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By Eddy Nurtjahya

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Impact of tin mining on the biota of Bangka Island, Indonesia – a proof to convince the tin supply chain of smartphones companies

E. Nurtjahya , Universitas Bangka Belitung, Indonesia

U. Umroh, Universitas Bangka Belitung, Indonesia

F. Agustina, Universitas Bangka Belitung, Indonesia

Abstract

Tin mining in Bangka Belitung islands has been exploited for about hundred years old. The islands are the largest tin producing islands in the world, second after China. Tin was exploited by the local people long time before the monopoly of VOC – a Dutch trading company in 18th century. From the occupation until the independence era, the local people had not been involved in mining. In 1999 the Department of Trade and Industry changed the tin trading status so that tin is not an export item to be watched over and regulated. This was followed by the issuance of the Bangka regent decree to legalize mining for people. That was a false perception, however believed by local government and people. While the excitement of freely mining is difficult to stop, the law enforcement proved to be weak. On one hand tin mining activities increase the wealth of the people, on the other hand they change and decrease the environmental stability. Unconventional miners (tambang inkonvensional – TI), the term used to describe local small scale tin mines, have expanded significantly since 2000. Unfortunately most of the TI activities are being carried out without regard to good mining practices, safety of land reclamation. In the last two years, local, national and international environmental non-government organizations (NGOs) have increased their campaign against exported tin ingot produced by non-standard practices. A foreign investigation found that it is highly likely that a smartphone has illegal Bangkanese tin in it. Huge foreign coverage in the media has given trouble to some smartphones companies, and local private miners and smelter owners. At the end of 2013, an international seminar to facilitate discussion on that issue was held in Pangkalpinang, Bangka Island. It was attended by some overseas smartphones representatives, local and international consultants, local and international environmental NGOs, local government, local private miners and smelter owners, and academics. Pluses and minuses of tin mining activities mostly by TI miners with regard to socioeconomic aspects, including the destruction of infrastructure, seem no objection in the reports, but the biological aspects do have substance. As a proof to convince tin supply chain to smartphone companies, this paper presents some evidence on the negative impact of non-standard tin mining operations to land and off-shore biotas. The decrease of biodiversity on the land system, in land and off-shore water bodies, and some oceanic biotas is discussed.

1 Introduction

1.1 Tin as strategic commodity and conflict

Tin has been exploited by the local people long time before the monopoly of VOC – Dutch trading company in 18th century via the Sultan of Palembang, South Sumatera. The islands are the largest tin producing islands in the world, second after China. Indonesia produced approximately 106,000 tonnes in the year to August 2013, representing more than one third of global tin supply (IDH, 2014). The figure is higher than in 2010, 60,000 metric tons or 23% of world demand of tin in 2010 (USGS, 2011) or down from 40% at 2005 (Astira, 2005). The majority is exported to Singapore (58% by value), Malaysia (13%), Japan (7%), and the Netherlands (6%). Tin mining is the most significant activity in Bangka-Belitung, and has been exploited for decades. Mining takes place onshore and offshore, including in protected forests and marine ecosystems.

Contact author: E. Nurtjahya, email: eddy_nurtjahya@yahoo.com

There are between 15,000 and 50,000 unconventional tin miners and approximately 30 independent smelters (IDH, 2014).

Increasing demand of tin in the world and the high quality of tin caused Bangka tin was in good trading. In 1847, 83% Bangka tin entered Amsterdam market, and became 25% supply for Europe demand. Tin Reglement in 1819 by the Dutch colonialism was to monopoly tin in Bangka. Tin price was low during recession in 1930 and Japanese occupation in 1942-1945, and has steadily increased since 1970 (Zulkarnain et al., 2005). As a strategic or group "A" commodity and under central law PP No. 27 tahun 1980, only PT Timah, a publicly listed company, has the right to mine and market. The decrease of rubber and pepper price, while the price of tin was increasing, and no alternative business, the intensity of violation by locals was increasing. Unequal benefit distribution between Jakarta and Palembang gave rise to protests since independence. It is among other reasons the Bangka Belitung province separated from South Sumatera.

During British and Dutch occupation, forest concession for tin mining was managed by immigrant Chinese of Banka Tin Winning (BTW) who also cultivated pepper since the beginning of 20th century. Local was not involved as the lazy stereotype and they disagreed with the contract system (Zulkarnain et al., 2005). Local people were not being involved in mining, while massive recruitment from Chinese mainland was reported. From the occupation until the independence era, the local people had not been involved in mining. In 1999 the Department of Trade and Industry in its decree No. 146/MPP/Kep/4/Tahun 1999 changed the tin trading status that tin was not an exporting item to be watched over and regulated. That was a false perception done by local government and local people. The excitement of freely mining is difficult to be stopped. The law enforcement proved to be weak. On one hand tin mining activities increase the wealth of the people, on the other hand they change and decrease the environmental stability. The Bangka regent decree SK Bupati Bangka No. 6 in 2001 gave room for locals to mine. Tin mining has become a dominant economic driver in the province leaving rubber and pepper (Zulkarnain et al., 2005).

