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Peatland Policy and Management Strategy to Support Sustainable Development in Indonesia

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Abstract. The existence of peatlands plays a very important role both locally, regionally, and globally. Besides having an ecological function to maintain biodiversity and environmental balance, it also has its economic and socio-cultural functions. Furthermore, it has provided enormous benefits for life and has had positive social and economic impacts. Peat ecosystems have been damaged due to the mismanagement of land. Areas that play specific roles in its sustainability have been converted to lands for business activities, which contradicts their characteristic function. Land cover restoration policies will be useful for improving the quality of participatory-based land cover, protecting peat domes, and conserving watersheds (DAS). An increase in greenhouse gas (GHG) emissions, which occurs due to insufficient peatland management is a serious threat to local communities and their livelihoods. Furthermore, the ecosystem can be conserved by ensuring that water is properly managed, drainage to cultivated areas is limited and peat swamp forest systems are protected. The application of eco-hydro technology can be beneficial to biodiversity as it minimizes degradation, reduces carbon emissions, and prevents fires.
Keywords: Peatland, coastal areas, wetlands, SDGs

1. Introduction

The existence of peatlands plays a very important role both locally, regionally and globally. Besides having an ecological function to maintain biodiversity, store carbon, produce oxygen and manage water, it also has its economic and socio-cultural functions, which include wood production, community livelihoods, ecotourism, as well as education and research sites. Furthermore, Syahza et al. [1], stated that not only does it serve as direct life support, especially by providing areas for agricultural purposes, it also plays an ecological role in controlling flood and global climate. According to Hergoualc'h et al. [2], Indonesia's peat swamp forests provide significant benefits on a local and global scale. Meanwhile, for some local community, especially small farmers, it is a viable and sustainable livelihood option.

Peatlands, which are a rich source of carbon, are threatened by land use, fires, and various intervention policies which affect many different stakeholder groups. Peat drainage and conversion of agricultural plantations have been affected by severe peat fires, which consequently lead to significant climate, public health and economic risks [3]. The amount of carbon resources and flux exchange in forested lowland tropical peatlands shows a large gap in the global carbon cycle. Coordination is essential to reduce uncertainty in estimates of carbon sources, as it facilitates the effective management of carbon [4]. Furthermore, an undisturbed area has the potential to be a sustainable carbon sink in the future, therefore their protection is crucial [5].

The peatland's ecological function in maintaining biodiversity and environmental balance is influenced by some of its characteristics, which are acidic pH, poor nutrients, thick organic matter and always submerged in water. This results in a unique biodiversity where only flora and fauna which can adapt to such conditions are in existence. Sutikno et al. [6], stated that peatland are formed due to dense accumulation of wet plant material over a period of about a thousand years therefore, they are classified a fragile ecosystem. Furthermore, according to Dommain et al. [7], they have been recognized as a globally important carbon absorbent for a long time, and produce a global net-climate cooling effect. However, the role of tropical peatlands in the global carbon cycle is not well-understood. Taufik et al. [8], stated that degradation of land by deforestation and excessive drainage caused fires to occur more frequently, especially in El Niño years. This lead to: (i) large amounts of peat soil carbon release into the atmosphere, impacting the climate, (ii) severe air pollution, affecting human health and air traffic, and (iii) decreasing ecosystem services due of reduction in biodiversity.

Peatlands have a high diversity of flora/vegetation, with various adapted plants, but compared to tropical rainforests, their diversity of vegetation is considerably lower. However, their vegetation diversity has a higher proportion of species characteristics than dryland ecosystems in the same biogeographic zone [9]. The management strategy which aims to conserve biodiversity relies on hydrogeological and hydrographic criteria that are widely applicable and provides a tool with which to assess the degree of biodiversity.

Vegetation diversity is closely related to the formation of peatlands. Furthermore, the thicker the peat, the poorer the type of vegetation that grows on it. This is due to that, nutrients will only be supplied by rainwater. There are many community activities, especially those related to socio-economic conditions, in peatland areas. Previous related research has been conducted, among others: Raising public awareness about ecosystem services through local potential and planting various types of local trees [10]. Perceptions across scales of governance and the Indonesian peatland fires [11]. Coastal economic empowerment through the development of economic institutions [12]. Meanwhile, research related to conservation and land management has been carried out [13,14]. Furthermore, studied the function and use of peatlands in Sumatra and Kalimantan [15-21]. In addition, the impact of Plantation development on this environment was studied by Syahza et al. [22] and [23].

