

The utilization of bioresources by local communities at Giam Siak Kecil-Bukit Batu Biosphere Reserve, Riau Province, Indonesia

PRIMA WAHYU TITISARI^{1,2}, TATI SURYATI SYAMSUDIN², ACHMAD SJARMIDI²

^{1,2} Department of Biologi, Faculty of Teacher Training and Education, Universitas Islam Riau. Jl. Kaharuddin Nasution No. 113, Marpoyan, Pekanbaru 28284, Riau, Indonesia. Tel.: +62-762-674674, email: pw.titisari@gmail.com

²School of Life Sciences and Technology, Institut Teknologi Bandung. Jl. Ganesha No. 10, Bandung 40132, West Jawa, Indonesia

Manuscript received: 20 April 2016. Revision accepted: 21 October 2016.

Abstract. *Titisari PW, Syamsudin TS, Sjarmidi A. 2016. The utilization of bioresources by local communities at Giam Siak Kecil-Bukit Batu Biosphere Reserve, Riau Province, Indonesia. Biodiversitas 17: 873-886.* This study aims to assess the use of bioresources of Giam Siak Kecil Bukit Batu Biosphere Reserve by the local community. The use of bioresources was characterized by the level of utilization of bioresources in the household economy. It classified into five groups; (i) subsistence group (SG), (ii) supplementary group (SpG), (iii) integrated group (IG), (iv) specialized extraction group (SEG), and (v) specialized cultivation group (SCG). The results showed that the local community used bioresources as main source of livelihood at the core zone and buffer zone. There are 36 species of fish, 17 species of non-timber, and 28 species of timber used by local community. Core area and buffer zone are dominated by SEG and SCG. In the core area, the relationship between SEG non-timber and timber is very significant. In buffer zone, the exploitation of fisheries, and timber were dominated by SEG. The correlation between the use of bioresources in the core area showed that the exploitation of non-timber and timber are very high by SEG community.

Keywords: Giam Siak Kecil Bukit Batu Biosphere Reserves, Specialized Extraction Group, Specialized Cultivation Group

Abbreviation: GSKBBBBR = Giam Siak Kecil Bukit Batu Biosphere Reserves, SEG = Specialized Extraction Group, SCG = Specialized Cultivation Group

INTRODUCTION

Biosphere reserves are a conservation area terrestrial and coastal/marine or a combination of more than one type of ecosystem, which is internationally recognized within the framework of the MAB (Man and the Biosphere) program (MAB, 2008), formation is to balance and harmonize the human relationship with nature (UNESCO 2011). Biosphere reserves explicitly recognize the human and human interest in the conservation of the landscape while preserving the ecological values of protected areas (Coetzer et al. 2013). In other words, the biosphere reserve should be able to integrate aspects of cultural, social, economic and natural capital for the sustainability of local livelihoods and ecosystems on a broad scale (Bozak 2008; UNESCO 2011; Coetzer et al. 2013; Agnoletti et al. 2015).

Unfortunately, setting up community involvement in conservation actually cause conflicts between stakeholders with local communities living in the biosphere reserve (Hill et al. 2015; Jacobs et al. 2015; García-Llorente et al. 2016). The conflict arises because policies that build on the biosphere reserve restrict the activities of local communities (Hill et al. 2015, Jacobs et al. 2015). The conflict arises because policies that build on the biosphere reserve restrict the activities of local communities (Hill et al. 2015; Jacobs et al. 2015). The local community considers the closing of the core zone which has been the main source of livelihood will affect the economic prosperity that led to changes in their livelihood strategies (Jorda-Capdevila et al. 2015; Kolka et al. 2016). The

problems that arise in the biosphere reserve caused by human activities such as illegal logging, poaching of wildlife, land use and sharing of economic benefits that do not fit (Habibah et al. 2010, 2011; Coetzel et al. 2012).

As well as in Giam Siak Kecil Bukit Batu Biosphere Reserve (GSKBBBBR), the problems are also caused by human activities, such as land ownership conflicts, illegal logging, poaching of wildlife, land use, burning of land and conflicts with policy makers. Since the beginning of 2000 to 2014, approximately 47,200 hectares buffer zone of GSKBBBBR disrupted due to illegal logging and forest fires, and followed by illegal palm oil plantations (Partomiharjo et al. 2007). There are around 126 plants (52 of rare plants and protected), 150 birds, 10 mammals and 8 reptiles are protected (Partomiharjo et al. 2007; LIPI 2008a, b).

Indeed human and biodiversity not be separated. Biodiversity is an asset for human beings to lives in the present and future, and the current biodiversity is threatened due to human activities. As shown in the Outlook Report (GEO-3) (UNESCO 2011), human activity is an important trigger factor for the rate of land use, climate change, pollution, and unsustainable the use of bioresources. Reduction of biodiversity caused by the human population growth is in line with the consumption patterns of unsustainable use of bioresources, land ownership conflicts, and injustice the distribution of economic and bioresources (Jacobs et al. 2015; Newton et al. 2015; Renaud et al. 2016). Reduction of biodiversity is closely related to sustainable development, so that the management of biosphere reserves require a more holistic

approach, integrated and comprehensive (Santhanam-Martin et al. 2015; Schmeller et al. 2016). To change unsustainable consumption and production patterns, it is important to calculate every sustainable contribution value and services including human wellbeing, biodiversity and cultural aspects (Szabo et al. 2016; Wyborn et al. 2016). The aim of this study to explore the use of the bioresources of the biosphere reserve by the local community in the GSKBBBR, Riau Province, Indonesia.

MATERIALS AND METHODS

Study area

This study was conducted in the Giam Siak Kecil-Bukit Batu Biosphere Reserves, located in Bengkalis Districts and Siak Districts in Riau Province. This area is one of seven biosphere reserves in Indonesia. Based on Proposal Management Plan of GSKBBBR (MAB Indonesia 2008). The area covered 705,271 ha. Administratively this area belongs to Bengkalis and Siak districts. The core zone is

about 25% of biosphere reserve (178,722 ha), which is a combination of natural forest conservation and forest production. Forest production has been converted into oil palm plantations, industrial tree plantations and settlements. The buffer area is about 32% of biosphere reserve (222,425 ha). The transition zone is about 43% (304,23 ha).

Research methods

The method used were survey method, focus group discussions, key informant interviews, ethnographic study, and secondary data. Household income data is a combination of social and economic data, qualitative and quantitative data, participatory data, and extractive data.

Samples were taken randomly by a wide variety of backgrounds demography of population, economic families and access to information about GSKBBBR, based on this approach then determined the percentage of household sample of 60% of the total population of households in each village that represent the core zona and the buffer area.

