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LOCAL ECOLOGICAL KNOWLEDGE AND IT'S BENEFIT TO CONSERVATION PROGRAMS IN INDONESIA

Mochammad Naufal RIZKI[1], Donna ASTERIA[2,*]

[1] Cluster of Interacation, Community Engagement, and Social Environment, School of Environmental Science, Universitas Indonesia, Jakarta, Indonesia, 10430
[2] Department of Communication, Faculty of Social and Political Science, Universitas Indonesia, Depok-Indonesia, 16424

Abstract

Conservation efforts in Indonesia in the last decade have been using many strategies to integrate Local Ecological Knowledge (LEK). Recognition of the role of local communities and indigenous peoples is part of efforts to mitigate climate change and the current biodiversity crisis. The mapping of the contribution of local ecological knowledge in forest management approaches for biodiversity conservation is very important. This study aims to describes the contribution of local ecological knowledge (LEK) adaptation in conservation programs in Indonesia. This research method uses a qualitative approach with an ethnoecological strategy. The research locations were in three local communities in Indonesia, namely: the Nusa Lembongan community in Bali, the Tobelo community in Halmahera, Maluku, and the Urang Kanekes/Bedouin community in Lebak, West Java. Local ecological knowledge contributes to resilience in the face of climate change, and how indigenous peoples ensure harmony between social capital, the forest environment, and forest use can be of particular concern to face the challenge of achieving zero hunger. This is related to forest ecosystems managed by indigenous peoples showing better results in sustainability based on environmental and social sustainability principles. This study shows that forest management processes based on local ecological knowledge (LEK) can be an alternative approach to biodiversity conservation. Local ecological knowledge shows an emphasis on the ongoing process of experience-based knowledge in communities that utilize the environment. The contribution of studies on LEK adaptation as dynamic knowledge can be used as a more flexible conservation approach and evaluation of forest conservation programs in Indonesia in relating to ecosystem adaptation. The finding of this study was important to LEK integration into the conservation program so it will become more adaptive and flexible to the changes. Understanding the dynamic characterization of LEK has benefit to conservation program that is based on community and participatory.

Keywords*: Local Ecological Knowledge; Climate Mitigation; Ethnography; Conservation; Local Knowledge; Indigenous People*

Introduction

Since the end of the 20th century, the urge to involve actors and local communities has been arising in conservation efforts and natural resource management on a global scale [1]. The mitigation effort of climate change is a shared responsibility and involves all elements of society. Global warming causes the degradation of biodiversity with increasing species extinction. This condition will have an impact on the quality of human life and is related to environmental resilience. Especially in the tropics, efforts are needed to overcome the impacts

* Corresponding author: donna@ui.ac.id

of climate change on biodiversity, so that all alternative conservation approaches need to be considered [2]. To overcome this biodiversity crisis, it is very necessary to involve local communities in conservation with used their indigenous knowledge [3]. As many studies have shown the success of local communities living in harmony with nature [4]. Back in the day, conservation efforts were done with a top-down approach, exclusively and hegemonically using single scientific knowledge [7-9]. In relation to climate change, forests have an important role in stabilise the climate. The forests regulate ecosystems, protect biodiversity, play an integral part in the carbon cycle, support livelihoods, and can help drive sustainable growth. So that, with halting the loss and degradation of natural systems and promoting their restoration have the potential to contribute climate change mitigation. In protection of the forests, indigenous peoples can do better in manage of land with lower deforestation rates and carbon emissions [5, 6]. Recognition of the role of indigenous peoples in climate mitigation is closely related to SDGs number 13 about climate action and goal number 15 about preserving terrestrial ecosystems which are required in the design and implementation of national REDD+ strategies and other priority actions. In this situation, indigenous peoples are actually among the most vulnerable to the impacts of climate change as a result of their close interaction and dependence on climate and natural systems. The paradox (and injustice) is that they are not responsible for the unsustainable levels of greenhouse gas emissions that have contributed to the climate crisis. Indigenous peoples are responding to climate change in innovative ways, leveraging their traditional knowledge, lands and resources; they are important contributors to mitigation efforts through regulation of carbon levels and climate cycles through abundance of forests, native plants and other sources of biodiversity.

One of the important conservation commitments that will be collaborative was at the 1987 World Commission on Environment and Development (WCED) report about the urgency to acknowledge the local knowledge system and custom society on tackling environmental issues. The effort continued in the 1992 United Nations Conference of Environment and Development (UNCED) or Rio Summits. In the summits, UNCED has stated a commitment to involve local communities in sustainable development programs [6]. To this day, an effort to involve local communities has been made. This is related to forest ecosystems managed by indigenous peoples showing better results in sustainability based on environmental and social sustainability principles.

The involvement of local communities in conservation needs a concern. It needs concern because previous studies show that local knowledge in the communities has positive impacts on environmental protection efforts [3, 6, 10-15]. The local knowledge that relates to the environment can be known by many terms, such as Traditional Ecological Knowledge (TEK), Local Ecological Knowledge (LEK), or Indigenous Ecological Knowledge (IEK).

The conceptual definition regarding various terms about it still needs to be clarified [12]. Those terms still have redundancy in many published research, and some studies have been interchanging the terms with the same concept [6, 12]. To avoid confusion, the term used in this study was Local Ecological Knowledge (LEK). These terms have been considered more flexible than TEK and IEK because the “local” aspects were more inclusive. On the other hand, the “traditional” and “indigenous” terms are still debatable in the definition and the boundaries of other anthropologists and social researchers [14, 16, 17].

Also, in previous research, LEK can be defined as the platform of knowledge, practice, and belief of some groups related to their environment [5, 11] that have been obtained by observation and interaction with the local ecosystem [18], has been passed by generations [5], and planted in their cultural values, spiritual beliefs, and their customary law [19]. On a global scale, LEK has been acknowledged for its benefit in solving many environmental issues. It is proven that LEK has been giving a positive impact on the conservation efforts such as the detection and monitoring of some species [3, 13, 15], biodiversity management of forest and coastal areas [10], landscape management [6], and management of protected areas [11]. In these

efforts, LEK has been proven that it can be utilized as complementary to general scientific knowledge and can be used as a reference in conservation programs [3, 15, 16, 20-22]. Also, LEK can have a practical function that can benefit its people, not only in environmental aspects [23-25]. From these benefits, many researchers agree to push the LEK integration into conservation programs globally, including Indonesia [8, 12].

This local wisdom in natural management needs to be studied and used as an approach to preserve biodiversity. Local wisdom related to the environment is known by various terms, such as Traditional Ecological Knowledge (TEK), Local Ecological Knowledge (LEK), or Indigenous Ecological Knowledge (IEK). In relation to the variety of terms, there is still no absolute clarity [13]. These terms are usually used overlapping in various studies, some studies even interchange these terms as one and the same concept [7, 13]. In this study, the term Local Ecological Knowledge (LEK) will be used. This term is considered more flexible than the term TEK or IEK because the use of the term "local" is more inclusive.