2. Peatland Management Strategy and Policy

2.1. Strengthening Peatland Institutional Management Strategy

Institutional problems in peat ecosystem management can be resolved by evaluating the central government authority division, which is currently not properly distributed. Furthermore, empirical coordination can be increased through the simplification of government organizational structures, the use of modern information technology and the spatial approach. For example, placing interelated institutions in one building complex, equipped with teleconferences and other sophisticated communication channels. On the other hand, coordination problem is considered to occur due to the absence of program direction from the central government. This causes each central institution to determine its own program. Moreover, this situation allows for overlapping which, reflects the lack of coordination between related agencies, including local governments. In order to overcome academic overlap, it is advisable to control the programs of government organizations, according to the constitutional mandate in the Main Performance Indicators (MPI) for each government organization. Pereira et al. [24], stated that the management of peat ecosystems is strongly influenced by stakeholders, especially in the environmental, social and economic aspects of protected areas. These stakeholders need to support government actions in preventing fire, suppression and the destruction of peatlands.

During the early stages of drying, networks of canals form, which makes the environment flamable. Furthermore, fires which occur during the dry season have caused serious damage and disruption. Therefore, a permanent solution to prevent future fires is needed to fully improve the condition and function of the ecosystem. This solution requires an appropriate and sustainable basic framework, that can be used as a clear, targeted, and comprehensive blue print by the government. Moreover, it needs to continuously pay attention to changes in natural behavior, in order to obtain permanent and measurable policies or concepts for handling and preventing land fires. Miettinen and Liew [15] stated, the peatlands degradation and development in Southeast Asia during the last two decades not only endangers the existence of peat swamp forest ecosystems, but also causes a significant rise in carbon emissions globally, and creates a constant source of carbon dioxide.

Protection and management efforts are described in regulations and policies, therefore they can be used as references in land management, in accordance with Government Regulation No. 71/2014 and PP No. 57 of 2016, where management consists of planning, utilization, control (prevention, mitigation and recovery), maintenance and supervision. In addition to technical aspects, the implementation of restoration strategies in active communities can aid the restoration of degraded lands.

Institutional factors are very important in community-based peat security. Furthermore, community involvement is important for the protection and management of the ecosystem. In fact, in several places, people already have local institutions that have implemented sustainable peatland utilization policies. In addition, some communities and individuals have consciously built nurseries for various types of forestry plants, either at their own expense, or with the assistance of the community or government social institutions.

In the aspect of policy, it is proposed that the regional government has reviewed the criteria for groundwater levels, and the Regional Spatial Plan (RTRW). This proposal is based on the following considerations: 1) Paying attention to the management of peat hydrological areas (KHU), and their inter-sectoral utilization, 2) The downward trend in CPO prices due to falling demand should be used to review the optimal area of oil palm plantations, especially in this region 3) Mapping need to be carried out on industrial plantation forest (HTI) working areas, in order to find out the area of peat in the IUPHHK-HTI working area (Business Permit of Timber Forest Product Utilization-Industrial Plant Forest), so as to formulate appropriate policies, 4) Annual crops can be planted on areas with groundwater level of more than 0.4 (zero point four) meters below surface (if properly managed according to the required requirements), 5) In the provincial RTRW, most of these lands are is included in forest areas, although from the aspect of land cover it is mostly in the form of shrubs, and has been used for agriculture, 6) The spatial use of degraded peatlands in RTRW for each province has different basic assumptions. However, they should be based on land suitability, in the context of developing agricultural commodities, 7) The utilization of degraded regions in provincial RTRW is different from that at the district / city level.

2.2. Peatland Cover Restoration Policies and Strategies

land cover restoration aims to improve the conservation of natural resources, and the environment. Furthermore, its quality can be improved by conserving plants, and planting crops which have economic value. According to Sanders et al. [25], changes in land utilization usually occurs as a result of negotiations between different interests. Furthermore, it is responsible for changes in the use of tropical peatland.

The relationship between environmental conditions and vegetation pattern in drained peatland's forest is determined by. a) differences in water and soil chemical properties between peatland types, b) vegetation patterns, depending on water chemistry and soil properties, and c) differences in water and soil chemical properties [26]. Policy directions and strategies for land cover restoration are useful for improving the participatory-based land cover quality, protecting peat domes and conserving watersheds (DAS). Several alternatives are needed to supervise and secure the protected forest, such as, 1) government interventions, to increase land cover and community participation by providing residential space and activities in the core zone (peat dome), in order to reduce the number of residents, and land managed by the community, 2) Increase the government role in allocating budget capacity, personnel and consistent implementation of law enforcement, so as to ensure that core zones are not used as residential areas (settlement relocation), and plants are not cultivated on them, therefore protecting the forests, as stated in PP 71 of 2014.