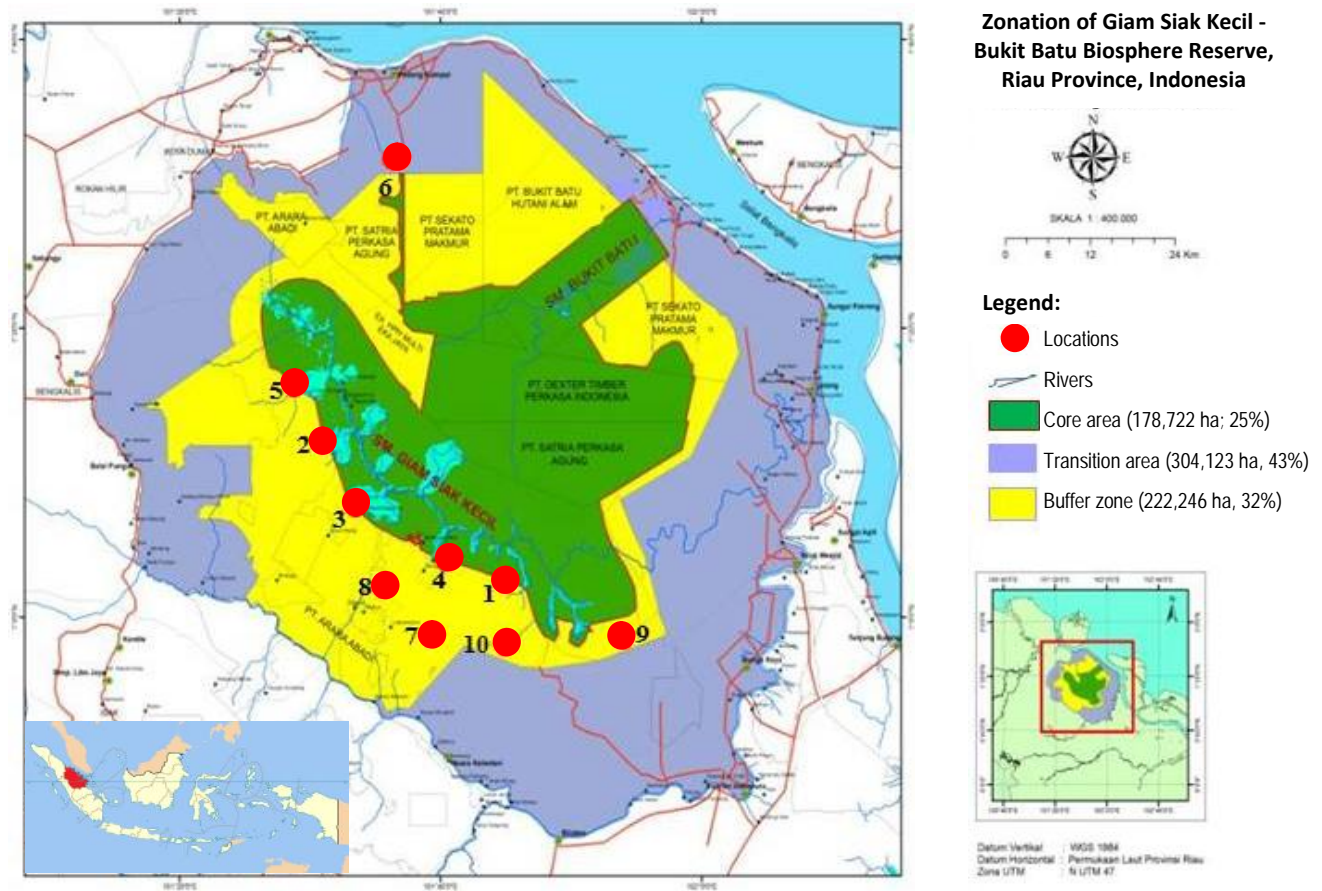


Figure 1. Giam Siak Kecil Bukit Batu Biosphere Reserve, Riau Province, Indonesia (LIPI 2008a). 1. Tasik Betung village, 2. Tasik Serai village, 3. Tasik Serai Timur village, 4. Tasik Tebing Serai village, 5. Tasik Serai Barat village, 6. Bukit Kerikil village, 7. Muara Kelantan village, 8. Sungai Selodang village, 9. Olak village, 10. Muara Bungkal village

Data collection

There were two types of data collected, i.e. primary and secondary data. The primary data were collected through key informant interviews, general observation, and focused group discussion (FGD). Key informant interviews were used to collect detail of information on local knowledge about forest use, land-use and bioresources. General observations carried out to illustrate the use of forest, land characteristics and utilization of bioresources. Observations were also conducted to test the cross-checking information collected from the community. FGD done basically to obtain general data from various people representing different groups in community. A community meeting initialized the methods of data collection. The secondary data consisted of demography, education level, public facilities, and land use systems. The related literature was collected from several sources.

Community meeting

A community meeting was attended by most of the community members, comprising young and senior inhabitant, men and women, and traditional leaders. During the meeting, the participants were asked to discuss how they described the forest land uses around them.

Interview with key informants

Key informants interviews conducted in 50 households by using a semi-structured questionnaire. The interview focused on local knowledge about land use and the utilization of forest and bioresources. In addition, interviews were also conducted with five key informants who understand the process and their involvement in land management and bioresources. The key informants were including the village head, customary leader, old villagers, and informal community leaders.

Focused group discussion (FGD)

We facilitate and initiate FGD on several groups participating in each village. Some of the topics covered include specific information about the importance of bioresources, the role of society and the rules of forest use.

Data analysis

There are two main effects that occur due to the use of bioresources in biosphere reserves. First, the impact on the species of the bioresources, such as changes in population, distribution and existence of the species. Second, the impact on the ecosystem in the form of ecosystem change, and no less important is the community's decision about the use of bioresources. Determination of biological indicators used in this study was to assess the sustainable extraction of bioresources, and the factors that influence decision-making in land use and utilization of bioresources. Specified indicators chosen based on three levels, namely the level of utilization of bioresources, land use at the ecosystem level, which will generally depict a mosaic of land use, including plantations and forests. The use of bioresources refers to the opinion Belcher et al. (2005), which is indicated by the level of utilization of bioresources as a source of economic income family, which

consists of (i) Subsistence Group/SG, (ii) Supplementary Group/SpG, (iii) Integrated Group/IG, (iv) Specialized Extraction Group/SEG, and (v) Specialized Cultivation Group/SCG.

RESULTS AND DISCUSSION

Community and livelihood

The population of households and communities in this research is dominated by the ethnic Malay. The level of education is generally only up to primary school, do not complete primary school, and there was never gone to school. Traditional regulations still applied to life as guidelines and rules to define norms for the whole community. The main source of the people's livelihood comes from plantations and fisheries. Most community work as shifting cultivators, rubber tappers, loggers, weavers (especially for women) and plantation workers. Most community plant rice to meet their daily needs. They also plant rubber intercropped with vegetables and fruit trees. In addition, they are also hunting, fishing and gathering products of non-timber forest such as rattan, fruits, vegetables, honey, and *nira* (for coconut sugar).

The utilization of bioresources as a source of livelihood

Giam Siak Kecil Bukit Batu Biosphere Reserves have a diversity of plants is high. According to the geographical location, the dominant plants are relatively the same as the vegetation lowland tropical rain on the Sumatra, Borneo and Malay Peninsula. Some species of plants and found several species of unique and rare allegedly include: *Johannesteijsmannia altifrons* HE.Moore, *Areca catechu* L., *Iguanura wallichiana* (Mart.) Benth. & Hook f., *Dyera costulata* (Miq.) Hook.f., *Daemonorops draco* (Willd.) Blume), *Shorea peltata* Sym, *Aquilaria malacensis* Lamk, *Calamus ciilegalis* Blume, *Calamus exilis* Griffith, *Gonistylus bancanus* Kurz, *Styrax benzoin* Dryand, *Eurycoma longifolia* Jack, *Nenga* sp., *Archidendron bubalinum* (Jack) Kosterm, *Phanera kochiana* (Korth.), *Baccaurea racemosa* (Reinw. ex Blume) Müll, *Baccaurea stipulata* J.J.Sm, *Palaquium* sp., *Alstonia scholaris* (L.) R.Br, *Koompassia excelsa* (Becc.) Taub, *Shorea* sp., *Litsea* sp., *Dehaasia* sp., *Parashorea* sp., *Pterospermum javanicum* Jungh, *Eugenia* sp., and *Pometia pinnata* J.R. Forster & G.Forster.

Giam Siak Kecil Bukit Batu Biosphere Reserves has a high diversity of animals, some of which are endangered, as *Panthera tigris ssp. sumatrae* Pocock, *Elephas maximus sumatranus* Temminck, *Aonyx cinerea* Illiger, *Neofelis nebulosa* Griffith, *Catopuma temminckii* Vigors and Horsfield, *Balionycteris maculata* Thomas, and *Megaerops wetmorei* Taylor, but it also found six species of primates, *Presbytis melalophos* Rafflei, *Macaca fascicularis* Rafflei, *Macaca nemestrina* Linnaeus, *Hylobates agilis* Cuvier, *Symphalangus syndactylus* Rafflei, and *Presbytis femoralis* Martin. It was also found various species of birds, among which *Ciconia stormi* Blasius, *Leptoptilos javanicus* Horsfield, *Anhinga melanogaster* Pennant, *Cairina scutulata* Muller, *Melanoperdix nigra* Vigors, *Lophura erythrophthalma/L. pyronota* (del Hoyo and Collar),

Lophura ignita (del Hoyo and Collar), *Batrachostomus auritus* Gray, *Buceros vigil* Sibley and Monroe, dan *Pitta granatina* Sibley and Monroe. Some of the bird species are endemic species in Sumatra, *Pycnonotus melanicterus* Gmelin, *Trichastoma tickelli* Blyth and *Lonchura striata* Linn.

CBGSKBR bioresources utilized in the community as a source of livelihood consists of three groups: (i) fishery, (ii) timber, and (iii) non-timber. Utilization as well as the current condition of existence of the three bioresources is illustrated in the tables below.