In Indonesia, efforts to involve local people with their LEK have been conducted [16, 23, 25, 26]. As one of the areas with the most biodiversity in the world, Indonesia has many biodiversities that should be protected. However, other threats such as deforestation and the climate crisis have endangered its biodiversity [27-28]. Also, Indonesia was not only located in the mega-biodiversity areas but hotspot biodiversity [29]. Scholars and decision-makers have been demanded to make solutions regarding the threats to biodiversities.

On the other hand, Indonesia not only has high biological and cultural diversity but also. The knowledge system is essential to the culture [30]. Hence, the cultural biodiversities in Indonesia have indicated that there are diversities in the local knowledge system, including Local Ecological Knowledge (LEK). This diversity can be seen as a benefit mentioned before, and much previous research shows a positive result of using LEK in environmental protection programs. Also, the conservation efforts based on LEK were compatible with some developing countries like Indonesia because, aside from the collaborative aspects, it is practical and inexpensive [2, 10, 15].

These benefits also have a possibility that conservation in Indonesia can be implemented with plural approaches. The plural approaches can be done by integrating scientific knowledge and local knowledge. These integrations have been regarded as more beneficial to conservation efforts [3, 31]. This process can be done by investigating various Local Ecological Knowledge (LEK) in Indonesia. Almost all areas in Indonesia have LEK that can be integrated with scientific conservation efforts.

One of the LEK types that various conservation scholars have known was LEK in the *Sasi* institution in Maluku and some coastal areas in Papua [26, 32-34]. *Sasi* was a traditional institution related to the utilization of natural resources on land and sea that managed the permission and prohibitions of resource extraction in sometimes and areas that covered forests, farms, mangrove forests, coral areas, and fishing areas [24]. Many LEK in various communities can be integrated into conservation efforts. Various studies also show that the *Kasse Tanda* tradition in Tabaru communities has been used to protect and add some plant types [32]. Some communities, such as Dayak, still use their knowledge about shifting cultivation to survive with subsistence and protecting the forest [25]. Cosmology also has a relation to Bajau customs that can be used for whale shark conservation [16]. *Sasi* and *Sin Wesie* have been used by Nuaulu, and Seram people to avoid exceeding forest exploitation [33]. Katingan people also used Ethnobotanical knowledge to protect the forest biodiversities [23].

From various cases of using LEK to protect the environment, it can be known that the integration of LEK into conservation efforts in Indonesia was essential. However, other studies also mentioned that the LEK integration process with conservation in Indonesia and World has huge problems. The problem is that LEK has been degraded because of industrialization, modernization, and globalization [3, 8, 32]. This study aims to describe the contribution of local ecological knowledge (LEK) adaptation in conservation programs in Indonesia. The urgency of

this study in order to explain the characteristic of LEK as dynamic knowledge, see the utilization of LEK for conservation in Indonesia, and see the future potential of LEK integration as dynamic knowledge for conservation programs based on the community in Indonesia.

Concerns Regarding Various Threats to LEK

The survey conducted by *S. Aswani et al.* [4] shows that many people in the world, especially rural and indigenous communities, have been facing massive social, economic, and cultural changes that have caused a degradation of their local knowledge and practice, including LEK. *S. Aswani et al.* [4] find that 77% of 92 reports about LEK degradation from 1992 until 2016 show the trend of LEK degradation in various local communities. These reports show that the main cause of LEK degradation was modernization, globalization, and integration between the local economic system and the market. In Indonesia, much literature about LEK has focused on these issues, especially concerning the challenge of LEK integration with conservation [23, 25, 26, 32-35]. The study by *A.A. Afentina et al.* [23] shows that local knowledge and practice about agroforestry in Katingan, Central Kalimantan, have been endangered by the palm oil plantation expansion that has been increasing. On the other hand, *M.H.I. Al Muhdhar et al.* [33] mention that from 2014 until 2017, only 14,42% of communities used sasi in Halmahera Islands caused by modernization have been made the oral tradition in local people regarding environmental protection has been decreasing.

From the literature provided, studies about LEK in Indonesia have focused on seeing faster social change, such as globalization, modernization, and industrialization, as threats that could make the LEK extinct [23, 25, 26, 32-34]. In this condition, a tendency shows that LEK can be seen as static knowledge that can only accept change. In the glocal literature, LEK is seen not only as static knowledge but as a form of dynamic knowledge [14, 36-38]. Studies about LEK have been advised by *E.A. Olson* [15] to avoid the presumption that the form of knowledge should be freezing because there is always a process to renew knowledge and culture. Also, *E.A. Olson* [15] argues that the romanticization of knowledge and culture to be passive and static has been abandoned by many anthropologists, especially since the appearance of approaches focused on the process. However, *S. Aswani et al.* [4] have summarized the shift in understanding about LEK: *"Despite the popular notion that local and indigenous knowledge systems are disappearing, the academic vision of LEK has progressively shifted from viewing LEK as a static body of knowledge to one of dynamism. Knowledge is being hybridized by accommodating new forms of information or its exposition to external socio-economic drivers"* [4].

This study explores local ecological knowledge in indigenous groups. Characteristics of community groups that include indigenous peoples, namely: having a small population compared to the dominant culture in their country; having their own language; practicing distinctive cultural traditions (including having customary laws and beliefs); having their own lands and territories, which they are connected to on various levels; and identity as a native. Meanwhile, local ecological knowledge (LEK) can be defined as a set of knowledge, practices, and beliefs of a group of people about their environment [5] obtained through observation and interaction with local communities. ecosystems [19], are passed down from generation to generation, and are embedded in cultural values, spiritual beliefs, and customary law systems [20].

Challenging the ideas of LEK as Static Knowledge.

Modernization, globalization, and industrialization are not causing the LEK easily to disappear because LEK has the capacity to survive and develop to be new knowledge or adapt to make LEK that is hybrid. These ideas have been strengthened by previous studies [37-39]. Studies by *A.L. Balbo et al.* [38] have conducted a historical exploration of various small-scale societies in dry-plain areas of the Sahara, Sahel, Gujarat, Donana, and Andalucia. The study shows that from time to time, the communities that have been investigated cannot defend, adjust, adapt, and use LEK as a strategy to adapt to changes that have been happening. Even in

modern times, when Hyper Connectivity happens, LEK still has the capacity to develop flexibly and creatively. *A.L. Balbo et al.* [38] also argue that in the massive change caused by modernization, society can improve its flexibility, diversity, and creativity from and through its local knowledge to survive.

Other findings also show that Tsimane people in Amazon can defend, adapt, and create LEK to respond to the change that is happening [38]. The study from *E. Gómez-Baggethun and V. Reyes-García* [39] also does not reject the threat of LEK disappearance caused by change because it can happen in the case of the study, but it is shown that the people can respond to the change with their knowledge. The study focused on the Tsimane people has criticized the assumption that LEK will be extinct because it is static. *"Those results challenge the assumption that TEK should be irremediably fade as indigenous people increase their interaction with national societies and the market economy"* [39].

Although the assumption that LEK was static has been challenged and received many criticisms from other studies conducted on a global scale, research about LEK in Indonesia still needs to be focused on this problem. From the existing literature, only some studies in Indonesia specifically focus on the dynamic aspect of LEK. Most existing studies also describe that LEK in Indonesia will be extinct because of the change driven by modernization, globalization, and industrialization [23, 25, 26, 32-35]. However, almost nonexistent studies discuss the dynamic response of local communities and LEK toward the changes. Some studies mention LEK persistence, such as Ellen [33], which sees the dynamic of the *sasi* institution in Nuaulu in responding to change from time to time. However, there is not yet a specific and extensive study discussing the dynamic characteristic of LEK in facing the flow of change in Indonesia. In fact, considering the dynamic character of LEK can open a potential for LEK to be integrated into conservation programs, especially that based on community [17].