Conflict among stakeholders, between company and community, among unconventional miners, and between local and immigrant took place during 2005 – 2013. A significant damage is the illegal mining on revegetated area which up to 5,000 ha, caused reclamation moratorium during 2000 – 2005. Community empowerment in reclamation project proved to be failed. Two hectare experiment plot belongs to the author was illegally re-mined and damaged by local in the sixth year. All facilities were stolen. Another big project called eco-park in ex tin mining area belongs to the tin company seems to be stopped due to unresolved local claims.

The casualties are increasing but little effort to minimize (Table 1). The standard operating procedure is neglected in small scale mining or illegal mining. Most of accident in inland mine sites is due to landslide, while non-standard diving device is responsible for most death besides landslide under water. A national environmental watch NGO, Walhi is concerned on abandoned mined sites as malaria habitat, and radioactivity. Gamma radioactivity in Bangka Belitung islands is three times higher than any gamma radiation rate in the world (Walhi – Friends of the Earth Indonesia, 2013). Until recently, radiation of technologically enhanced naturally occurring radioactive material (TENORM) has not drawn attention from all stakeholders.

Table 1 Casualties of tin mining operation in Bangka Belitung province from 2011 – 2013

2011	2012	2013
32	80	22

Notes: from various sources

1.2 Impact of reformation

Unconventional miners (tambang inkonvensional – TI), the term used to describe local small scale tin mines, have expanded significantly during 2000 to 2010 (Figure 1). It was estimated more than 10,000 unconventional miners, supporting more than 50,000 people (ITRI, 2012). In 2013 it was reported that there are 80 dredges and 3,600 floating tin miners in Bangka offshore (Bangka Pos, 2013). Tin production from artisanal and small scale mines contribute up to 80% of Indonesia tin export (ITRI, 2013). Unfortunately most of the TI activities are being carried out without regard to good mining practices, safety of land reclamation. After 15 years intensive mining, the availability of reserves of tin drives the unconventional miners to dig deeper, or to work in more off-shore waters, increasing the risks.

Figure 1 Inland mined sites and unconventional mine (TI) boats in the beach and on operation (Nurtjahya et al. 2008 and primary photographs)

The positive impact of tin mining is shown on wealth. The majority of Bangka Belitung people live at wealthy family category 2 and 3, and only 1,184 people in the pre-wealthy category in 2011 is due to government initiatives and TI income and it multy-plyer effect. This is proven by the number of people own motorcycle and cars, and the increase of people who perform hajj pilgrimage. Bangka and Belitung islands are among the five most expensive provinces in Indonesia (Erman, 2013). The negative impact is this province Dampak is the second biggest drop out students in Indonesia in 2011 due to children involvement in mining and follow their parents who move to other mine sites (Erman, 2013).

Many people continue to practice traditional and subsistence land-based activities. As a result, ecological disruption caused by mining continues and neglected because of the economic benefit. Community empowerment in reclamation is suggested as third party scheme reclamation often faces social difficulties. Lack of trust to the company, mindset, and low law enforcement play contribute to unsuccessfulness. Benefits promises for people have not frequently come true, adding a lack of trust. Poor communications has further increased the lack of trust in many cases.

Excluding land function change from pepper plantation, revenue from tin from land function change value are lower than non-mining activities. Land recovery and coral reef transplantation are costly. Except for pepper plantation which is 10.8 years, the tin revenue from land function change from protected forest, rubber plantation, and beach and its offshore ecosystem into tin mining is below 3 years (Table 2).

Table 2 Land function change value

No.	Description	Land function value (USD) / Ha / month			
		Protected forest	Pepper plantation	Rubber plantation	Beach
1	Revenue from tin	2.116	7,653	468	8,100
2	Revenue from plantation, fishing, and environmental service	48	59	12	6,278
3	Land recovery, coral reef transplantation in 25 years	4,099	4,099	4,099	13,000
4	Balance to non-mining (1-(2+3))	-2,031	3,494	-3,643	-11,178
5	Equality in years (1/(2*12))	3.6	10.8	3.2	0.1

1.3 International concern on good minning practice

Tin mining leaves disturbed land, ex-tin mining ponds, damages natural drainage and habitats, and causes pollution. Sand tin tailings may have 95% sand, C-organics less than 2%, cation exchange capacity less than 1.0, its soil temperature may reach 45°C (Nurtjahya et al., 2008), and phosphate solubilising bacteria and arbuscular mycorrhizal fungi readings were reported low (Nurtjahya et al., 2009). Evaporation on tin mined land is almost double than it on undisturbed land (Nurtjahya et al., 2011). Tin-mined lands are considered useless lands and take a long time to recover. Sand tin tailings need amendment before planting (Nurtjahya et al., 2009).

Together with other marginal lands, the total of mine-impacted lands in the province totals 1,642 ha (Metro Bangka Belitung, 2008), or even more than 5,000 ha if those which have been already reclaimed and revegetated are included (Nurtjahya et al., 2008). Land use has changed from pepper and rubber plantation to mining (Nurtjahya et al., 2009), and in the coastal area a change of profession from fishermen to miners has been reported. Studies show that some efforts to restore previously tin-mined lands face significant challenges. Reliance on natural succession to restore sand tin tailings without any human intervention will take a long time before an effective cover is established (Mitchell, 1959; Ang, 1994; Nurtjahya et al., 2009).