Based on Table 1, Figure 2 and 3, illustrated condition the existence of various types of timber in the core zone and buffer area GSKBBBBR. Since 2005 there has been a significant decline existence of different kinds of timber, including some types of protected categories, as *Gluta renghas* L, *Camnosperma auriculata* Blume, *Comnosperma macrophylla* Hook.f, *Fragraec fragrans*

Roxb, *Anisoptera costata* Korth, *Palaquium leiocarpum* Boerl, *Koompassia malaccensis* Maing, and *Shorea parvifolia* Dyer. The condition of the existence of timber due to illegal extraction of timber excessive. These conditions are in addition to affecting the existence of a type as well as the conservation aspects in the core zone will also affect the livelihood resources that they extract the bioresources of timber as a source of livelihood, even though what they are doing is against the law and undermine the preservation of biodiversity in GSKBBBBR. In Figure 2, seen the rate of decline of seven types of timber which since 2005 has been in dangerous conditions and getting very hard to find. Figure 2 data derived from illegal loggers, illegal timber collectors and traders of illegal timber, they stated that within a period of fifteen years there has been a significant decline, until this study is completed, illegal logging is ongoing, especially in the area of the buffer that have greater access to the timber stolen.

Table 1. The existence of bioresources timber used as a source of livelihood by local community at the core zone and buffer area at GSKBBBBR, Riau Province, Indonesia

Biological resources		Times (years)						
Local vernacular name	Scientific name	< 1990	1990	2000	2005	2008	2011	2013
			s/d	s/d	s/d	s/d	s/d	s/d
		2000	2005	2007	2010	2012	2015	
Balam/Jongkang	<i>Palaquium leiocarpum</i> Boerl.	Green	Yellow	Yellow	Yellow	Yellow	Yellow	Red
Bengku	<i>Santiria laevigata</i> Bl., Mus. Bot.	Green	Green	Green	Green	Green	Green	Red
Bintangur	<i>Calophyllum soulattri</i> Burm.f.	Green	Green	Green	Green	Green	Green	Red
Durian Burong	<i>Durio carinatus</i> Mast.	Green	Green	Green	Green	Green	Green	Red
Gaharu	<i>Aquilariella malaccensis</i> (Lamk.) van Tiegh	Green	Green	Green	Green	Green	Green	Red
Geronggang	<i>Cratoxylum arborescens</i> (Vahl) Blume, Mus. Bot. Lugd. Bat.	Green	Green	Green	Green	Green	Green	Red
Kelat	<i>Eugenia</i> spp.	Green	Green	Green	Green	Green	Green	Red
Kempas	<i>Koompassia malaccensis</i> Maing	Green	Green	Green	Green	Green	Green	Red
Keranji	<i>Dialium indum</i> L., Mant.	Green	Green	Green	Green	Green	Green	Red
Ketiau	<i>Ganua motleyana</i> (de Vriese) Pierre ex Dubard	Green	Green	Green	Green	Green	Green	Red
Mendarahan	<i>Myristica inners</i> Blume	Green	Green	Green	Green	Green	Green	Red
Mengeris	<i>Kompassia excelsa</i> Benth	Green	Green	Green	Green	Green	Green	Red
Meranti bakau	<i>Shorea uliginosa</i> Foxw.	Green	Green	Green	Green	Green	Green	Red
Meranti mersawa	<i>Anisoptera costata</i> Korth	Green	Green	Green	Green	Green	Green	Red
Meranti rawa	<i>Shorea parvifolia</i> Dyer.	Green	Green	Green	Green	Green	Green	Red
Meranti bungo	<i>Shorea teysmannia</i> Dyer.	Green	Green	Green	Green	Green	Green	Red
Meranti merah	<i>Sloanea guianensis</i> Aletón	Green	Green	Green	Green	Green	Green	Red
Nyamplung	<i>Calophyllum inophyllum</i> Linn.	Green	Green	Green	Green	Green	Green	Red
Nyatoh	<i>Payena leerii</i> (Teijsm. & Pinn.) Kurz.	Green	Green	Green	Green	Green	Green	Red
Para	<i>Aglaiia ignea</i> Bark.	Green	Green	Green	Green	Green	Green	Red
Pulai	<i>Alstonia pneumatophora</i> Back.	Green	Green	Green	Green	Green	Green	Red
Punak	<i>Tetramerista glabra</i> Miq.	Green	Green	Green	Green	Green	Green	Red
Rasak	<i>Vatica rassak</i> (Korth.) Blume	Green	Green	Green	Green	Green	Green	Red
Rasak	<i>Vatica umbonata</i> Hook.f.	Green	Green	Green	Green	Green	Green	Red
Rengas	<i>Gluta renghas</i> L.	Green	Green	Green	Green	Green	Green	Red
Terentang	<i>Camnosperma auriculata</i> Blume	Green	Green	Green	Green	Green	Green	Red
Terantang	<i>Comnosperma macrophylla</i> Hook.f.	Green	Green	Green	Green	Green	Green	Red
Trembasah	<i>Fragraec fragrans</i> Roxb.	Green	Green	Green	Green	Green	Green	Red

Note:

- = Still easily found in any collection/logging timber species is still widely available, and can be used as a source of income and the remainder can be used for its own needs and other needs
- = Easy to found in any collection / logging timber species is still available but not many and distance timber extraction has been away to the middle of the forest, including the price of timber is expensive
- = Difficult to found in any logging timber species is still available but not many and distance timber extraction has been away to the middle of the forest, including the price of timber is expensive, specially *Koompassia malaccensis* Maing, *Vatica rassak* (Korth.) Blume, and *Palaquium leiocarpum* Boerl.

The condition of the existence of various types of non timber bioresources use by the communities in the core zone and buffer area CBGSKBR illustrated in Table 2. Bioresources are exploited non-timber comprising two groups of plants and animals. Both of these bioresources is the substitution of the bioresources of timber with adequate economic value, the level of dependence of some communities to bioresources for non-timber high enough, for enough help their household income, of 280 households in the sample, 13% rely on their economic returns from non-timber biological resources. Based on Table 2, since 2005 the availability of non-living resources of timber began to decline, and since 2011 some type of non timber biological resources, especially from animals getting hard to come by. The saddest thing is the exploitation is too much on some types of protected animals, such as *Chitra chitra* Nutphand, *Amyda cartilaginea* Boddaert, and *Manis javanica* Desmarest who mythologized as a traditional medicine. Based on information from the respondents, namely catcher and sellers of these animals in Bengkalis, since 2014 almost no longer sell these animals, because there is no supply from the field. Arrest activity and sales are illegal, because the traded animals are protected by government regulations, but based on field observation illegal activity is still ongoing. Illegal activities like this if allowed to continue, it will damage the biodiversity of protected animals in CBGSKBR.

The condition of the existence of various types of bioresources utilized by the fish in the core zone and buffer area GSKBBBBR illustrated in Table 3. The dependence of society to the bioresources of fish is very high, because it helps their household income, from 280 households in the sample, 37% rely on their economic income of the bioresources of fish. Since 2005 has been the availability of biological resources, the fish began to decline, and since 2011 some kind of fish is getting hard to be obtained. The decline in fish catches, in addition affected by the excessive exploitation, also due to seasonal factors, in a year there are only four months (October-December) the effective time to catch fish, it is influenced by conditions of drought or dry months. In 2011 through 2013, most of his lakes and creeks in GSKBBBBR experiencing a severe drought, which resulted in almost no retrieval or fishing. In Figure 5, since 2008 there are six kinds of fish presence is very difficult to find, *Scleropages formosus* Müller & Schlegel, *Hemibagrus nemurus* Kottelat & Whiten, *Bagrichthys macropterus* Bleeker, *Notopterus notopterus* Pallas, *Kryptopterus lais* Bleeker, *Lepidocephalichthys hasselti* Valenciennes, dan *Wallago attu* Bloch & Schneider.

Based on data from Table 4 and Table 5, all categories of Belcher et al. (2005) can be found at the study site, the group Subsistence group/SG, Supplementary group/SpG, Integrated group/IG, Specialized extraction group/SEG and Specialized cultivation group/SCG the details are as follows:

Table 4 to explains the level of dependency of people in the core zone GSKBBBBR to the extraction of bioresources at 62% SG, SPG, IG, and SEG, this percentage is very large, especially in the SG and SPG, contributions extraction of bioresources become the main source of

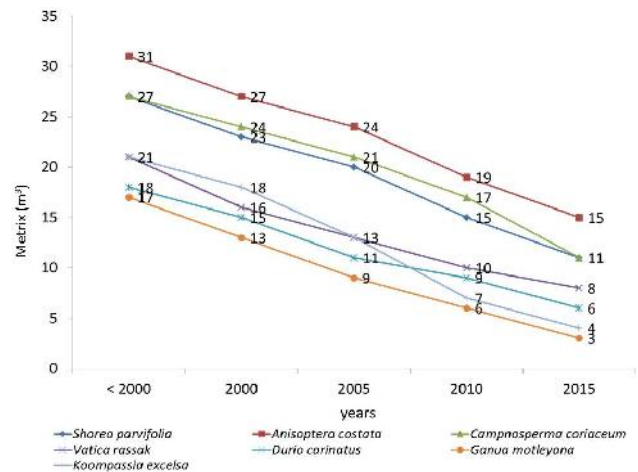


Figure 2. Reduction in the quantity of harvest some high value timber species taken through illegal logging in the core zone and buffer area at GSKBBBBR, Riau Province, Indonesia