This can be a gap in discussing LEK and its integration with conservation programs in Indonesia. Hence, this study offers a new perspective by conceptualizing LEK as the knowledge that can be dynamically fluid, not only accepting the change from the outside. Instead, viewing modernization, globalization, and industrialization as an absolute threat to LEK's existence and an issue to integrate LEK into the conservation program. This study will present another perspective on viewing LEK and conservation in Indonesia, namely the dynamic LEK. As a dynamic knowledge system, LEK can respond to the flow of change [36-38]. From these gaps, this study is trying to fill the existing by giving questions: Why the dynamic character of LEK was important to pay attention to? And how dynamic character of LEK can be useful for integration with conservation programs in Indonesia?

This study will contribute to the discussion regarding LEK and conservation in Indonesia: (1) Theoretically, this study will challenge the idea that LEK was a form of static and passive knowledge. Otherwise, LEK can be understandable from its dynamic character; (2) This perspective tends to be new in understanding LEK and its relation with conservation program in Indonesia so that it can offer an alternative perspective from the existing discussion; (3) this study hopefully can show the benefits of the investigation regarding the dynamic character from LEK to conservation models that based on the community in Indonesia. These contributions also can be used as academic discussion preference about LEK, especially in Indonesia. Also, these contributions can be utilized as recommendations to implement conservation programs that involve the active role of local people in Indonesia.

The point is that this study will be given a new perspective that can position Lek as a form of knowledge that not only accepts the change passively but can be active to responding the change, whether in the form of survival, the development on becoming new knowledge form or adaptation to the change. However, it should be emphasized that this perspective only sometimes results in an optimistic assumption that seeing LEK eternally will have the capacity to survive, develop or adapt to every condition.

From the existing studies that use the same perspective, it is indeed found that there are symptoms of degradation caused by a massive and quick change [38, 40]. Nevertheless, these studies still focusing the dynamic character of LEK regardless of whether the dynamic character of LEK can make LEK possible to survive, develop, and adapt or will be completely gone. What is clear, these studies agree that abandoning the dynamic character of LEK has implications of abandoning the information property of LEK itself [38, 40, 41], that in this study, it can be assumed it will have the benefit to conservation efforts that were collaborative with local people. The benefits can come in many forms. Zent [41] mentions that the innovation that LEK produced in some cases can be working efficiently than the innovation that was produced from *ex-situ* scientific experiments, and *E. Gómez-Baggethun et al*. [43] saw the dynamic character of LEK caused a possibility of small-scale societies can survive harmonically between the livelihood and biodiversity conservation.

This study's perspective has been generated from empirical and ethnographic data found in the field, especially from examples of comparison from some sites: Nusa Lembongan community in Bali, Tobelo community in Halmahera, and Urang Kanekes/Badui community in Lebak. These three communities strongly relate to nature and have customary laws relating to their local ecosystem. Hence, investigating the LEK dynamic in each community can enrich the understanding of LEK as a dynamic knowledge system from different social, historic, and cultural aspects.

The different contexts also will reveal the dynamic process of different LEK. From the LEK comparison in these three communities, this study hoped to show LEK as a form of knowledge with dynamic characteristics that can benefit conservation programs. Investigating the dynamic aspect of LEK can bring new insight into its capacity for conservation programs, especially to the conservation programs based in the community in Indonesia. Discussion about LEK dynamic from the comparison between three communities hoped will be an opening to future studies that will be looking at LEK not only as static, freezing, stable, and closed knowledge but as a form of knowledge that was dynamic so the utilization to the conservation will be more flexible.

Methods

This study will be used a processual anthropology approach to see the dynamic and process of LEK in communities and the implication to conservation programs in Indonesia. in the processual approach, culture and society are not positioned as an object that can be observed with stability and static (as culture). So, the efforts of cultural essentialization will be almost impossible. Otherwise, the culture can be seen as a process that will change (as cultural) [43]. This approach implies that LEK will not understand as a form of knowledge that freezes, is static, and is isolated from the other relation with a broader world.

Regarding the selection of research in Indonesia, the research location on three local communities in Indonesia, namely: the Nusa Lembongan community in Bali, the Tobelo community in Halmahera, Maluku, and the Urang Kanekes/Bedouin community in Lebak, West Java. These three communities have a fairly strong bond with nature, and have customary laws relating to their respective local ecosystem systems. Excavations in the three communities have different contexts in the forest ecosystem which will show the dynamics of different LEK according to their respective characteristics.

This study is an ethnoecological study that methodologically uses a processual anthropological approach to see the dynamics and processes in LEK and the community and their implications for conservation programs in Indonesia. Ethnoecological studies are interdisciplinary in nature regarding the knowledge of local communities in adjusting and managing habitats as a result of the co-evolution of culture and nature [5]. In the processual approach, culture and society are not positioned as objects that can be observed stably and

permanently (as culture), where culture is seen in an ever-changing process (as cultural) – author *R. Borofsky* [44]. The implication is that with this approach, LEK is not understood as a frozen, fixed and isolated form of knowledge from its relations with the wider world. Another implication lies in the aspects of observation and attention taken in this study. In order to fully understand the process, the actions aspect of individuals must be of primary concern, especially by contextualizing them in a series of intertwined historical experiences [45].

To show the various dynamics that occur in LEK, this study conducts ethnographic research at several research sites, namely Nusa Lembongan, Tobean and Kanekes. The study was carried out for two years, from 2019-2021. Data was collected through an extensive participatory observation process, and in-depth interviews with local communities and local policy makers. For data collection to the field carried out in close proximity to each research location. Prior to visiting the research site, permits and regulations were arranged in the local community under study. To see the series of events in the complete process, this study also uses secondary data from historical and ethnographic documents related to the research site. This is important because of one of the defects in attempting to uncover processes is the failure to find relationships between events. Therefore, historical and ethnographic data from the available literature are considered to provide a continuous temporal context for the data obtained in this study [45].

Theoretically, positioning in this study has been obtained from the study that has been conducted by *S. Zent* [42]. Using the processual anthropology approach, *S. Zent* [42] express the urgency that similar is the need for more concern and investigation for the dynamic character of LEK to respond to the changes. From exploring various cases, *S. Zent* [42] was trying to conceptualize LEK as a processual approach emphasizing change and continuity. Using that approach, *S. Zent* [42] found that LEK was not a piece of knowledge that was discrete, pure, and stable but open, active, and dynamic. From the various cases that have been investigated, *S. Zent* [42] expresses the dynamic form of LEK in responding to change through various processes of transformation, diffusion, hybridization, and innovation.

