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Ecological criteria for sustainability in global, national, and local scales: a review of the literature and case study in the Indonesian palm oil sector

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Abstract. Current sustainability assessment methods are mostly disseminated at global or national scales. However, the sustainability criteria often fail to capture many ecological characteristics that are important to the local population. This article aims to understand the importance of ecological criteria for sustainability by reviewing the literature on issues related to the implementation of ecological criteria on global, national, and local scales. This study uses qualitative content analysis by examining secondary data searches such as journal articles and research reports regarding the topics. We use NVIVO software for theme coding. We also use a case study in the oil palm plantation in Belitung Island and the Indonesian palm oil sector to see how global and national ecological criteria for sustainable palm oil were designed and whether it is adaptable to the local context. This study reveals three main themes namely the function of ecological criteria and indicators, the adaptation of global and regional criteria, and the importance of local characteristics and value. We concluded that although global and national criteria for sustainable palm oil have been established, the characteristics of local biodiversity and social value and its prioritization are needed to ensure sustainability reached the lowest scale.

1. Introduction

The concept of sustainable development which aims to ensure the creation of human needs in the present without ignoring the ability of future generations to meet their needs [1] is very general and raises a variety of different practical implications in various sectors. Current sustainability assessment methods are always aimed at a global, national, or state scale. However, modeling sustainability at smaller spatial scales, such as regions, is very important for understanding and achieving sustainability [2].

The Sustainable Development Indicator (SDI) is one of the tools most often used to assess sustainable development from an international scale to a local scale, where the tool is considered to support the purpose of evaluation and reporting [3]. These indicators of sustainability are often designed by a group of stakeholders and global experts. However, the criteria and indicators often cannot be implemented in the local context because unable to embed some local characteristics that are very important to the local population [4]. From this point we seek to know the answer of what actually are the important aspects of ecological criteria that needs to be considered for the implementation of sustainability agenda either in global, national and local level.

This article, thus, aims to review the literature related to the ecological criteria from global, national, and local scale and their adaptation into the local context. As an attempt to see the reliability to implement the ecological criteria into the local scale, we use the case study in the palm oil industry



sector in Indonesia. Concerns about the development of unsustainable palm oil plantations in Indonesia continue to be echoed by various parties both on a national and international scale because of the many environmental and social problems surrounding Indonesia's palm oil production. Those are including environmental problems such as the conversion of natural forests to oil palm plantations have increased habitat fragmentation and biodiversity loss (Gillison and Liswanti, 1999; Maddox, 2007); endangered species (and subspecies), such as Orangutans, Sumatran elephants, and Sumatran tigers which threatened by oil palm expansion; the problem of fires on oil palm lands [5], etc.

This paper is divided into four sections. The methods of this study are presented in the second section. The third section presents the results of content analysis of the literature review followed by results of the case study in ecological criteria based on the ecological characteristics of Belitung Island. The fourth section presents conclusions of the study.

2. Methods

This study uses qualitative content analysis by examining secondary data searches such as policy documents, articles, and research reports regarding the importance and appropriateness of local ecological criteria of sustainable palm oil in the Indonesian context. We use NVIVO software to do the theme coding. The coding theme was defined after reading the text. Afterward, similar or interrelated themes were categorized into main themes.

Additionally, this study also uses the results of research conducted in 2010 that used specific ecological criteria case studies, namely in Belitung Regency, Bangka Belitung Province, Indonesia. The use of data from the results of this study is to find examples of how global and national criteria can be adopted and integrated with the local ecological characteristics of an area in Indonesia to produce ecological criteria that fit the ecological characteristics and interests of the population in the area. The data collection was carried out qualitatively by identifying national and global principles and criteria such as RSPO, RSB, and Cramer criteria from the Netherlands (top-down approach), studying the results of HCV identification (High Conservation Value) in the area and conducting semi-structured interviews with the company's worker, the government, and indigenous people of Belitung Island (bottom-up approach). To update the results from 2020 we validated with the high conservation value expert and by cross-checking with the newest articles.