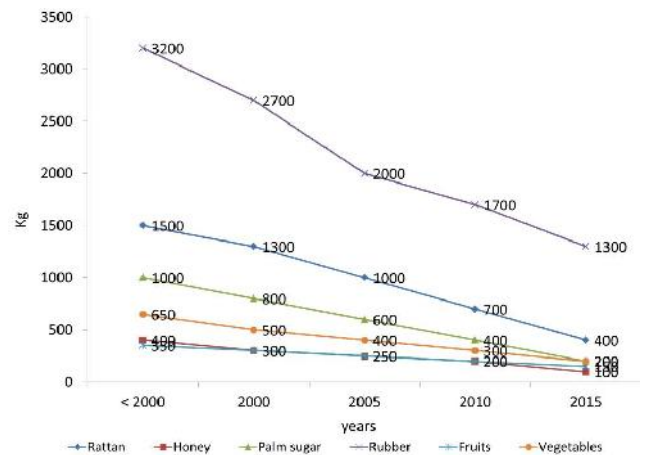


Figure 4. Reduction in the quantity of harvest some high value non timber species taken through illegal logging in the core zone and buffer area at GSKBBBBR, Riau Province, Indonesia

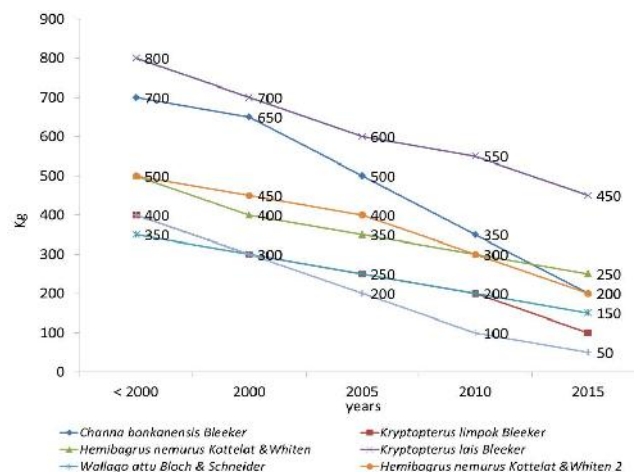


Figure 5. Reduction in the quantity of harvest some high-value fish species at GSKBBBBR, Riau Province, Indonesia

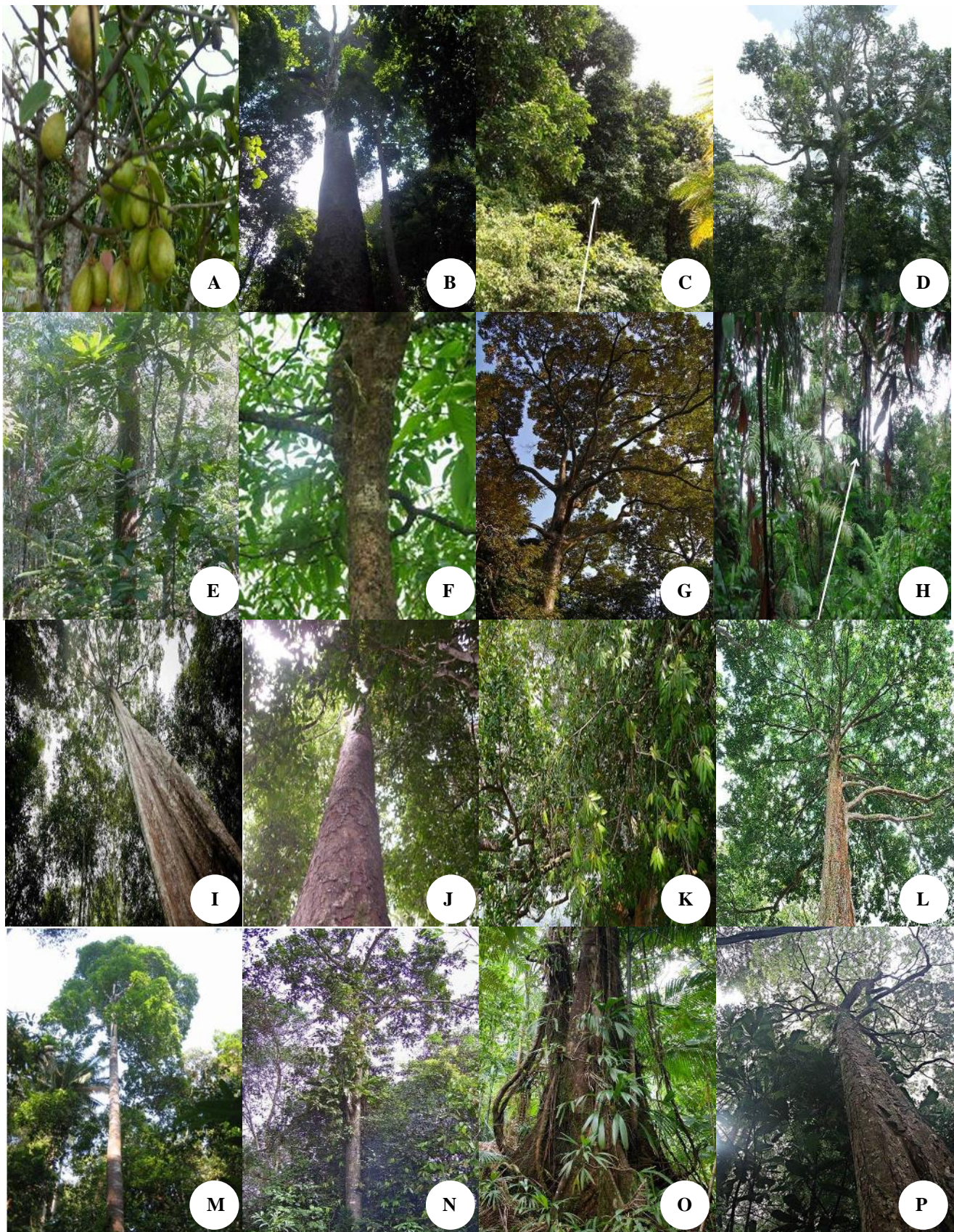


Figure 3. The diversity of high value timber in the core zone and buffer area which is utilized local community at GSKBBBBR, Riau Province, Indonesia. A. *Anisoptera costata*, B. *Aquilariella malaccensis*, C. *Calophyllum inophyllum*, D. *Calophyllum soulattri*, E. *Cratoxylum arborescens*, F. *Dialium indum*, G. *Durio carinatus*, H. *Ganua motleyana*, I. *Kocompassia excelsa*, J. *Kocompassia malaccensis*, K. *Myristica inners*, L. *Palaquium leiocarpum*, M. *Shorea parvifolia*, N. *Shorea teysmannia*, O. *Shorea uliginosa*, P. *Vatica rassak*

Table 2. The existence of bioresources non timber used as a source of livelihood by local community at GSKBBBBR, Riau Province, Indonesia

Biological resources	Times (years)						
	< 1990	1990	2000	2005	2008	2011	2013
		s/d 2000	s/d 2005	s/d 2007	s/d 2010	s/d 2012	s/d 2015
Plant resources							
Rattan	Green	Green	Green	Yellow	Yellow	Red	Red
Honey	Green	Green	Green	Yellow	Yellow	Yellow	Yellow
Various kinds orchids flowers	Green	Green	Green	Yellow	Yellow	Red	Red
Various kinds vegetables	Green	Green	Green	Yellow	Yellow	Yellow	Yellow
Various kinds fruits	Green	Green	Green	Yellow	Yellow	Yellow	Yellow
Wild rubber	Green	Green	Green	Green	Green	Yellow	Yellow
Palm sugar	Green	Yellow	Yellow	Yellow	Yellow	Yellow	Yellow
Pandanus roofs	Green	Green	Green	Yellow	Yellow	Yellow	Yellow
Wild animal resources							
<i>Muntiacus muntjak</i> Zimm.	Green	Green	Green	Yellow	Yellow	Red	Red
<i>Tragulus kanchil</i> Milne-Edwards	Green	Green	Green	Yellow	Yellow	Red	Red
<i>Helarctos malayanus</i> Raff.	Green	Green	Green	Yellow	Yellow	Red	Red
<i>Chitra chitra</i> Nutphand	Green	Green	Green	Yellow	Yellow	Red	Red
<i>Amyda cartilaginea</i> Boddaert	Green	Green	Green	Yellow	Yellow	Red	Red
<i>Manis javanica</i> Desmarest	Green	Green	Green	Yellow	Yellow	Red	Red
<i>Varanus salvator</i> Laurenti	Green	Green	Green	Yellow	Yellow	Red	Red
<i>Paradoxurus hermaphroditus</i> Pallas	Green	Green	Green	Yellow	Yellow	Red	Red
<i>Sus scrofa</i> Linnaeus	Green	Green	Green	Yellow	Yellow	Yellow	Yellow