Results and discussion

As a country located in the tropics, Indonesia has several types of forests, including tropical rain forests and mangroves. At the research site, it is known that there is a wealth of biodiversity in each type of forest ecosystem. The application of knowledge about mangrove forest management by local communities in Nusa Lembongan shows a relatively different adaptation to knowledge of tropical rain forest management by the Tobelo and Kanekes communities due to different ecosystem and environmental conditions. However, the basis of knowledge about biodiversity management is based on religious beliefs and applicable customary law.

Nusa Lembongan: Awig-Awig adaptation and its Benefit to Mangrove

Nusa Lembongan island was part of Bali Province, located between a group of Nusa Tenggara in the east of Indonesia. Regarding administration, Nusa Lembongan was in the Nusa Penida sub-district, Klungkung Regency. This island was split into two administrative areas. Jungutbatu Village in the Northeast and Lembongan Village in the southwest. Geographically, Nusa Lembongan is southeast of Bali Island, precisely in Badung Strait. Nusa Lembongan coast was inhabited by a vast mangrove ecosystem to the northeast and southeast, specifically in the administration areas of Jungutbatu Village. The mangrove forest on this island was approximately 202ha wide.

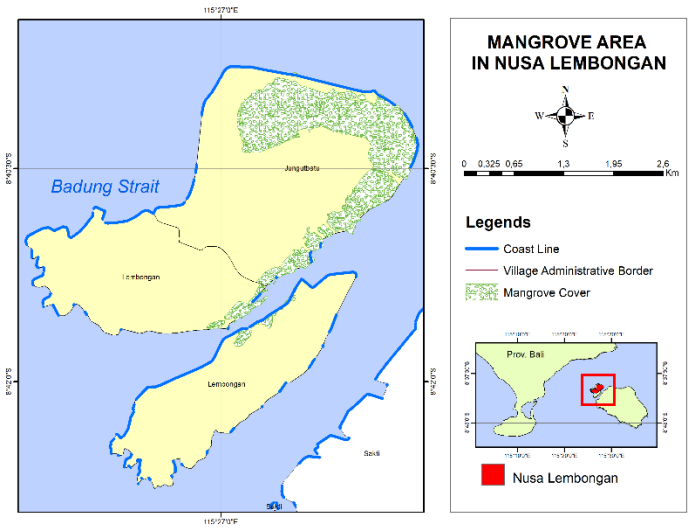

Fig. 1. Distribution map of mangrove in Nusa Lembongan

Like other Bali people, most Nusa Lembongan people follow Hinduism, which has been blended with local customary law. In this case, we will see how adaptation of LEK through customary law can demonstrate the dynamic character of LEK as well as demonstrate its benefits for Mangrove conservation. LEK contained in adat is part of the daily life of the people of Nusa Lembongan, generally Bali. In the midst of the current of change, modernization and other changes that are predicted to threaten the existence and sustainability of LEK, the interesting thing about customary law in Nusa Lembongan is that it does not fade. Awig-awig custom, for example. Awig-awig is one of the customary laws that signifies the form of knowledge of the people of Nusa Lembongan regarding environmental sustainability. Awig-awig provides guidance regarding the social relations of the people of Nusa Lembongan with each other, as well as with the surrounding ecological system. In relation to nature, awig-awig provides rules regarding what resources can be used; what trees can be cut; what areas can be touched. In its implementation, the enforcement and supervision of awig-awig is assisted by local officers known as pecalang, or often referred to as the adat police. For supervision of mangroves through awig-awig, the officer is usually referred to as pecalang immediately who is specifically tasked with maintaining the application of customary law for the sea and coast, including mangrove areas. Each pecalang works for the banjar level, at the level of the community unit (*Rukun Warga* or RW in Indonesian). For example, if someone is caught picking part of a mangrove tree, he will be fined as much as fifty thousand rupias (Rp. 50,000), a penalty for cleaning the holy place for half a day, as well as social sanctions from the village community. Such customary rules are formulated by traditional interpreters who are members of the village paper. The customary leader can formulate this custom joined in *kerta desa*.

In the last decade, customary law in Nusa Lembongan, including *awig-awig* have been addressed the massive change of modernization, Nusa Lembongan people have shown its dynamic character that has been proven by the process of LEK adaptation and their customary law. In the middle whirlwind of rapid change, customary law in Nusa Lembongan, including *awig-awig,* not just stays silent and freezing to accept the changes but responds actively through adaptation. Those adaptations were obtained from *awig-awig* codification that has been done since 2003. Previously, *awig-awig* was like other customary laws, understood and implemented through oral, never in writing. Instead of disappearing by modernization, *awig-awig* changed to the modern law product.

"Before 2003, awig-awig in our village in Nusa Lembongan was only implemented orally, not written. In 2003, we put awig-awig to be written, and untilnowt some rules prohibit cutting down Mangrove, complete with its sanction. This local wisdom was so positive that from year to year, the ignorance of people that there used to be people still doing that (cutting down mangrove trees), but since there are written rules, they are not. It is there already, including the sanction" – Informant 2.

The adoption of customary law to the formal law system has been acknowledged by the informant, which has been met as something that benefitted nature and Nusa Lembongan communities. They say that in the seventies through the eighties, seawater always went up to the mainland, but the intensity right now was reduced. The increasing seawater in the past was caused by the abrasion caused by cutting down the mangrove trees and the necessity of salt burning. After *awig-awig* had been tightened and especially codified, the logging of mangroves was more difficult. People have been changing their livelihoods from making salt to seaweed farmers. Alongside with adaptation of *awig-awig* in formal law, the efforts to protect, preserve, and rehabilitate mmangroves have been embedded. This is considered to have benefited nature and people. Interestingly, the informant said that this preservation practice benefits the conservation program and can bring economic benefit to them through increasing mangrove tourism potential.

This means a mutual relationship exists between communities and nature through the LEK medium, which is customary law. The adaptation of *awig-awig* as customary law to the formal law system has given concrete rules to preserve mangroves. On the other side, mangrove preservation has been helping Nusa Lembongan people to get economic benefits from the tourism potential that has been offered.

Kanekes People: "*Gunung Ulah Dilebur, Sawah Ulah Dirusak"*

When in the Kanekes community area, precisely in Coboleger Village. Many boards are written: "*gunung ulang dilebur, lebak ulah dirusak"* which if translated means *"The Mountain Should not be Destroyed, The Lowlands Should not be Destroyed"*. This sentence can be an early illustration of the relationship between Kanekes as agrarian communities intimate with their local ecosystem. Kanekes people, or Baduy, inhabited some villages in part of Lebak villages extending from Ciboleger Village in the north until the border of a protected forest area in kendeng mountain in the south. In the extent of customary land that is 5.136ha wide, Baduy people have two custom communities: Baduy Luar and Baduy Dalam.

Baduy Luar was a community that followed Baduy customs more flexibly, not rejecting the lifestyle from the outside. However, the Baduy Dalam community needs to be stronger on their stricter custom system, such as not using modern technologies and appreciating Jati Sunda teaching more. The field research has been conducted in these two communities, precisely in Ciboleger Villae (Baduy Luar) and Cibeo Village (Baduy Dalam).

In general, these two communities know about nature sustainability, especially forests, in the understanding as a hereditary inheritance from an ancestor that should be guarded. However, these rules about the environment that have been protected are only present in Baduy Dalam's custom. One of the examples is the Baduy Dalam custom prohibits the use of the chemical in any activities; it even prohibits any form of technology from outside of Baduy. In their livelihood, they should plant paddy but be prohibited from selling it except for other plants aside from paddy.