Changes in the control of land use / cover is carried out through several applicable policies, namely: 1) Formulation of plans that promote forest and land rehabilitation programs, or forest restoration that are in line with RTRW, and therefore, strengthen forest protection functions, 2) Socialization and Community Empowerment around the peat dome area, 3) Potential forest resources utilization and land rehabilitation, protection and conservation of forest resources, as well as fostering and controlling the forest product industry. A research by Ritzema [27] stated the restoration of degraded peatlands usually begins with the restoration of water level, which wet surfaces, control fires, and initiate reforestation. Furthermore, channel blocking strategy is a potential way to achieve this goal.

2.3. Peat Ecosystem Utilization Strategy atan Ekosistem Gambut

Peatlands have provided enormous benefits for life, and have had positive social and economic impacts. However it will lose some of its environmental functions such as; buffer of the hydrological system, storage of biodiversity, and carbon (C) due to drainage. In order to prevent this, certain policies and strategies, which restore natural functions and provide benefits to society needs to be implemented. Furthermore, this type of land can be used optimally without changing its function and characteristics. According to Hapsari et al. [28], tropical peatlands are important for the global carbon cycle, due to that, they stores 18% of total global peat carbon. Furthermore, the vulnerability to rainfall, fluctuation in temperature and rapid environmental changes endanger the these lands, and their carbon storage potential. Lastly, understanding the carbon accumulation mechanism, from previous development studies can help determine its future role.

In a natural condition, peat forests undergo a decomposition process that slowly produces greenhouse gases (GHG). The produced emissions are relatively balanced, and even lower than the absorption of CO2 by natural vegetation. Therefore, this forest plays a natural role as carbon sinks, even though its carbon stocks are unstable, or very easily emitted if there is a disturbance in its natural conditions. Furthermore, it may be cleared, and used for the development of plantations, especially that of oil palm. Clearing is generally carried out by slashing and burning, which produces CO2. Dhandapani and Evers [29] stated that, post-fire from land clearing for oil palm farming has a direct impact on greenhouse gas emissions, physico-chemical properties, and nutrient concentrations. Carbon is greatly lost in areas that are subjected to burning.. In addition, the surface layer, to a depth of 20 cm is mostly influenced by slash and burn activities in oil palm farming.

The increase in greenhouse gas (GHG) emissions due to inappropriate or insufficient management showed that environmental aspects are a serious threat to the local livelihoods communities, watershed functions, and various forms of biodiversity. Furthermore, it poses environmental risks, due to that, it is very vulnerable to biophysical attack, and therefore, easily degraded. Poorly managed lands are usually subjected to these attacks, therefore, their rate of decomposition becomes too large and consequently, they become prone to fire. Dhandapani and Evers [29] stated in a research that, the concept of sustainable peatland management needs to be carried out by maximally increasing productivity, and reducing GHG emission levels.

Utilization of these lands for agriculture purposes faces a dilemma, as it is needed to meet food needs and security, bio-energy development, and economic growth, especially in the aspect of developing export commodities. Conversely, Indonesia is committed to reducing GHG emissions by avoiding the deforestation, as stated in Presidential Regulation No. 61/2011. Gunawan's research results [18], the peat swamp forest ecosystem in provides various important environmental effects, both locally, nationally and globally. However, as land scarcity increases, the pressure to use it to utilize these lands for agriculture is increasing. The opportunity cost of reducing CO2 emissions by conserving peat swamp forest, therefor, preventing their conversion to oil palm plantations ranges from USD $ 3.7 to 8.25 / t CO2e, which is much higher than the currently registered emission reduction compensation price. Conservation actions are very expensive. However, native and adaptive crops increase economic value, therefore, assist market development. Furthermore, paludiculture techniques can be used as a management option for wetting peatlands.

According to Wahyunto et al. [30], out of a total area of 14.9 million hectares of peatland, 3.74 million were degraded, about 20% had a thickness of <2 m, and were suitable for food crops and horticulture, while 60% had a thickness of 2-3 m and were suitable for annual crops. The remaining 20% has a thickness of> 3 m and therefore were converted into forest areas that needed to be rehabilitated. Consequently, the degraded lands which were suitable for agricultural development were around 3 million hectares. Therefore, they became alternative reserves for agricultural land in the future. Evans et al. [31] stated that, no conclusive evidence supporting the claim that land subsidence was intrinsically faster under acacia plantations, than in native forest (compared to previous studies) or in oil palm plantations for the same drainage level, was discovered.