Note:

- = Still easily found in any collection non timber is still widely available, and can be used as a source of income and the remainder can be used for its own needs/making home/cage and other needs, the price of non timber is cheap
- = Still quite easily found in any collection non timber is still available but not many and distance non timber extraction has been away to the middle of the forest, including the price of non timber is expensive
- = Difficult to find in any decision non timber is still available but not many and distance non timber extraction has been away to the middle of the forest, including the price of non timber is expensive, specially *Chitra chitra* Nutphand, *Amyda cartilaginea* Boddaert, and *Manis javanica* Desmarest.

livelihood is above 50%, the number of respondents who entered this group is quite large, as 33%. Unlike in the buffer area, Table 5 illustrates the level of dependence of communities on biological resource extraction is smaller, at 56% SG, SPG, IG, and SEG. Besides extracting biological resources, groups SG and SPG seek additional livelihood through agriculture, plantation, fisheries and other businesses. Its growth is composed of rubber and oil palm plantations, with the limited area of land ownership gardens, plantation crops generally are not sufficient as the primary source of livelihood, especially the trend of the price of rubber and oil palm tends to decrease.

All the groups have made of fishery resources as a source of livelihood, based on Table 3 and Figure 5, there was a downward trend in the number of fish caught, in addition due to the large number of people involved, the season also be a determinant factor, especially in the dry season or drought. Since 2010, the fish caught is generally not worth the high economic, especially the fish sold fresh, to increase the sale value of the fish processed into smoked fish.

Almost all the group does not have a plantation area and considerable agricultural, most of the land belonging to the indigenous and certified, thus weakening their position as landowners. From the aspect of economics and law, land

certificates can be used as capital that can help improve their access to financing sources. The group has its own land is the SEG and the SCG, but not certified, so it not yet be used as morally effort.

Difficult access roads in and out of the village, making the access to the market is also limited, they can only access the market of the village and market of the district which takes place weekly. This causes the processed products plantation, fishery, agriculture and household industry they produce does not have a high value. The level of dependence on middlemen and collectors very high, so they do not have the bargaining value of the price of the products they produce.

Figure 7 illustrates the relationship between the use of the bioresources of fish, timber and non-timber typology biological resource user community by Belcher et al. (2005), five groups, SEG has a strong relationship as extracting or utilizing bioresources fishery, timber and non-timber. This represents a large role SEG group as a group of contributors decline in the quality and sustainability of the diversity of bioresources in GSKBBBBR, Based on personal interviews with SEG group, generally illegally clearing land for oil palm and rubber that occurs mainly in the core zone, forest fires, illegal logging and overfishing carried out by them.

Table 3. The existence of bioresources of fish are used as a source of livelihood by local community at the core zone and buffer area at GSKBBBR, Riau Province, Indonesia

Biological resources		Times (years)						
Local vernacular name	Scientific name and family	< 1990	1990 s/d 2000	2000 s/d 2005	2005 s/d 2007	2008 s/d 2010	2011 s/d 2012	2013 s/d 2015
		Arwana	<i>Scleropages formosus</i> Müller & Schlegel	Green	Green	Yellow	Yellow	Red
Baung kunyit	<i>Hemibagrus nemurus</i> Kottelat & Whiten	Green	Green	Green	Green	Green	Yellow	Red
Baung Munti	<i>Bagrichthys macropterus</i> Bleeker	Green	Green	Green	Green	Green	Green	Red
Belida	<i>Notopterus notopterus</i> Pallas	Green	Green	Yellow	Yellow	Red	Red	Red
Betok	<i>Anabas testudineus</i> Bloch	Green	Green	Green	Green	Green	Green	Green
Gabus/haruan	<i>Channa bankanensis</i> Bleeker	Green	Green	Green	Yellow	Yellow	Yellow	Yellow
Julang	<i>Hemirhamphodon phaisoma</i> Collette	Green	Green	Green	Green	Green	Green	Yellow
Kelabau	<i>Osteochilus spilurus</i> Bleeker	Green	Green	Green	Green	Yellow	Yellow	Yellow
Kemuringan	<i>Puntius eugrammus</i> Silas	Green	Green	Green	Green	Green	Green	Green
Kemuringan	<i>Puntius lineatus</i> Duncker	Green	Green	Green	Green	Green	Green	Green
Kepar selinca	<i>Belontia hasselti</i> Cuvier	Green	Green	Green	Green	Green	Yellow	Yellow
Lais Kuning	<i>Kryptopterus limpok</i> Bleeker	Green	Green	Green	Green	Yellow	Yellow	Yellow
Lais Putih	<i>Kryptopterus macrocephalus</i> Bleeker	Green	Green	Green	Green	Yellow	Yellow	Yellow
Limbek bolang	<i>Clarias teijsmanni</i> Bleeker	Green	Green	Green	Green	Green	Green	Green
Limbek patil	<i>Clarias nieuhoffi</i> Valenciennes	Green	Green	Green	Green	Green	Green	Green
Pantau codiak	<i>Rasbora einthovenii</i> Bleeker	Green	Green	Green	Green	Green	Green	Green
Pantau kuning	<i>Rasbora tornieri</i> Ahl	Green	Green	Green	Green	Green	Green	Green
Pantau merah	<i>Rasbora kalochroma</i> Bleeker	Green	Green	Green	Green	Green	Green	Green
Pantau perak	<i>Rasbora sumatrana</i> Bleeker	Green	Green	Green	Green	Green	Green	Green
Riu	<i>Pseudeutropius brachyopterus</i> Bleeker	Green	Green	Green	Green	Yellow	Yellow	Yellow
Sasau	<i>Rasbora cephalotaenia</i> Bleeker	Green	Green	Green	Green	Green	Green	Green
Selais	<i>Kryptopterus lais</i> Bleeker	Green	Green	Green	Yellow	Yellow	Yellow	Red
Selais hujan	<i>Kryptopterus macrocephalus</i> Bleeker	Green	Green	Green	Green	Yellow	Yellow	Yellow
Seluang/Mengkarik	<i>Rasbora argyrotaenia</i> Blkr	Green	Green	Green	Yellow	Yellow	Yellow	Yellow
Sepat Rawa	<i>Trichogaster trichopterus</i> Pallas	Green	Green	Green	Green	Green	Green	Green
Sepimping	<i>Parachela oxygastroides</i> Bleeker	Green	Green	Green	Green	Yellow	Yellow	Yellow
Silok	<i>Lepidocephalichthys hasselti</i> Valenciennes	Green	Green	Yellow	Yellow	Yellow	Red	Red
Sopek Hitam	<i>Parambassis macrolepis</i> Bleeker	Green	Green	Green	Green	Green	Green	Green
Sopek Hitam	<i>Pristolepis fasciata</i> Bleeker	Green	Green	Green	Green	Green	Green	Green
Sopek Batik	<i>Sphaerichthys osphromenoides</i> Canestrini	Green	Green	Green	Yellow	Yellow	Yellow	Yellow
Sopek Mujair	<i>Helostoma temminckii</i> Cuvier	Green	Green	Green	Green	Green	Green	Green
Tabak	<i>Luciocephalus pulcher</i> Gray	Green	Green	Green	Green	Green	Yellow	Yellow
Tapah	<i>Wallago attu</i> Bloch & Schneider	Green	Green	Green	Green	Green	Green	Red
Tempalo	<i>Betta anabatoides</i> Bleeker	Green	Green	Green	Green	Green	Green	Green
Toman	<i>Channa micropeltes</i> Cuvier	Green	Green	Green	Green	Green	Green	Green

Note:

- = They are easy to find (a) in any arrests, this fish are still many caught, and can be used as a source of income and the remainder can be used for its own needs, (b) general price of fish is not too expensive, and more often processed into smoked fish, in order to fish selling price remains high.
- = Still pretty easy to find (a) in any arrests, this fish they caught, but not so much, and no longer be used for its own needs, but rather used as a source of income, (b) the price of this fish is expensive, and more often processed into fish smoked, so that the fish selling prices remain high.
- = Hard to find (a) in any form of arrest, the type of fish caught is extremely difficult, if caught because the price is expensive, it is more often processed into smoked fish, that fish selling price remains high. Except for *Scleropages formosus* Müller & Schlegel are generally sold alive.