Even though the Baduy Dalam have customs that are more strict and more closed structure, the fact was found that the Baduy Dalam communities interact with the more abroad structure of society outside their communities. One of the examples was about the commodities of the plant. From that was founded, both Baduy Dalam and Baduy Luar communities planted various commodities outside of paddies, such as bananas, ginger, chili, and galangal. Interestingly, some people from Baduy Dalam communities acknowledged that galangal has recently become a plant they cultivate.

That was founded in Cibeo and founded a new field that will be planted with galangal. The working farmer said that galangal was massively planted not long ago. When the conservation with farmers more deeply, the farmers said the reason for planting the galangal was "it is sold enough, the galangal."

This means LEK of the Baduy Dalam community regarding the consideration of agriculture in their daily activities was affected by more abroad market structure. When they talk about selling, there is a talk about the high demand in the market, which will be one factor affecting how Baduy Dalam people will cultivate their land.

Again and again, it was found that in the communities considered completely closed, the external change in the market context can be infiltrated and touch Baduy's LEK. However, Baduy people can respond with adaptation. The market did not completely grind and erase Baduy's LEK because it was found that LEK can change and adapt according to the change that was created by the market. So, the market changed local knowledge about land management, but some did not. One of the examples is that even though paddy has become the main commodity in the market, Baduy people are still reluctant to change their agriculture pattern: only harvest once a year, not using any chemicals, and not being sold to the market. Conversely, there is LEK about crops that can be changed as a form of adaptation to the market, precisely about the type of field crops aside from paddies such as galangal.

More deeply, it can be interpreted that the external change did not immediately force the local knowledge of Baduy communities. Some of them show their resilient character. This means there is some LEK that still survives from time to time. Baduy people were happy to explain these things with the sentence: *"buyut teu meunang dirobah, lojor teu meunang dipotong, pondok teu meunang disambung"* which means "Buyut should not be changed, long should not be cutting, and short should not be connected." This is because some of Baduy's life aspects were fully set in customs inherited from their ancestor, so some aspects were impossible to change. The informants uniformly said that there should not be any addition on custom to the law, including the custom that rules about their relationship with nature, because they feel *"kaamanatan nenek luhur"* or "mandated by the ancestor".

Also, in some respects, the understanding of nature from custom can interact harmonically with the understanding of nature from modern knowledge, for protected forest matters was one of the examples. If this was pulled from the source of the history, the discourse about protected forest does not be present in the Baduy communities' system. However, it should be noted that they understand "prohibited" forests that, in the custom, should be protected. When the Banten government made the "prohibited" forest become an "absolute protected forest" through Regional Regulation Number 32 in 2001, the Baduy people welcomed it. Interestingly, Baduy communities mixed these two sources of understanding in daily practice. When talking about the protected forest, the Baduy people still use custom references *(pamali)* and talk in the formal law aspects. *"the government, the forestry, sets it"*. From this, LEK of Baduy communities about sacred forests can be merged with the discourse of protected forests produced by the government through formal law, which is also very useful for forest conservation in these areas. This means LEK about forests can be developed as a form of hybrid knowledge that benefits conservation programs.

Tobelo Dalam People: Halmahera Forest Protector

The Tobelo tribe lives in the northern peninsula of Halmahera Island and on some mainland Morotai Island. They live nomadic in the four mainlands of East Wasile, East Halmahera, North Maluku. To be precise, in Dodaga Village, Tukur-tukur Hamlet, Titipa Hamlet, and Tutuling. Their area of origin is included in the Galela District in North Maluku Regency, Maluku Province. Tobelo Dalam People were an ethnic group that inhabited the Halmahera Forest area. The Tobelo tribe often called the "O'Hongana Manyawa" community meets their daily food needs by hunting, gathering, shifting cultivation, fishing or a combination of these methods. The effort to meet the needs of this community is still subsistence because

they live in harmony with the surrounding natural conditions in accordance with the values of environmental wisdom. This population is known as “orang Togutil” but, from the experience in the field this term has the meaning of pejorative and Tobelo Dalam people reject be categorized as “Togutil”. Tobelo Dalam people were spread over almost the entire forest that includes in Akejatawe-Lolabata National Park in North Halmahera. However, the Tobelo Dalam people were nomads, Tobelo Dalam people can live in the entire Halmahera Forest. This study only focuses on observation and interviews in some sites: Tusuri Village, Dodaga Village, and Tuguis Village. However, Tobelo Dalam people staying in the village now were the people that the government housed. Tobelo Dalam people needed a better occupation system but always moved according to their needs and resources. Efforts to make Tobelo Dalam live in a house outside the forest have been done since the colonialism era, continued by the Indonesian government since independence, precisely in the 70s in the new order era.

However, the effort to make Tobelo Dalam people live and stay affects LEK, which relates to the forest. First, from ethnobotanical aspects, Tobelo Dalam people that stay starting to know about medical treatment through the village maternity hut or Pondok Bersalin Desa in Indonesian and from the presence of midwives. From time to time, LEK about treatment based on herbal from the forest will be abandoned. This means that there is ethnobotanical knowledge that is decreasing. Second, knowledge about local plants as food consumption material will decrease since they were introduced to a subsidized rice program by the government called Poor Rice or Beras Miskin in Indonesia. Third, the appearance of market systems and monetary value change some of their perspective about forests. Previously, before they were introduced to market demand, the Tobelo Dalam people did not permit the wood trees to be cut down from the forest. Another example is hunting endangered bird species such as Nuri or Kakak tua was never done. Interaction between markets has started the hunting activity of these endangered species. Even though from the interview conducted with the National Park of Akejatawa-Lolabata, the employee told that Tobelo Dalam people had been found out to catch a bird, they gave them and did not fight back. The national park employee also only sees Tobelo Dalam people cutting bigger trees, except small trees such as Woka, to build their own houses.

However, along with the disappearance of some LEK aspects in the Tobelo Dalam people’s lives, some aspects still survive. One point that has been found is that Tobelo Dalam people are always selective in accepting outsiders when they explore Halmahera Forest. Tobelo Dalam people who live in the residential area or the forest have mutually acknowledged that the forest is an integral part of their lives. Hence, they tend to protect the forest from outsiders. From various stories through field research, it was found that there is some fear of going through the forest. They tend to believe that Tobelo Dalam can do magic that makes the outsider go lost in the forest. This scare can be made outsiders not go to the forest. Aside from the mythical stories, it has been interpreted that the stories effectively accomplished the Tobelo Dalam people’s mission: protecting the “purity” of the forest from exploration by an outsider. This means that in the middle of intervention from the market, resettlement from the state, and other modernization flow, there are some Tobelo Dalam people’s knowledge about forests can be changed. However, they still understand that the forest was integral to the Tobelo Dalam people’s lives. Hence, knowledge about the urgency of forest protection has been planted and manifested through folklore and the mythical.