Furthermore, degraded lands are not only unproductive but also a source of greenhouse gas (GHG) emissions. Therefor, if they are neglected, degradation may continue and re-forestation will take a very long time. In formulating the policy direction for land management strategies, it is necessary to consider several factors, such as: 1) The detailing and delineation of the peat ecosystem function need to pay attention to the integrated areas and regional infrastructure development, as well as service centers for the public interest, 2) Reviewing the protection and cultivation functions, especially in protected areas, 3) Balancing utilization and protection, 4) Determine the pattern or model of peat utilization, especially in the protected areas, where rights or permits still exist and regulate use and cultivation. Meehan et al. [32] stated that, in order to achieve a commitment to reduce greenhouse gas emissions, deforestation emissions, as well as forest and peatlands degradation needs to be reduced. Lastly, the national action plan for reducing greenhouse gas emissions is the first comprehensive plan.

2.4. Application of Advanced Hydrological Restoration Technology on Peatlands

An important key to the management of this land is proper water management. This can be achieved by limiting drainage to cultivated areas and protecting conserved peat swamp forest systems. A company has applied eco-hydro technology to canals located on its operational land (Figure 1). Wahyuni [33] stated that, eco-hydro is a concept of advanced technology, where water management systems are implemented, specifically in peatlands by-pass. Therefore, the peat sustainability is maintained, as well as possible emissions. Furthermore, subsidence, fire hazard and soil damage are reduced. This concept is supported by the use of the Telemetic Watergate and Logger model to support the water regulatory system (Figure 2). This telematic water gate can be controlled remotely, due to that, it is supported by a GSM network, which controls drainage in real time. Therefore, water level management in HTI area can be managed more accurately.

Source: Bukit Batu District [34]

Figure 1. Ecohydrology System with Sisir Pass Design for Peatlands Water Control

The application of this technology can be reaffirmed to provide benefits for biodiversity, minimize degradation, reduce carbon emissions, and prevent fires. Therefore, this ecosystem has great potential to become a source of life through sustainable management. Lupascu et al. [35] stated that the tropical peatland degradation, due to the development of oil palm plantations has reduced its ability to naturally regulate flooding. Conversely, more severe and frequent flooding can seriously disrupt plantation productivity.

Source: Bukit Batu District [34]

Figure 2. Telematic Watergate Model and loggers on Peatlands

2.5. Restoring Strategy of Peat Ecosystems Ecological Characteristics Diversity

Peat swamp forests, which are important sanctuaries for biodiversity in Southeast Asia are currently targets for exploitation. Furthermore, Natural peat swamp forests (NPF) have irreplaceable value for the conservation of bird diversity, however, low-maintenance rubber plantations are home to several forest-dependent species, and partly support bird diversity, compared to high-maintenance acacia plantations [17]. The use of land as a source of community economy cannot be stopped. Moreover, it is impossible to restore forest lands that have been converted to agricultural farmlands, in order to meet the global community demands. However, these two different interests need to find mutually beneficial common ground. In order to achieve this, several efforts can be taken, including limiting the cleared area through regulations, improving cultivation and selecting low-emission commodities.

Peatlands have been used by various parties, due to its classified into areas of HTI or plantation business permits, especially oil palm. The Business Permit for Utilization of Industrial Forest Timber Forest Products (IUPHHK-HTI) currently has reached 10.5 million ha, while the cultivated and uncultivated lands are at 4.7 and 5.8 million ha respectively. Baqiroh [36] stated that, the government gives an obligation to all permit holders (HTI and plantation concessions) to secure the peat dome peaks, and the use of areas outside the peat dome tops is allowed as long as water is properly managed. Evans et al. [31] stated that the cultivation of drained peatlands supports the livelihoods of many people, particularly during the ongoing economic development activities in Indonesia, and in Malaysia. However, reductions associated with plantation drainage causes environmental and socio-economic challenges, as well as increases in $CO2$ emissions, impacts forest habitats, and causes long-term changes in plantation drainability.