Discussion

Local community perceptions towards CBGSKBR

The results showed low levels of participation and awareness among local communities in the conservation program CBGSKBR. Approximately 7% of the 280 respondents who know and realize the importance of the conservation program and be willing to be involved in conservation programs in CBGSKBR (eg meeting / focus group discussions, workshops, and training).

Based on the results of the FGD respondents perceptions of the conservation program, 39% better assess the conservation activities, 28% rate it very good, and 33% said it was not well and did not care about the conservation program in CBGSKBR. Respondents welcomed the conservation program only if they see no benefit to them for the long term as well as the involvement of local communities. It requires good management of the conservation program to provide pro-people programs so



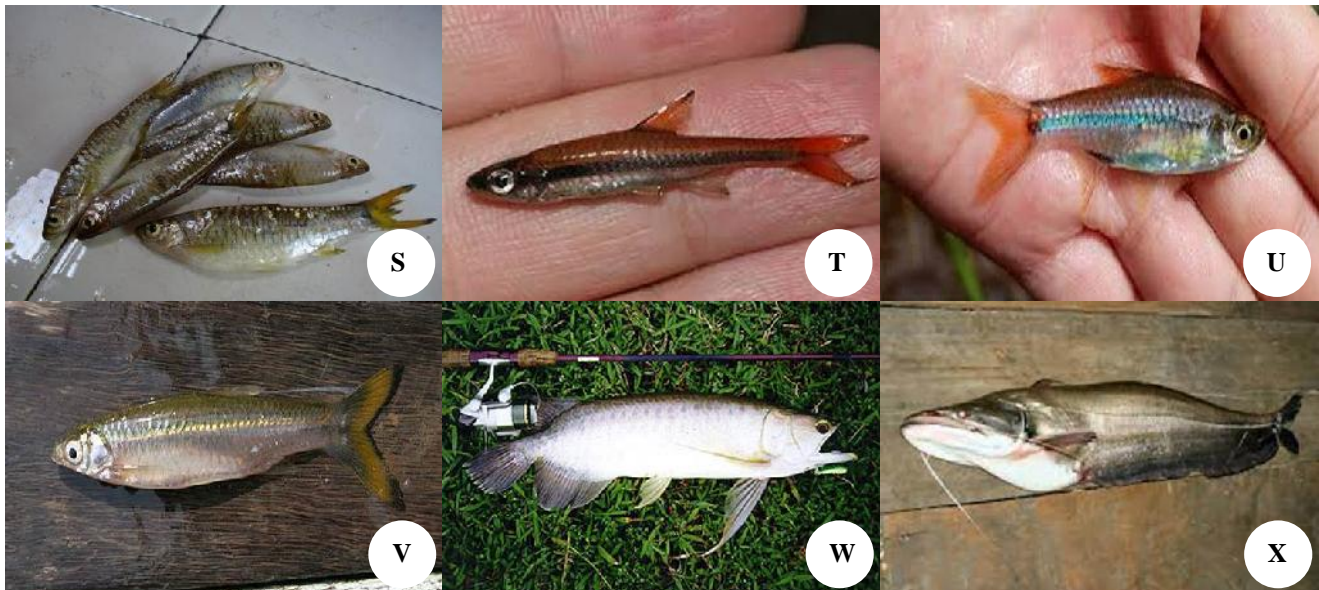


Figure 6. Diversity valuable fish are utilized by people in the core zone and buffer area at GSKBBBBR, Riau Province, Indonesia. A. *Anabas testudineus*, B. *Anabas testudineus*, C. *Bagrichthys macropterus*, D. *Belontia hasselti*, E. *Belontia hasselti*, F. *Betta anabatoides*, G. *Channa bankanensis*, H. *Channa micropeltes*, I. *Clarias nieuhoffi*, J. *Clarias teijsmanni*, K. *Hemibagrus nemurus*, L. *Kryptopterus lais*, M. *Kryptopterus limpok*, N. *Kryptopterus macrocephalus*, O. *Luciocephalus pulcher*, P. *Notopterus notopterus*, Q. *Parachela oxygastroides*, R. *Pseudeutropius brachypterus*, S. *Rasbora* spp. T. *Rasbora kalochroma*, U. *Rasbora sumatrana*, V. *Rasbora tornieri*, W. *Scleropages formosus*, X. *Wallago attu*

Table 4. Typology of local community on the utilization of bioresources in the core zone in the GSKBBBBR, Riau Province, Indonesia

Household strategy	Subsistence group	Supplementary group	Integrated group	Specialized extraction group	Specialized cultivation group
Household (N = 140)	6%	18%	16%	28%	32%
Bioresources contribution in household (income)*	>50%	>50%	<50%	<50%	<50%
Distribution integrated or cashflow in household **	<50%	>50%	>50%	>50%	>50%
Agri culture	yes	yes	no	No	no
Plantation cultivation	yes	yes	yes	Yes	yes
Fishery culture	yes	yes	yes	Yes	yes
Land ownership	communal	communal	communal	Private	private
Product value	low	medium	medium	High	high
Markets	Local	Local	Regional	Regional	Regional

Note: * = Contributions utilization of bioresources economic value to the fulfillment of the minimum requirements of households; ** = Percentage of total income received in the form of money

Table 5. Typology of community based on the utilization of bioresources in the buffer area in the GSKBBBBR, Riau Province, Indonesia

Household strategy	Subsistence group	Supplementary group	Integrated group	Specialized extraction group	Specialized cultivation group
Household (N = 140)	3%	6%	18%	29%	44%
Bioresources contribution in household (income)*	>50%	>50%	<50%	<50%	<50%
Distribution integrated or cashflow in household **	<50%	>50%	>50%	>50%	>50%
Agri culture	yes	yes	no	No	no
Plantation cultivation	yes	yes	yes	Yes	yes
Fishery culture	yes	yes	yes	Yes	yes
Land ownership	communal	communal	private	Private	private
Product value	low	medium	high	High	high
Markets	Local	Local	Regional	Regional	Regional

Note: * = Contributions utilization of bioresources economic value to the fulfillment of the minimum requirements of households; ** = Percentage of total income received in the form of money

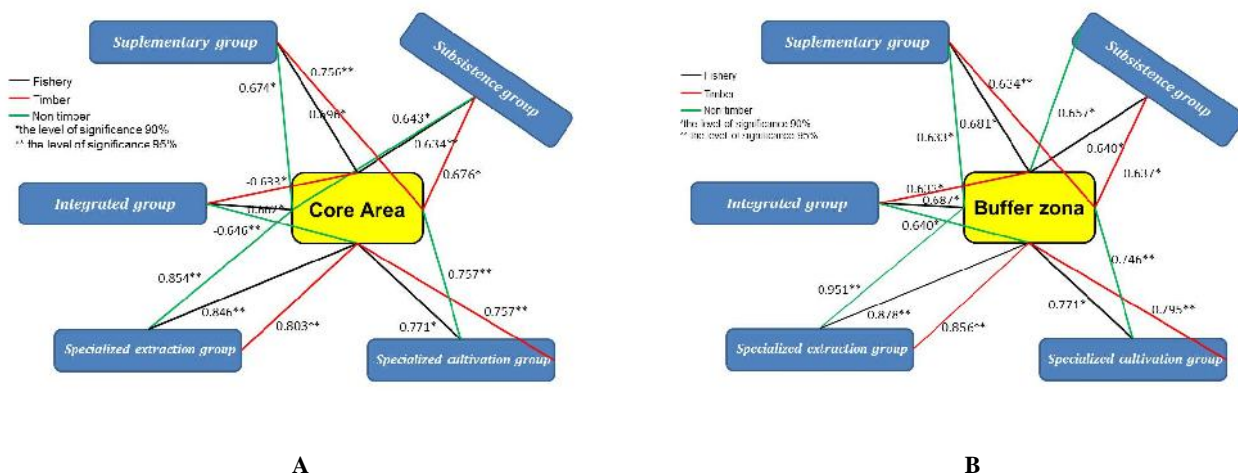


Figure 7. The relationship between the utilization of bioresources by local community based on Belcher et al. (2005) in the GSKBBBR, Riau Province, Indonesia

that people want to lend a hand to contribute to the conservation programs and change their perceptions of the functions and existence CBGSKBR. CIFOR (2012) and Santhanam-Martin et al. (2015) and Szabo et al. (2016) supports the view that decentralized participatory conservation programs can help and minimizing the barriers between conservation and sustainable development program, if implemented carefully.