3. Results and Discussion

3.1. Content Analysis of the literature review.

Based on the review of the literature; three main themes can be found related to the local ecological criteria, including the function of ecological criteria and indicator, adaptation of global and regional criteria, and the importance of local characteristics and value. Each main theme will be described in more detail in the following subsections.

Table 1. Coding themes on ecological criteria

Main Themes	Themes	Authors
The function of ecological criteria and indicator	Ecological indicator can help to balance the socio-economic aspect in the decision-making process	Turnhout, Hisschemöller, and Eijsackers (2007) [6]; Turcu (2013) [7]
	The function of ecological indicator	Phelps (2009) [8]
	Identifying characteristics	Lautenschlager (1998) [9]
	The importance of ecological indicator	Hayati, Ranjbar and Karami (2010) [10]; Lähtinen <i>et al.</i> (2014) [11]

	Ecological indicator to show the environmental dynamics or changes	Gilbert (1996) [12]
Adaptation of global and regional criteria	The consequences of global to local criteria	Schouten, Leroy and Glasbergen, (2012) [13]; Oosterveer <i>et al.</i> , (2014) [14]; Cattau, Marlier and Ruth (2016) [15]; Johnson (2019) [16]; Martens <i>et al.</i> (2019) [17]
	Local people involvement important for managing one sector to aim for sustainability	Turnhout, Hisschemöller and Eijsackers (2007) [6] ; Kotwal <i>et al.</i> , (2008) [18]
	Multi-stakeholder interaction is important	Crate (2006) [19]
	The importance of the indicator's priority setting	Turcu (2013) [7]
	The problem of scale	Turnhout, Hisschemöller and Eijsackers (2007) [6]; Coelho and Subtil (2010) [3]; Tolunay and Akyol (2015) [20]
	The standard need to be flexible	Crate (2006) [19]; Coelho and Subtil, (2010) [3]
	The importance of adaptation process	Johnson (2019) [16]
	Difficulties in determining criteria regionally	Graymore, Sipe and Rickson, (2008) [2]
The importance of local characteristics and value	Sustainable local criteria as a communication tool to the stakeholders	Domingues <i>et al.</i> (2015) [21]
	The importance of local actors	Sherry <i>et al.</i> , (2005) [4]
	The importance of local criteria	Sherry <i>et al.</i> , (2005) [4]
	The importance of local knowledge	Lautenschlager, (1998) [9]; Sherry <i>et al.</i> , (2005) [4]; Reed, Dougill and Baker, (2008) [22]; Coelho and Subtil, (2010) [3]; Clark and Clarke, (2011) [23]; Marin-burgos, Clancy and Lovett, (2015) [24]

3.1.1. The function of ecological criteria and indicator. Several themes were grouped under this main theme as a function of ecological criteria and indicator which describes how the ecological criteria and indicator can be utilized to achieve balance in social, economic, and environmental aspects as a basis for sustainability. The ecological criteria and indicator can be used for determining the environmental dynamics of changes. The change can be seen as (i) the pressures of one ecological function, for instance, habitat loss or land-use change and as (ii) incidental or structural shocks to the quality and quantity of the environment itself [10]–[12]. Moreover, the ecological indicator is needed to assess the progress of one scale of environmental management and help to set the goal towards sustainability as well as finding a solution for the ecosystem management [7]. Turnhout *et al.* (2007) emphasized that the ecological criteria and indicator will help to balance of socio-economic aspect in the decision-making process.

Ecological indications are often based on relationships between environmental factors and biological parameters and use existing ecological knowledge on cause and effect relationships and mechanisms in

ecosystems [25]. Lautenschlager (1998) argued that identifying the specific species in one site will give a picture of the ecological characteristics in that place. It will give some ideas for a practical solution from the management level on that site to the context of the ecosystem on various levels. In the end, it will bridge the sustainability goals of the paper into reality. In practice, the function of ecological criteria and the development of indicators based on specific conditions or special characteristics of an area has been carried out in several studies [18]. For instance, a study by Domingues et al. (2015) calculating ecological indicators as a tool to communicate the environmental condition to the stakeholders and the entire world community.