In addition, collaborative management is carried out between Aketajawe Lolobata National Park and the Tobelo Dalam Community in the utilization zone related to area boundaries and joint monitoring. As for the form of collaborative management model in the utilization zone, namely, existing community homes are used as tourist homes (home stays) for tourist purposes. This causes the activities of the Tobelo Dalam community in the utilization zone for gathering, hunting, and gardening to be minimized.

Result and discussion

Positioning LEK as Dynamic Knowledge

Based on the findings, there are elements of compliance (through the prohibitions, rules, and myths that apply in the community) and sustainability that forms the basis for the harmonization of forest management. In the three ethnic groups in Indonesia, forest management based on LEK has a symbolic meaning of place and spiritual relationships with views about the environment, which is based on beliefs about relationships to share and obligations towards other community members and other creatures, and management of community resources based on shared knowledge and meaning. The value of belief regarding customary rules in managing forests to prevent damage, both preventing landslides and maintaining abundant water resources to facilitate agricultural activities [58]. The wealth of LEK owned by indigenous peoples has an important role in effective climate action and sustainable development cannot be achieved.LEK shows that community ecological knowledge can have value for biodiversity conservation whether developed over a decade or over thousands of years. Community behavior in utilizing natural resources, especially forest management, actually exists in indigenous peoples or indigenous peoples through traditional knowledge which is also known as local wisdom. As previously explained, LEK has a dynamic character as a form of knowledge. If previous research saw the change that affects society and the threat of LEK degradation with some concern regarding response and the dynamic [23, 25, 26, 32-34], this study conducted in three research sites shows that LEK can be flexible and dynamic.

Finding about the threat to LEK existence has been found anywhere, such as in the Tobelo Dalam, where the communities that usually live in the forest stay in the village by interacting with state and church institutions. However, it was found that LEK as a knowledge system is partially closed and static, so it is only sometimes ground in the middle of changes. Focusing on the LEK character that pretends to be static can make skipping various information and benefit from the LEK character that dynamic [38-40]. From the data obtained, it was found that in the middle of the degradation threat, LEK can survive; LEK can be developed as new knowledge; LEK can be adapted to be hybrid.

Nusa Lembongan communities show that LEK incorporated into the custom can coexist with modern law. Such as, an argument by *A.L. Balbo et al.* [38] show that this finding has challenged the general assumption that LEK will not develop and will be acting as the meeting between local communities with changing the flow from the market, state, and modernity. Instead of being pressed by modern law, *awig-awig* in Bali has been intervening with modern law while not leaving the character of custom. The comparison shows similar processes have happened from *sasi* customs on Maluku Island. *C. Zerner* [46] mentioned that since the 19th and 20th centuries, sasi custom institutions have been codified and integrated with the formal law system of the colonial government, even with different political contexts. However, *C. Zerner* [46] observes that through the 20th century, when colonialism was finished, *sasi* still developed, interpreted, and codified as the product of custom law directed toward sustainable development goals and conservation. Local communities have been interacting with many stakeholders, such as The Ministry of Environment and Forestry and NGOs, to adapt sasi to stronger social and environmental change. Other examples can be seen in Kanekes, understanding customs related to the forest have been coexisting with the discourse of protected forest from the government. This means that the interaction with knowledge and the discourse about forests that the state has produced still needs to make the local knowledge of Kanekes replaced. Finally, their knowledge regarding forests becoming hybrid: forests can be understood in both their legal and sacred status. These examples can be evidence that, in some cases, LEK that has been adapted can be uprooted from the culture of the people [46]. Even though in this study, there are no symptoms of those worries.

Aside from their capability to produce hybrid knowledge, the communities have shown the dynamic character of LEK by developing new knowledge [26, 36]. LEK, which relates to land management in Kanekes, was one of the examples. When facing the economy of the market, Kanekes people develop local knowledge that fits the market. The interaction between markets makes them choose the species that result in profit (e.g., Kaempferia Galanga) according to the market demand. The patterns of knowledge change regarding the utilization of land and resource have been founded significant change after the local communities were integrated into the market [14].

Such findings were important to step up from the general assumption that knowledge from local communities, especially those considered isolated, is static knowledge and needs more capacity to respond to change. From these cases, the knowledge and culture of local communities can interact with other knowledge and culture; and could change due to dynamic interaction. In *R. Borofsky* [44], "cultural in motion" should be understood. Not always understanding culture, including the local knowledge system in the passive-static framework. However, it should be noted that the emphasis on the dynamic character from LEK is not solely abandoning the LEK degradation when operating with the change.

A.L. Balbo et al. [38] said that the flow of modernization that has been so strong on a bigger scale could make the LEK abandoned by communities. Such as what was founded in Tobelo Dalam when the population that hundred years have been live in the forest was made to live in the residential areas. In this process, lifestyle changes happened so massively in a short time. Tobelo Dalam people living in residential areas have been introduced to another lifestyle, and the patterns of medicine and consumption can be mentioned. If in the past, they knew the various food from forest resources such as sago, *Kahuku*, *bete*, cassava, and sweet potato. When they live, they should rely on subsidized rice from the government. The transmission of knowledge about food diversification has been threatened because it is not used anymore.

Also, the medical practice that in the past still relied on herbal plants in the forest when they live in they start relying on modern health services. Aside from that, Tobelo Dalam people have been experiencing massive identity and cultural shifts since Christianity have been accepted in the 90s [47]. The Christian conversion has significantly made Tobelo Dalam people come out of the forest and stay in the residential areas. These changes have been massive, and the consequence of this shift was the ethnobotanical about food and ethnomedicine about medicine have been abandoned and transmission. Hence, in the long term some aspects of LEK that Tobelo Dalam people have slowly faded away. What happened to the Tobelo Dalam people can be understood as a *cultural rupture* [48]. These things were not uncommon to be happening, especially since LEK could not compete for the flow of changes that were massive and rapid [37, 40].

However, Duncan [47] reminds us that in the process of changes the flow never will be directed; change is not a "simple decision between domination or appropriation meanwhile a dialectic between both of them" [47]. This means in the process of massive changes, Tobelo Dalam people still have the agency to choose the direction of change in some aspects.

Similar ideas also have been found when this field research was conducted. Tobelo Dalam people show the capacity to defend some LEK aspects. Even though already experiencing some changes (e.g. Christianization, stay in one place, become citizen, and entering market systems) Tobelo Dalam people still shows their capacity to defend LEK, such as about understanding f identity and the unity of their self with forest. It has been found that even though they already stay in residential areas, Tobelo Dalam people are still going to explore and find resources in the forest. They still see the forest as an important and sacred part of their own life and there is a possibility that they protect the forest. The distribution of folklore and mythical stories about forests was one of their methods that still exist to prevent the outsider from Halmahera forests. Even though it can't be denied that there is still a very small possibility of Tobelo Dalam people that start to sell woods after interacting with market.

However, in general, in the middle of the thear of the LEK existence, the LEK about their unit idenitty with the forest still exist.

Similar patterns are also present in Kaneke when knowledge about land management meets with market systems. It is found from the field that the change of LEK can be totally happening. The pattern of planting has been following the market, same as that have been explained before. However. The LEK that relates to agriculture systems still exists according to the customs that have been transmissioned from generation to generation. On the other side, Kanekes people have been making the market a new source of knowledge about the choice of planting in the field. However, on the other side they still defend the pattern of their authentic paddy rice planting that is sustainable. The paddy rice planting has not been disturbed by market influence; the goal was not profit but subsistence. The pattern of planting is still done according to customary laws (e.g., harvest once in a year, no chemical and modern technologies) without consideration from market condition. The interaction with changes can be raises the degradation to LEK but, in some aspects the community also have capacity to defend their local knowledge [3, 40, 42].