In developing countries dependence on bioresources is very high. This is due to the economic value of high bioresources as well as a major source of livelihood (García-Llorente et al. 2016; Hill et al. 2015; Jacobs et al. 2015). Attitudes and perceptions of performed the visible benefits of the added value of bioresources (Asara et al. 2015). In this study, respondent participation is low, but most of them have a positive outlook on conservation programs and activities in CBGSKBR. Positive attitudes and perceptions are a good indicator if the initiatives taken conservation program, for example, community-based conservation approach, the greater likelihood of further enhancing the participation of local communities in conservation activities. However, the approach to conservation programs in CBGSKBR currently has limited public participation in decision making and planning.

Extraction of bioresources

During FGD, a majority of the participants raised concerns about the degradation of the GSKBBBR ecosystem from excessive resource extraction. Habitat destruction, as a result of illegal logging, and illegal hunting has reduced habitat for bigger animals. Large mammals such as *Panthera tigris ssp. sumatrae* Pocock, *Elephas maximus sumatranus* Temminck, and *Helarctos malayanus* Raff., has not been seen since 2012. Local and migratory bird species are also in a declining state, and this information has been verified by an analysis of resource sustainability trends. The current population pressure and increased settlements, fragmentation and thinning of the

forest, and expansion of plantations and agroforestry are the major factors contributing to habitat degradation.

Bioresources and the income of the household economy

Our survey indicates that nearly 52% of households have adopted plantation and agriculture, followed by oil palm plantation workers (12%), as fisherman, small businesses, and other types of jobs. Percentage of respondent households rely on bioresources CBGSKBR both for their own consumption or for sale by 64%. Fahmi et al. (2015) found that 77% of the population living in the wetlands of South Sumatra depend on bioresources to maintain household food security and livelihoods. Najiyati et al. (2005) found that 73% of the local communities residing around the wetlands in Riau and Jambi rely on bioresources to supplement their income. Overall, we found that each local household extracted wetland resources with an annual economic value of Rp. 4.7 million (\$361 USD; range: Rp 13,000).

Statistical analysis showed that the bioresources make a significant contribution to the economy of the household. When compared between groups with the extraction of bioresources do not extract, obtained significant economic benefit of Rp. 4.7 million, or \$ 361 USD in the group of extractors and Rp 1.8 million, or \$ 138 USD in the group not extract. This shows the economic contribution of GSKBBBR resources to the utilizing bioresources users.

Bioresource sustainability trends

In the FGD activity, respondents were asked to express their perceptions of the general trend in the utilization of bioresources CBGSKBR over a period of 15 years from 2000 to 2015 (Table 4). Three options for the indication of trends were given to the respondents: increasing, constant, and decreasing, and respondents were free to choose an option on the basis of their own understanding. The conditions of the GSKBBBR resources, including timber, non timber and fish, declined sharply during the last fifteen ten years. The majority of the utilizing bioresources and

non utilizing bioresources households were convinced of an increase in some types of fish available at the complex during the same period. In contrast, both groups stated that mammals, reptiles, amphibians, and resident and migratory birds had decreased, which corroborates the trend reported by (Partomihardjo 2007). Direct human impacts such as landslides and erosion were found to have increased, resulting in the degradation of vegetation stock and condition, confirming the information obtained during FGD. These results are consistent with the findings of Wyborn et al. (2016), who reports intense socioeconomic activities and poor management practices as the main causes of degraded wetland ecological status in the Lake Tana region of Ethiopia. Rahmawaty et al. (2014) and Bosma et al. (2012) provide a similar observation regarding the East Kalimantan, where 80% of the population perceived that the degraded condition of the wetland ecosystem was due to overexploitation. Overall, both the utilizing bioresources and non utilizing bioresources households communities had similar perceptions of each of the goods and services provided by the GSKBBBR.

Socio-economic factors affecting the extraction of bioresources

Socio-economic variables are factors that most influence the extraction of bioresources in CBGSKBR. Revenue earned from the extraction or sale of bioresources is considered as the main indicator of bioresource extraction. Revenues derived from CBGSKBR significantly affected by the number of members in the household, the length of time have made use of bioresources, age, level of education and access to other sources of livelihood. Number of family members and significant positive effect on the extraction of bioresources. More family members who could be involved to bioresources extracting it will increase the amount of revenue. The long duration of biological affect their mindset, because they are used to extract, they are not trying to find alternative sources of income.

The level of education also affects the extraction of bioresources, the higher the educational level, the less dependent on the extraction of bioresources. This is because they have other alternatives to earn their livelihoods. Ownership plantations (rubber or palm plantations) positive and significant effect on the income derived from CBGSKBR. Own planter with plantation fairly broad ownership tends no longer extract the bioresources compared with smaller land holdings or none at all. In some cases though the respondents had a fairly extensive plantations, but they are still extracting bioresources CBGSKBR.

Local community views on the use of bioresources

Some focus group meetings and activities have been conducted to gather the views of local communities on the use of bioresources in CBGSKBR. This view is required as a long term solution that may be understood by the local community about the issues and consequences of the excessive use of bioresources in CBGSKBR.

More than 11 ideas collected from the FGD participants, from 11 to the idea, can be grouped into three main ideas. The first idea is the adoption of a model of community forestry in CBGSKBR. Along with the application of the idea of community forests, the participants believe that aspect of the legality of the law submitted to the government as the initiator and primary responsibility CBGSKBR management. If transferred into a model of community forestry, forest user groups will be formed strong, taking into account the poor and disadvantaged who have been totally dependent on the extraction of bioresources CBGSKBR. Forest user groups will be entitled to develop, preserve, use, and manage bioresources CBGSKBR. Thus, the model community forest will suppress the illegal use of bio-resources, facilitate sustainable utilization of biological resources, the application of strong management and participatory.

The second idea is to look for alternative forms of utilization of bioresources by utilizing a variety of technologies of cultivation without affecting the function of the core zone as a conservation area. FDG participants realized that the population is increasing, so is the dependence on natural resources. The lack of livelihood options for alternative means of overexploitation of biological resources. Lakes and rivers as well as the buffer and transition zones could be the basis of the provision of sustainable bio-resources to provide raw materials. The development of forest and lake resource-based non timber forest products community is possible.

The third idea is the introduction of ecotourism in the complex to diversify the economic opportunities of the local people and reduce their direct dependency on the lake resources. The indigenous Malay culture, rich biodiversity, and strategic location of the lake complex between two wildlife reserve, Giam Siak Kecil and Bukit Batu, could facilitate the publicity and attraction for tourism development. Basic tourist infrastructure would be needed, such as lodges, cafés, and walking trails inside the complex to view wildlife and natural scenery. The requirement of sufficient tourist guides would provide direct employment opportunities to local youth.

Lessons learned and study limitations

This study shows that although the local people are very dependent on the utilization of bioresources CBGSKBR, they also wanted to reduce such dependence. They expect CBGSKBR developed as ecotourism potential. However, to develop tourism, the existence of biodiversity CBGSKBR need to be maintained and preserved well, local communities may not have the expertise to do so. It provides a lesson that although the participation of local communities is the key to conservation, they also need support from outside agencies, initially to support their livelihoods through alternative sources of income.

Such support can help to create awareness among the local people and enable a smooth transition from consumptive to non-consumptive use without compromising the sustainability of the wetland resources. However, outside support for conservation of the wetlands should not interfere in local decision making for resource

conservation. The GSKBBBBR resources are contributing a significant amount to the gross income of the households. We also found that there is ethnic sentiment associated with GSKBBBBR. This shows a clear linkage between social and ecological systems, as advocated by Olsson et al. (2004). Therefore, its conservation is necessary through improved social transformation that helps sustainable conservation and improved livelihood. Adoption of a community-based conservation approach, along with alternative livelihood strategies, justifies the sustainability of resource use without its degradation, which has been successful in Bangladesh (Thompson et al. 2007). These lessons are valid not only for Indonesia, but are equally applicable to all developing countries that are struggling to manage and conserve biosphere resources.

Finally, some limitations of this study should be noted. This study had limited sample sizes, with a focus mainly on households that live close to the core area and buffer area GSKBBBBR; therefore, our findings should be interpreted with caution. We also investigate only a small number of bioresources and excluded the valuation of tangible resources such as culture, tourism and climate mitigation. Future studies should take this area into consideration so that a holistic picture of bioresources of biosphere reserves can be obtained to formulate conservation policies and sustainable livelihoods better.

This study leads us to recommendations, the management system of the GSKBBBBR could be transformed into a form of community-based conservation with options for to develop ecotourism to reduce resource dependency. Finally, social and ecological systems are linked, so more awareness programs are needed, focusing at all levels of community members in the study area, as peoples participation in conservation activities is comparatively low.

