should compensate the loser. The ideal equilibrium condition could be achieved if we can calculate the value of benefit and loss. If the benefit (profit) of the business (palm oil and pulp industries) cannot compensate the cost bear

by the community because of land/forest fires and loss of ecosystem services, oil palm and pulp industries that have already occupied peatland areas must be stopped and withdraw from the peatland.

The application of Government Regulation No.57/2016 have to be evaluated economically, socially, and ecologically. Study on these aspects could at least explain that the regulation has more positive impacts compared to negative impacts. There will not be loss to any party without compensation. Evaluation has also to be implemented in relation with its impact to future generation. Finally, results of the evaluation should be implemented with appropriate policies together with low enforcement.

3.8 the Opportunity of Palm Oil Industries

Currently, oil palm plantation areas are about 11,4 million ha while areas that suitable for oil palm plantations are 9.7 million ha (PPKS Marihat, 2004). These data show that about 1.7 million ha of oil palm plantation located in areas that are not suitable for oil palm tree. If oil palm production on average 18 ton FFB/ha/year, assumed the price of FFB IDR 1,000 per kg, the value of FFB in the "not suitable" land is about IDR 30.6 billion. The value might increase when there are peatland which do not meet the Government Regulation No.57/2016 in part of the suitable land. The cost of unsustainable use of peatland particularly the impact of haze yearly are IDR 221 billionloss in economy, 504,000 people have health problems, 5 million students have to stop school activities, increase GHG emission by 15.95 million ton CO2 per day, and biodiversity loss in 2.6 million ha (Askary, 2017). These informations should be evaluated to find policy alternatives that improve the welfare all parties.

3.9 Sustainable Policy Alternatives

Sustainable oil palm production can be achieved in foursteps (Figure 2). First, to stop oil palm expansion to forest and peatland area in E, F, and G.Second, withdrawing existing oil palm plantation from forest and peatland area in B, C, and D. Third, restoration in forest and peatland ecosystem in B, C, and D. Four, increase oil palm productivity in A to compensate production loss when production in B, C, and D is stopped.

First step, oil palm expansion to forest and peatland areas has to be stopped to avoid deforestation. Currently, the Government of Indonesia has established Presidential Instruction No.10/2011 and No. 6/2013 regarding Peatland and Primary Forest Management Improvement and Moratorium of New Permit.

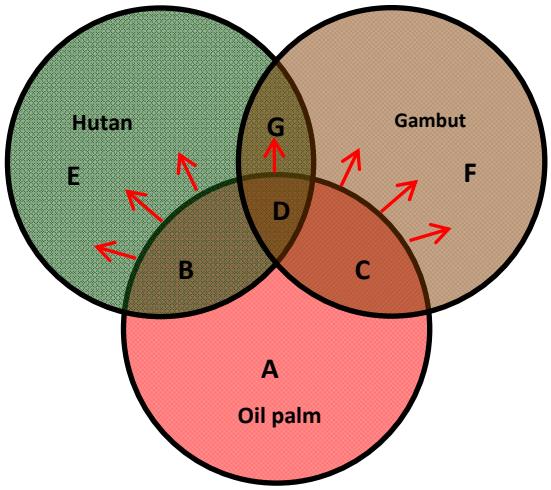

Figure 2: Sustainable Policy Alternatives.

Second steps, Government of Indonesia establishedGovernment Regulation No.57/2016 that regulate criteria of water table and depth of peatland. The regulation might be policy tool to withdraw oil palm plantation from forest and peatland areas (areas B, C dan D).

Third step, Government of Indonesia established the BRG to recover peatland ecosystem through hydrological and vegetation restoration at areas B, C and D. Activities of BRG include identify peatland ecosystem and mapping final peat hydrological unit, determine peatland ecosystem function, i.e., protected and cultivated functions, establishing peatland ecosystem management and protection plan.

Four steps, Government of Indonesia motivate improvement of oil palm productivity in area A for compensating area B, C and D that have to be quitted by oil palm plantation. This objective can be achieved by implementing *Good Agricultural Practices (GAP)* and *Best Management Practices (BMP)*.

Policy on sustainable use of peatland should be supported by stakeholders. Peatland ecosystem management and protection plan include (a) technological and information transfers to prepare migration of oil palm plantation and other activities that degraded peatland ecosystem, (b) introduce original peatland vegetation that can be commercialized, (c) rearranging and replanting original peatland vegetation, (d) improving

collaboration amongst stakeholders (gainers and losers) to implement peatland restoration, (e) improve local community capacity and use of local wisdom to manage ecosystem service, and (f) provide opportunity for oil palm plantation and related activities to move their business after planting cycle.

4 CONCLUSION

Government of Indonesia and investors claim that palm oil industry have positive impacts on economic growth and community welfare. The application of Government Regulation No.57/2016 is claimed to be a constraint for oil palm plantation in peatland areas. In contrast, environmental activist claimed that oil palm activities in peatland is the source of fires and haze that cause economic loss and reduce the welfare of community.

Peatland restoration is an effort to recover and rearrange peatland ecosystem based on peat hydrological unit. Peatland restoration is expected to reduce and to stop fire in peatland areas, recover peatland ecosystem and rearrange sustainable use of peatland.The implementation of peatland restoration should involve related stakeholders to use and manage peatland. All activities of restoration should be planned and implement with care and measurable to minimize lose for any party.

Lesson from peatland restoration shows that managing equilibrium between economic benefits and sustainable natural resources is a challenge faced by many countries.

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