This means the real threath to LEK degradation has been seen and is present. However, in some aspects it is found that some communities can show their capacity and agency to respond to these threats through: (1) defen the knowledge (persistence); (2) resulting new knowledge (innovation); or (3) adapt to be hybrid (adaptation). Actually, regarding these three responses this study was agree with *A.L. Balbo et al.* [38] asude from the disappear or not disappear of LEK from the society. That have been important to observe was the community abilities and their knowledge system to respond to the dynamic that have been happening, such as from these three responses.

Observation should not stop to the fact that the threat of LEK disappearance that caused by changes from these previous studies. However, this study argues that their is should be a deeper exploration to reveal the capacities of community to respond and do dynamics toward these changes. To be more specific, it should be understood about "*... capacity to regenerate and apply knowledge that enables action and adjustments in response to current and future changes, and therefore it is the capacity to generate and apply knowledge—and not the knowledge itself—that contributes to increase the resilience of a socio-ecological system"* [37].

This capacity to respond to the change with dynamic can be key points in this study. Positioning Lek as dynamic knowledge system has been opening the potential to respond the change. Not only can be utilize to increase the resilience from socio-ecologic system on facing social change like *A.L. Balbo et al.* [38] said but, looking on dynamic aspects from LEK can be seful to support conservation that in the present time have been facing to similar issues: environmental changes that move rapidly.

Dynamic Chatacter of LEK and Its Benefit to Conservation

From the explanation above, it has been found that LEK could not just disappear or be degraded because of massive societal changes. However, LEK can survive, develop, and adapt. It raises the question, what are the significances of the conservation?

First, this study has emphasized that if the dynamic character of LEK is not explored, there is a bigger possibility for researchers, policymakers, NGOs, and conservationists to skip the valuable information about persistence, innovation, and adaptation from LEK in society. Letting through that valuable information means letting through the opportunity to make an adaptive conservation program; that is appropriate to the socio-culture contexts, which can increase the capacity of socio-ecology resilience in the society, making the conservation can be competing with the rapid environmental flow of changes. Remembering the conservation effort in the 21st century have been facing difficult challenges that haven't been found in the previous centuries, the rapid environmental change on a global scale caused by anthropogenic activities—this can be a massive challenge to the conservation in the age of human or *Anthropocene* [49]. These implications from the change in the Anthropocene era were

ecological destruction that was irreversible in a short time frame. The indication can be seen from various destroyed ecosystems and the increasing flow of extinction.

That was said before, as biodiversity hotspot areas, ecosystems, and biodiversity in Indonesia can be seriously threatened. In biodiversity hotspots, the change in the Anthropocene era can cause vulnerability to the ecosystem and biodiversity [29]. LEK integration in conservation was one of the strategies to compete with ecological threats. It has been mentioned that many researchers have been trying to integrate LEK into conservation needs in Indonesia. However, it is valued that this integration can only be successful if LEK is positioned as static knowledge. Seeing the dynamic character of LEK has been creating a possibility to make a conservation program that is dynamic and adaptive to change without injuring social welfare [42].

From the stories that have been told in Nusa Lembongan, Kanekes, and Tobelo Dalam the dynamic character of LEK could contribute to the environmental conservation effort that was knitted from various actors. The dynamic character of LEK can appear in their survival form (*persistence*) when responding to change [3, 42, 50]. Such as that has happened to Kanekes in surviving their sustainable agriculture systems even though they have been interacting with the market system, or in Tobelo Dalam communities when they survive their relationship with the forest even though they have been introduced to state structure and modern religious institutions. LEK survival can empower the community to protect the ecosystem in the middle of a threat caused by massive environmental change, such as climate change [51]. Also, in responding to the change, local communities can show the new and innovative LEK [36]. Such as when new knowledge about planting patterns appears due to interaction with the market system in Kanekes. *I. Ruiz-Mallen and E. Corberra* [18] explained LEK's innovative features in many conservation programs that have been proven useful in solving the issues.

Then, using LEK for conservation can be sourced from the adaptive capacity, resulting in hybrid knowledge [42, 52, 53]. In Nusa Lembongan, after LEK has been institutionalized in the modern law system, mangrove conservation can be operated structurally. Codification of *awig-awig* has made the adat police (*pecalang*) have stronger legitimacy through the given formal authority (from the state) to enforce the rule related to the protection of mangroves and coastal ecosystems. From this explanation, it can be seen that there is no superimposition of modern knowledge products (formal law) to the customs sourced from local knowledge. LEK can even be mixed with the conservation discourse produced by formal law without abandoning the customary characteristic.

What Kind of Conservation Model?

From the explanation above, it is safe to say that the dynamic character of LEK was important to discuss because of its potential benefit in conservation programs. However, the question is: what conservation model can concretely show the practical value from the dynamic character of LEK?

It can be valued that the utilization of LEK dynamic character will be very appropriate to integrate with the conservation model based on communities (*Community-Based Conservation*). *K.A. Galvin et al.* [55] emphasize that integrating LEK in CBC was very important so the conservation can be operated with correct intervention to specific socio-cultural contexts. Also, *I. Ruiz-Mallen and E. Corberra* [18] describe that LEK's dynamic character can give a positive offering to CBC from two mechanisms. First, the communities could offer the capacity to elaborate their knowledge about the local ecosystem through iterative examination, the learning process from experience, and trial and error. Second, the LEK dynamic character has allowed the conservation to be managed by locals, adjusting to the management practice with socio-ecological conditions that happened directly to the communities. Dynamic character from LEK always makes evolution so it can potentially reinforce the socio-ecological resilience system of the communities, such as increasing natural resources management capability in the middle of the flow of changes [55].

There is the third important mechanism, like the other two. Understanding the elaborative capacity of LEK can be directed to the fair distribution of power in conservation management, and it can be noted that in the conservation that is based on community, usually there is unfair power relation between researchers and the community, between science and local knowledge [53, 56]. Also, other positive offerings are more practical: this program will be cheaper and suitable for developing countries [2, 10, 15].

However, there are some concerns about how LEK can be integrated into a conservation model that tends to be flexible such as the examples above, without understanding it first and putting serious concern to the dynamic capacity of LEK itself? From this point, we emphasize that observing and understanding LEK's capacity to change, develop or survive should be done first. Those concerns can help the actors involved in conservation to get information about the community's capacity to respond to the change with their knowledge, whether it is a capacity to defend the LEK, mix various knowledge, or create new LEK. From these things, conservation can be an opportunity to utilize the dynamic of LEK. This adjustment can be varied according to the socio-cultural context of the community. It can happen with the self-regulated principle that the strategy emphasizes authority and responsibility to the community with informal rules and flexible social institutions [17], such as in Kanekes, or *co-management* that have conservation strategy involving various actors (communities, adat/custom institution, and the government) in Nusa Lembongan.