ACKNOWLEDGEMENTS

We would like to thank to people of ten villageS for their open hearts and support on our works. Moreover, we are thankful for BBKSDA Riau Province, Forestry Offices in Bengkalis District and Siak District, for facilities and works.

REFERENCES

- Adato M, Meinzen RD. 2003. Assessing the Impact of Agricultural Research on Poverty and Livelihoods. *Quart J Intl Agric* 42 (2): 149-166.
- Agnoletti M, Rotherham ID. 2015. Landscape and biocultural diversity. *Biodivers Conserv* 24: 3155-3165.
- Asara V, Otero I, Demaria F, Corbera E. 2015. Socially sustainable degrowth as a social-ecological transformation: repoliticizing sustainability. *Sustain Sci* 10: 375-384.
- Bahadur KKC. 2011. Assessing Rural Resources and Livelihood development strategies combining socioeconomic and spatial methodologies. *Intl Res J Agric Soil Sci* 1 (2): 040-052.
- Belcher B, Ruíz Pérez M, Achdiawan R. 2005. Global patterns and trends in the use and management of commercial NTFPs: implications for livelihoods and conservation. *World Dev* 33 (9): 1435-1452.
- Belcher B. 2005. Forest product markets, forests and poverty reduction. *Intl For Rev* 7 (2): 82-89.
- Bosma R, Sidik AS, van Zwielen P, Aditya A, Visser A. 2012. Challenges of a transition to a sustainably managed shrimp culture agro-ecosystem in the Mahakam Delta, East Kalimantan, Indonesia. *Wetlands Ecol Manag* 20 (2): 89-99.
- Bozak K. 2008. Nature, conflict, and biodiversity conservation in the Nanda devi Biosphere Reserve. *Conserv Soc* 6 (3): 211-224.
- Coetzer KL, Witkowski ETF, Erasmus BFN. 2013. Reviewing Biosphere Reserve Globally: Effective Conservation Action or Bureaucratic Label?. *Biological Reviews*. Cambridge Philosophical Society. DOI: 10.1111/brv.12044.
- Colfer CJP. 2005. *The Complex Forest: Communities, Uncertainty, and Adaptive Collaborative Management*. Resource for the Future, Washington, DC and CIFOR, Bogor.
- Dev OP, Yadav NP, Sringate-Baginski O, Soussan J. 2003. Impacts of Community Forestry on Livelihoods in the Middle Hills of Nepal. *J For Livelihood* 3 (1): 221-219.
- Fahmi MR, Ginanjar R, Kusumah RV. 2015. Diversity of ornamental fish in peatlands Biosphere Reserve Bukit-Batu, Riau Province. *Pros Sem Nas Masy Biodiv Indon* 1 (1): 51-58.
- García-Llorente M, Harrison PA, Berry P, Palomo I, Baggethun EG, Arandia II, Montes C, del Almo DG, Lopez BM. 2016. What can conservation strategies learn from the ecosystem services approach? Insights from ecosystem assessments in two Spanish protected areas. *Biodivers Conserv* 24: 1327-1334.
- Habibah A, Hamzah J, Mushrifah I. 2010. Sustainable livelihood in Tasik Chini Biosphere Reserve. *J Sustain Dev* 3 (3): 184-196.
- Habibah A, Mushrifah I, Hamzah J, Toriman ME, Buang A, Jusoff K. 2011. The success Factors of Public Consultation in the Establishment of a Biosphere Reserve-Evidence from Tasik Chini. *World Appl Sci* 13: 78-81.
- Hill R, Miller C, Newell B, Dunlop M, Gordon IJ. 2015. Why biodiversity declines as protected areas increase: the effect of the power of governance regimes on sustainable landscapes. *Sustain Sci* 10: 357-369.
- Husnah, Makri, Riani E, Fatah K, Maturidi, Sudrajat A, Marini M, Darmansyah, Rastina MD, Junianto RS. 2010. Characteristic habitats, marine resources and fishing on the lake marsh complex flood of sub das Mandau, Riau Province (annual report). Research Centre for Fisheries Management and Conservation of Fish Resources, Research and the Ministry of Maritime Affairs, Jakarta.
- Jacobs DF, Oliet JA, Aronson J, Bolte A, Bullock JM, Donoso PJ, Landha'usser SM, Madsen P, Peng S, Rey-Benayas, JM, Weber JC. 2015. Restoring forests: What constitutes success in the twenty-first century? *New Forests* 46: 601-614.
- Jorda-Capdevila D, Rodri'guez-Labajos B. 2015. An ecosystem service approach to understand conflicts on river flows: local views on the Ter River (Catalonia). *Sustain Sci* 10: 463-477.
- Kolka RK, Murdiyarto D, Kauffman JB, Birdsey RA. 2016. Tropical wetlands, climate, and land-use change: adaptation and mitigation opportunities. *Wetlands Ecol Manag* 24: 107-112.
- LIPI [Lembaga Ilmu Pengetahuan Indonesia]. 2008b. The final report LIPI-PT Arara Abadi : The Study of social studies, economics and culture in the Giam Siak Kecil-Bukit Batu, Riau. Cibinong, Bogor.
- LIPI [Lembaga Ilmu Pengetahuan Indonesia]. 2008a. The final report LIPI-PT Arara Abadi : The Study of Biodiversity in the Giam Siak Kecil-Bukit Batu, Riau. Cibinong, Bogor
- Man and Biosphere-Indonesia (MAB). 2008. Management Plan Giam Siak Kecil-Bukit Batu Biosphere Reserve, Riau Province, Indonesia.
- Najiyati S, Muslihat L, Suryadiputra INN. 2005. Peatland Management Guide for Sustainable Agriculture. Project Climate Change, Forests and Peatlands in Indonesia. Wetlands International-Indonesia Programme, Bogor and Wildlife Habitat Canada.
- Newton AC, Cantarello E. 2015. Restoration of forest resilience: An achievable goal? *New Forests* 46: 645-668.
- Olsson P, Folke C, Hahn T. 2004. Social-ecological transformation for ecosystem management: the development of adaptive co-management of a wetland landscape in southern Sweden. *Ecology and Society* 9 (4): 2. [online] URL: <http://www.ecologyandsociety.org/vol9/iss4/>
- Partomiharjo T, Sutrisno H, Sadeli A, Dewanto G, Mulyadi, Yitno. 2007. Biodiversity of the Giam Siak Kecil Wildlife Sanctuary Tasik Betung Block and Consesion Forest of PT. Arara Abadi Block Bukit Batu, Riau. [Research Report]. Cooperation between Biotechnology Research Center, LIPI and PT. Sinar Mas Asia Pulp and Paper, Riau. [Indonesian]

- Rahmawaty, Rauf A, Siregar AZ. 2014. Peatland distribution assessment as paddy land in east coast of North Sumatra. *Warta Konservasi Lahan Basah* 22 (3): 10-21. [Indonesian]
- Renaud FG, Szabo S, Matthews Z. 2016. Sustainable deltas: livelihoods, ecosystem services, and policy Implications. *Sustain Sci* 11: 519-523.
- Santhanam-Martin M, Ayre M, Nettle R. 2015. Community sustainability and agricultural landscape change: insights into the durability and vulnerability of the productivist regime. *Sustain Sci* 10: 207-217.
- Schmeller DS, Bridgewater P. 2016. The Intergovernmental Platform on Biodiversity and Ecosystem Services (IPBES): progress and next steps. *Biodivers Conserv* 25: 801-805.
- Szabo S, Brondizio E, Renaud FG, Hetrick S, Nicholls RJ, Matthews Z, Tessler Z, Tejedor A, Sebesvari Z, Foufoula-Georgiou E, da Costa S, Dearing JA. 2016. Population dynamics, delta vulnerability and environmental change: comparison of the Mekong, Ganges-Brahmaputra and Amazon delta regions. *Sustain Sci* 11: 539-554.
- Thompson P, Choudhury SN. 2007. Experiences in wetland co-management — the MACH project. Conference Paper 8. World Fish Center, Penang, Malaysia. [online] URL: http://www.worldfishcenter.org/resource_centre/WF_37452.pdf.
- UNESCO. 2011. Lessons from Biosphere Reserves in the Asia-Pacific Region, and a Way Forward: A Regional Review of Biosphere Reserves in Asia & Pacific to Achieve Sustainable Development. UNESCO, Jakarta Office, Indonesia.
- Wyborn C, van Kerkhoff L, Dunlop M, Dudley N, Guevara O. 2016. Future oriented conservation: knowledge governance, uncertainty and learning. *Biodivers Conserv* 25: 1401-1408.

THIS PAGE INTENTIONALLY LEFT BLANK