3.1.2. Adaptation of global and regional criteria. The second main theme has been capturing the topic on the adaptation of global and regional criteria to the local context including its difficulties, challenges, and some factors that need to be considered to implement these criteria into local scale. Several attempts have been made in the world to develop specific criteria and indicators for various environmental conditions, for example, the standard for sustainable forest management (Forest Stewardship Council for forestry products) and sustainable palm oil (RSPO - Roundtable of Sustainable Palm oil) are recognized as appropriate tools for assessing and monitoring progress for sustainability practices in both sector. Those global indicators are usually not suitable for all measurement contexts and therefore require modifications to service other or new sustainability evaluation situations. Those standards mostly have been made through roundtable discussions between the stakeholders, including the industries, processors or traders, consumer goods manufacturers, retailers, banks and investors, environmental or nature conservation NGOs and social or developmental NGOs. Problems related to this standard mostly occurred in how it will be implemented in the smallest level, i.e. in the smallholder plantation. Although those top-down standards have made an effort on increasing the smallholder's certification, they are lacking on the information of how their management system and how the knowledge was transferred between the smallholders [26]. In the case of RSPO, smallholders did not consider the traceability useful in their business, and as they are facing the huge uncertainty with the development of world price and sustainability standards, they feel excluded from the roundtable because their voice was not heard by the stakeholders [13], [14], [17]. Moreover, standards such as RSPO was seen as having limited capacity to solve problems in Indonesia's agricultural concessions [15].

How about implementing the ecological criteria at the regional level? The regional level might be good in designing the ecological criteria for sustainability, but there are difficulties in determining the criteria regionally. The lack of data and method play important roles. Data were seldom collected on a regional scale, and the limitation in the method which can assess the sustainability itself effectively and practically particularly for the decision-maker is also hindering the data collection on a regional scale [2].

On the other hand, literature has shown that the national standards need to be adaptable based on the political situation in one country where the standard will be adopted. If not, there will be unbalanced power distribution from this sector. The adaptation process before the publication of national interpretation is needed so that the principle and criteria can be shaped and reflecting the political, ecological, and geographical situation in one local area [16]. Key for realizing the sustainability goals is the active involvement of international communities, the local people, researchers, and the government. It needs a flexible approach which can be adjusted with local context as well [3], [19]. Sustainability labels are not only can be used to assess some activities and public organization but also as a communication tool to all stakeholders at local, national, and international levels [21].

3.1.3. The importance of local characteristics and value. The third main theme is the importance of local ecological characteristics, or identifying local value either environmental and social value. Definition and modification of indicators can be based on a top-down or bottom-up approach: top-down indicators are created through a political process and can be applied primarily to decision making at the macro and national level, while the definition of indicators in the bottom-up approach is based on local participation to account for micro-level diversity from local conditions. Local knowledge is more

holistic than many lists of indicators published to monitor vegetation, soil, livestock, wild animals, and socioeconomic indicators [22]. The involvement of local communities and other local stakeholders in decision making is important for the management of a sector to achieve sustainability [6], [18].

By analyzing all local indicators and evaluating the importance of those indicators as a whole system, we can have a reliable sustainability assessment [7]. For example, policies can target indicators that pay greater attention to certain local communities and override indicators that have less attention. 'Priority indicators' can only be seen in the overall local sustainability system, given the local interrelationships and fundamental processes in place discussed as a case study. Only by linking certain indicators with other actions and evaluating their importance in the system, we can make meaningful assessments of sustainability [7].