So, back to the early question: what kind of conservation model? Unfortunately, this study has limitations in answering this question. An extensive answer to this question will be interesting to be extracted in future research. However, we can offer an introductory idea to answer it: conservation strategy options based on the community in Indonesia can be opened if the dynamic character from LEK is truly considered. In the middle of findings regarding the flow of change that threatened LEK existence in many Indonesian local communities [23, 25, 26, 32-34], LEK, can respond the flow of changes dynamically. The findings in Nusa Lembongan, Kanekes, and Tobelo Dalam show that the change was not directed, so LEK cannot be said to have been just degraded. Local communities have agencies to defend local knowledge, such as the survival of intimate relations with the forest in Tobelo Dalam people or the survival of the customs regarding planting patterns in Kanekes; develop new knowledge, such as choosing filed plant species in Kanekes; or adapt it such as customary law codification in Nusa Lembongan.

Understanding the dynamic character of LEK can be the first step in formulating a conservation program based on an adaptive and participatory community. Realizing the dynamic character of LEK has been opening many conservation potentials that in the past still need concern if LEK is still seen as passive-static knowledge.

First, not focusing on persistence capacity in the dynamic of LEK when facing the change means letting through the opportunities to support the integration in the conservation effort, especially based on community. Even though it can be seen the concern to the knowledge persistence about the customary forest in Kanekes and Tobelo Dalam has been empowering conservation based on the community with *self-regulated* principles.

Second, letting through the capacity of communities to produce new LEK means letting through the opportunities to extract knowledge innovations that can be useful to conservation. Cush as new knowledge regarding the choice of fled plant species in Kanekes people obtained through the interaction with the market. These examples do not directly relate to conservation, but the community could keep developing its LEK along with the changes. The renewal of LEK can result in innovations that benefit conservation.

Third, keeping the flexibility of LEK to adapt will help the integration process in the conservation programs that have sources from modern knowledge. However, from our findings in Nusa Lembongan, LEK can be adapted to the modern knowledge system to facilitate LEK

integration into conservation. A similar potential has been utilized through *sasi* codification in Maluku.

As one of the efforts to support climate action as SDGs number 13, forest management based on indigenous peoples' LEK will be able to provide benefits in several ways, namely: ensuring biodiversity conservation and sustainable management of natural resources, which can be used for forest and other resource management (on land or at sea). In relation to forest management and agriculture, it is related to SDGs number 15 so that it can maintain diversity in terrestrial ecosystems. In addition, LEK can be used to improve sustainable agricultural practices and food security. This is related to SDG number 2 to overcome hunger and poverty. Utilization of LEK as a forest management approach will also improve sustainable livelihoods, pay attention to environmentally friendly aspects and encourage innovation, entrepreneurship, and climate-sensitive businesses. Involvement of LEK as part of mapping ways to tackle the climate change crisis, can also contribute to achieving gender equality and enabling increased participation of women in decision-making and natural resource management, among other areas. In addition, support for indigenous peoples will support the security of more peaceful, stable and resilient communities for inclusive socio-economic development, as well as monitoring and accountability to ensure no one is left behind.

In terms of contributing to climate action [59], LEK actually has a greater contribution to climate change mitigation and adaptation, as well as to equitable transition policies, where:

1.The practice of traditional farming methods that are resistant to climate change, for example with terraces that stop soil erosion or floating gardens that use waterlogged land.

2.Conservation and restoration of forests and natural resources, where natural resources are considered as common property and must be respected in their use.

3.There is a variety of native foods that can add to and diversify the global diet by relying on a small number of staple crops. Currently only wheat, rice, potatoes and corn represent 50 percent of the daily calories consumed, even though the existence of indigenous peoples' food systems can help mankind in expanding the variety of food ingredients.

4.The existence of native food types that are resistant to climate change, with the selection of plant species that can adapt to changes in ecosystems due to climate change. There is now a need for native plant species that are better adapted to local contexts and often more resistant to drought, altitude, flooding or other extreme conditions that will help agricultural resilience.

5.In indigenous territories there are about 80 percent of the world's biodiversity that needs to be conserved. Not only for food security and nutrition, but also for herbal medicine. Forest conservation will uphold the biodiversity of plants and animals in nature.

6.It can be learned that there is a lifestyle of indigenous peoples who are able to adapt locally and respect natural resources. For example, in mountainous areas, indigenous peoples' systems conserve land, reduce erosion, conserve water and reduce disaster risk.

But on the other hand, the threats facing indigenous peoples related to climate change still persist, including specific threats to their livelihoods, culture and way of life, their situation is different from other groups and the poor. One way to strengthen the role and contribution of indigenous peoples in forest governance and support communal territorial rights is to compensate indigenous and tribal communities for environmental services. In addition, it is necessary to facilitate community forest management. State recognition of indigenous peoples and their customary forests does not only change the character of the relationship between the state and indigenous peoples, but also as a form of recognition of local wisdom in conserving forests. Forests and indigenous peoples are two entities that cannot be separated. The indigenous peoples must be seen as strong agents of change and able to access decent work opportunities and participate in the development, implementation and evaluation of sustainable policies and measures aimed at combating climate change [60]. There is co-management of local resource users by forming formal, power-sharing partnerships with the state that allows

indigenous peoples to take an active role in, and share responsibility for, resource management and decision-making [61].

Conclusions

This study shows that forest management processes based on local ecological knowledge (LEK) can be an alternative approach to biodiversity conservation. Local ecological knowledge shows an emphasis on the ongoing process of experience-based knowledge in communities that utilize the environment. The contribution of studies on LEK adaptation as dynamic knowledge can be used as a more flexible conservation approach and evaluation of forest conservation programs in Indonesia. LEK can be studied interdisciplinary by exploring the socio-ecological aspects of society, relating to ecosystem adaptation and finding ecosystem changes.

Collecting local ecological knowledge will provide living space for indigenous peoples and protect customary rights and local wisdom in protecting forests. So, if the community gets the benefits of the forest, they will protect the forest so that carbon conservation will be maintained. The benefits of local ecological knowledge in the social forestry approach have a major role in realizing climate change mitigation through forest conservation, in the form of: (1) Reducing emissions from deforestation; (2) Reducing emissions from forest degradation; (2) Conservation of forest carbon stocks; (4) Sustainable Forest management; and (5) Increasing forest carbon stock.

Local ecological knowledge can be integrated with the application of science in protecting biodiversity and ecosystem health in general. Collaboration and partnership with local communities is an important strategy in mitigating and anticipating the crisis due to climate change. For further research can be carried out that explores and collects data on local ecological knowledge in an effort to empower and involve local communities through interdisciplinary studies between policy studies to recognize territorial rights and the contribution of indigenous peoples in forest management. This means the persistence, innovation, and adaptation of LEK in various local communities can be investigated deeply to support LEK integration in some conservation programs in Indonesia. So, the opportunities for conservation that are more adaptive and contextual will be kept open. Although this study is not yet giving a concrete, and practical image of the conservation model that was ideal for utilizing dynamic character from LEK, in accordance with the objectives of this study it has been able to describe the dynamic characteristics of LEK and its utilization opportunities in adaptive conservation programs involving local communities. Further exploration of options for that conservation model will be deserved to continue in future research.

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