Specifically, almost the entire peat ecosystem in Riau province has been divided into large/small companies. In addition, it has been over-drained, making it more vulnerable to fire/haze disasters. Several things that need to be considered in formulating policies, include: 1) The large number of these lands used for the cultivation of oil palm plantations, industrial forest plantations (HTI), transmigration and other settlements, 2) The area for HTI business permits that have been issued by the government is 10 million hectares, of which 4.7 million have been used and 5.8 million have not been cultivated. The average HTI growth rate is around 500 thousand ha / year, 3) The number of these lands, which are considered part of the HTI work area or oil palm plantations, especially operational areas, need to be ascertained.

2.6. Socio-economic and cultural development strategy in Peatlands

Policies and strategies for socio-economic and cultural development, which aim to promote community welfare are characterized by increasing quality of life, and aiding the supply of basic needs of the community. Program objectives, such as: 1) Realizing healthy environmental qualities, which protect people from environmental threats, therefore improving the health of individuals, families and communities, and 2) Empowering individuals, families and communities in the healthcare sector, in order to nurture, enhance, and protect their health and environment. Uda et al. [37] stated that most of Indonesian peatlands have been converted for agricultural and plantation purposes. The is potentially flooding the area with CO2 emissions, and increasing the risk of fire outbreaks. Syahza et al. [38] further stated that sustainable utilization of this type of land contributes to the income of local community. Meanwhile, the rural welfare Index is rising through the development of community-based plantations. In addition, Saito et al. [39] stated that tropical forest in these areas has contributed to the timber industry, and conversely led to degradation and deforestation.

2.7. Peatland Control (Prevention, Management and Restoration)

The main causes of degradation are open drainage and land fires. Open drainage management allows water to quickly escape, therefore drying the environment and making easily inflammable. During land preparation for planting, sometimes, land are burnt deliberately. Land clearing by burning is still the most effective way according to some communities. Therefore, the only, and most effective way to stop this practice is by the implementation of binding policies by local governments, and customary agreements (community deliberations) that provide social sanctions for perpetrators.

Empowerment and increased public participation are key to sustainable peatland management, both from the establishment and implementation of binding customary regulations for environmental issues and their adoption into government regulations. Lastly, Customary Leaders are key figures, who can help emphasize the importance of environmental sustainability, especially of peatlands, in communities.

Some of the recommended fire prevention measures at the local community level include: 1) Increasing the prediction and warning of fire risk, 2) Establishment of local community fire prevention volunteer groups, 3) The adoption of alternative soil preparation methods instead of slash and burn such as, making compost or briquettes using bio-mass waste, 4) Implementation of socialization programs to raise awareness among local communities and the agricultural private sector, on non-burning practices, 5) Written agreements by farmers not to conduct open burning.

Empowerment and the increase of public participation in the prevention and management of fires, participation and synchonization of the manggala agni community, society, planters, and related agencies in preventing and dealing with fires is still difficult realize.

In the context of accelerating the restoration of land and the hydrological functions of peat, due to forest and land fires in a specific, systematic, targeted, integrated and comprehensive manner, it is necessary for the government to establish a Peat Restoration Agency through Government Regulation No. 1 of 2016. The main task of the agency is to coordinate and facilitate peat restoration in Riau, Jambi, South Sumatra, West Kalimantan, Central Kalimantan, South Kalimantan and Papua Provinces.

Restoration of the ecosystem can be carried out by rearranging the hydrological function, where peat domes are utilized as a long-term water storage, therefore, they remains wet and difficult to burn. This can be achieved through water system restoration and vegetation rehabilitation.

3. Conclusion

Peat Ecosystems were damaged due to mismanagement of land. Furthermore, areas which played specific roles in the sustainability of the ecosystem were used for business activities, which contradicted their characteristic function, therefore, leading to irregularities in land function. Furthermore, this was exacerbated by the draining of water, which resulted in drought, and, consequently, increased risk of fires. This increase indicates that the environment is no longer in its natural state or is damaged.

Vegetation Rehabilitation aims to restore land cover, and consequently, the function of the peatland ecosystem. Furthermore, rehabilitation efforts need to be carried out immediately before water in the peatland dries up. Moreover, it should use endemic swamp plant species that do not require drainage (paludiculture), and are highly recommended for activities in the peat protection and cultivation function zone (outside the protection function). In addition, planting of fruits, food crops, NTFPs including sap, rattan, energy wood, honey bees, and Cratoxylon arborescens is recommended.

Agroforestry patterns are also recommended for various community activities which occur in peatland zones. Meanwhile, community involvement in the vegetation rehabilitation process can be developed through local community-based nurseries of endemic plants. However, besides developing the economy, this activity also educates the local community and increases environmental awareness and a sense of belonging.

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