It was argued that sustainability can be reached effectively on the local scale [7], [20]. However, at the local level, most indicators of sustainability focus on clear outputs (such as recycling and air pollution) but not on other outcomes (such as biodiversity, social welfare) or on outcomes outside the local boundaries or services to capture external impacts and dependence on services in other regions, especially in terms of environmental aspects [21]. Therefore, in principle, the development and determination of indicators using a hybrid (top-down and bottom-up) approach need to be done. Future developments in ecological indicators must be linked to other national initiatives, for example reducing emissions from deforestation and forest degradation in collaboration with scientists, government officials, companies, communities, and network organizations [27]. Local actors may not accept easily the global or national standards or criteria. Some local actors may oppose the industry where the global or national criteria and indicators are determined. It depends on several factors including their perceptions about how those standards handle core issues of their claims, formed by correspondence between core values and core values of actors local represented and promoted by the government system. Another aspect is how local people have effective participation and inclusion in the process of creating and implementing standard-setting at the national and local levels [28].

3.2. Case study: Ecological criteria based on the ecological characteristics of Belitung Island

The area used in this research were two areas of oil palm plantations managed by private companies. The first area was Nyuruk, in East Belitung with an area of 3500 hectares of palm oil plantation and Tanjung Rusa region in Belitung with an area of 2512 hectares. Based on research that has been conducted on Belitung Island, Indonesia, several indicators were built based on ecological characteristics that exist on this island and are the priorities of the stakeholders on this Island. Criterion regarding the conservation of water source areas for daily life such as springs, water bodies such as swamps, lakes, and rivers to meet the needs of clean water for the surrounding communities and ecosystem service providers (criterion 1) are the most priority. Concerns about the future water deficit make all parties, including the government, local communities, environmental practitioners, and also the company have big attention to this aspect. Also, Belitung Island does not have many sources of deep groundwater and the main water source comes from surface water that flows through the water head. When the dry season arrives, and rainfall is very low, the flow of water becomes very limited. With special characteristics in the Tanjung Rusa area which is a low-lying and near-shore area, seawater intrusion has begun to occur frequently, especially in swampy areas and is related to tides. In practice, efforts to manage these water conservation areas are often ignored by oil palm plantations, for example by not building riverbanks in areas that are water heads.

Besides, the criteria regarding the conservation of biodiversity and their protected areas (criterion 2) also become criteria that are considered more important than other criteria for Belitung Island. Criteria for the conservation of important areas marked by the status of existing areas are usually contradictory in their application and there needs to be cooperation in their management. When companies try to leave forests as areas that have high conservation value, the role of the government to oversee areas of important area status, and areas with native ecosystems is also very necessary, but in reality, at this time, supervision is still lacking. If there is no periodic supervision, in the end, the forest is again encroached

by other parties who are not responsible. Animals on Belitung Island, such as *Tarsius bancanus saltator* are animals with cruising areas that are difficult to track, therefore, permanent key habitat is needed.

The last criterion that becomes the main criterion is the criterion regarding the conservation of rare ecosystems and environmental service providers (criterion 3) named *kerangas* ecosystem. For some local people, this *kerangas* ecosystem doesn't have tangible economic value to the surrounding community, thus they prefer to plant oil palm plant than *kerangas* as a good solution for utilizing the land. However, this paradigm will endanger the existence of *kerangas* forest in Belitung Island, because the land in this *kerangas* forest will be degraded very quickly and turn into the sand when the vegetation cover above is removed, making this type of forest very vulnerable.

Another criterion that is considered as important for the local people is the need for conservation for areas that function as forest and land fire barriers because forest fires often occur in their area. Some local communities are still using this method to clear the forest, however for the big companies planted their palm oil in Belitung island, it is very dangerous and it relates to the work safety of all employees and plantation workers, so that criterion is one of important priority to them.

Table 2. Proposed criteria based on the characteristic of Belitung Island

Criteria 1	The existence of conservation areas as a source of water for daily life such as springs, water bodies such as swamps, lakes, and rivers to meet the needs of clean water and latrines for communities and providers of ecosystem services.
Criteria 2	The existence of conservation to the important area identified by the status of the area, the authenticity of communities, ecosystems, and the existence of endemic flora and fauna, rare and endangered species.
Criteria 3	Protection of flora and fauna endemic and restricted range and rare species, endangered or endangered according to national legislation and international (IUCN and CITES), and has a specific function according to the local community.
Criteria 4	Conservation for the area that serves as a bulkhead to land and forest.
Criteria 5	Preservation of rare ecosystems that function as a provider of environmental services for the other subsystems.
Criteria 6	Preservation of key habitats and the areas that became the path that connects the activities of animals of one area with other areas (corridors).
Criteria 7	The plantation in the areas based on appropriate landscape ecology and topography.
Criteria 8	The effort to prevent flooding in the surrounding plantation areas.

3.3. Discussion

Based on the study literature and case study of the ecological characteristics in Belitung island, the need to consider and prioritize local characteristics into sustainability is very important. Those ecological characteristics such as the susceptibility of seawater intrusion to the island, and rare ecosystem existed in the surrounding palm oil plantation indicated that every place is unique, therefore prioritization in implementing the criteria is crucial. Also, the criteria related to water resources is the closest one to the needs of society, and the most practical and feasible to be implemented. Besides, the conservation of wetland areas or water sources to provide benefits to the ecosystem such as flood control, reduce pollution, are also believed to maintain the native species. Criteria of the conservation of water resources are based on ecosystem approach principles revealed by Grumbine (1994), namely the principle of maintaining ecological and evolutionary processes that took place among the hydrological cycle.

To create synergy between oil palm production and protection of surrounding ecosystems as a realization of sustainable development of oil palm plantations, there needs to be a holistic perspective, one of which is with an ecological and ecosystem approach and by using ecological criteria and indicators based on local characteristics in an area [29]. The specific environmental conditions in some areas planted with oil palm plantations are one of the most important things that need attention and can never be ignored. Local stakeholders are also a very important element in the process of determining ecological criteria because they can provide a variety of opinions and perceptions to produce a sustainable system.

Therefore, global standards must be more adapted to the ecological characteristics of a country where these standards are adopted. The adaptation phase before national interpretations are published needs to be carried out so that existing principles and criteria can be formed and reflect local political, ecological, and geographic conditions. There is also a need for monitoring the extent to which these standards can be modified to ensure the integrity of the standards, but are still included with specific references from local flora and fauna so that these standards can be more applied to the local conditions of an area/country. This can increase the involvement of local actors in the process of formulating national interpretations. The more local actors involved and from various sectors, the better. Yet, the standards that are too 'open' and very flexible (extreme) can also make actors who have the power to put their will into the criteria being processed. In contrast, very inflexible standards will hinder the adoption of these standards into the context of each country [16].

Further development of ecological criteria can be done using ecoregional concepts, which are focused on large ecosystems that have the same geographical characteristics. For the development of ecological criteria for a national scale, ecoregional approaches can be carried out because there are similarities between regions in an ecoregion. Palm oil in Indonesia is also a concern to the global community, has risen the idea of applying ecological criteria with ecoregional concepts on a global scale. Palm oil production in Indonesia, however, has a strong link with the global system, especially when demand for this commodity continues to increase from around the world.

4. Conclusion

This study seeks to know about the important aspects of ecological criteria that needs to be considered for the implementation of sustainability agenda either in global, national and local level. We concluded that although global and national criteria for sustainable palm oil have been established, the characteristics of local biodiversity and social value and its prioritization are needed to ensure sustainability reached the lowest scale. Future study needs to find out whether the existing criteria developed by global private multi-stakeholders and criteria developed by the national government have had included local ecological characteristics for the various Indonesian archipelago. Also, we need to know how criteria based on local ecological characteristics in Indonesia can be integrated and embedded into the global and national criteria.

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