In the last two years, local, national and international environmental non-government organizations (NGOs) have increased their campaign against exported tin ingot produced by non-standard practices. A foreign investigation found that it is highly likely that a smartphone has illegal Bangkanese tin in it (Hodal, 2012). Illegal tin either comes from the negligence of environmentally friendly mining process, or export process which does not follow the regulations (Bangka Pos 2014).

Huge foreign coverage in the media has given trouble to some smartphones companies, and local private miners and smelter owners. At the end of 2013, the IDH Indonesian Tin Working Group (TWG) facilitated discussion on that issue was held in Pangkalpinang, Bangka Island. It was attended by some overseas smartphones representatives, local and international consultants, local and international environmental NGOs, local government, local private miners and smelter owners, and academics. TWG is to explore if and how its members can positively contribute to addressing the sustainability challenges of tin mining in Bangka and Belitung province while also recognizing the economic benefits of the sector and poverty reduction (IDH 2014).

TWG identified that many of the sustainability issues are derived from the local and national operating environment and are not directly intrinsic to the business and practices of mineral exploitation and trade, which is where the efforts of the TWG can be focused. As a complex governance issue, it requires action from all stakeholders, including governmental agencies, development agencies, NGOs and industry. The IDH Indonesian Tin Working Group intends to reach out to local stakeholders in order to understand their priorities and opinions on desirable pathways towards a more sustainable tin sector. Possible scenarios to be explored may be strengthening the economy through rehabilitation of land, research into low-impact techniques for offshore mining, or strategies for enhancing risk management at mine sites (IDH 2013).

Pluses and minuses of tin mining activities mostly by TI miners with regard to socioeconomic aspects, including the destruction of infrastructure, seem no objection in the reports, but the biological aspects do have substance. As a proof to convince tin supply chain to smartphone companies, this paper presents some evidence on the negative impact of non-standard tin mining operations to land and off-shore biotas. The decrease of biodiversity on the land system, in land and offshore water bodies, and some oceanic biotas is discussed.

2 Methodology

2.1 Site description

Bangka island with the area of 1.16 million hectare (PPTA, 1996) is located off the eastern coast of South Sumatera island with its population of 991,062 people (BPS, 2012). The climate of the area is hot and wet, belongs to Af type (PT Timah Tbk., 1997). Average temperature is 26.3 ^{o}C with its average humidity and rainfall are 61.7%, and 241.4 mm per month respectively, with July to September are the lowest precipitation months of the year (BPS, 2012). The landscape is flat with average of 50 m and some hills with their highest elevation of 700 metres.

The inland site is a pepper plantation in Silip village (01^{o} 42' 48.1"S; 105^{o} 52' 26.7"E); a rubber plantation in Bencah village (02^{o} 44' 25.0"S; 106^{o} 25' 27.6"E); and a protected forest in Lubuk Kelik hamlet (01^{o} 54' 09.4"S; 106^{o} 05' 46.9"E). The beach site is Pantai Bubus beach in Belinyu district (01^{o} 31' 36.8"S; 105^{o} 46' 27.8"E), and Pantai Rebo beach in Sungailiat district (01^{o} 55' 57.4"S; 106^{o} 12' 58.6"E). The offshore sites for seagrass and molusks is Tanah Merah beach, Central Bangka (02^{o}14'37,2''S, 106^{o}12'57,6''E; 02^{o}14'40,6''S, 106^{o}13'5,4''E; 02^{o}14'35,6''S, 106^{o}12'59,6''E), and Tukak beach, South Bangka (03^{o} 0' 17.3"S, 106 ^{o}42'6,2"E; 02^{o} 58' 22,6"S, 106^{o}40' 38,12''E; 02^{o} 58'33,1''S, 106^{o}38'59,8"E). The other 18 study sites were secondary data and enrich the discussion (Figure 2). Water quality analysis and specimen identification were conducted at Fishery Laboratory, Universitas Bangka Belitung.

2.2 Sampling

The case studies have been developed through a literature review using academic, corporate, and community sources, and interview. Primary data collection is gathered through interview to owners, workers of small scale miners, pepper farmers and rubber farmers of selected respondents (*purposive sampling*).

2.2.1 *Social*

The number of interviewee in inland ecosystem is 26 persons of 20 – 60 years old, while 25 persons of 25 – 45 years old in beach sites. Some of respondents in Pantai Rebo beach were local fishermen which changed their profession to floating tin miners, and Javanese immigrants. Tin miners in Pantai Bubus beach are from more diverse part of Sumatera and Java islands.

2.2.2 *Water quality*

Sampling method for water quality uses a purposive sampling (Fachrul, 2007) and quadrate transect. Each station has three sub-stations with 20 m distance between sub-stations, and at each sub-station sampling was carried out in 3 quadrate transects with 10 m distance between sub-stations. The total number of quadrate transects in three stations was 27 plots. Clarity, current velocity, and total suspended solid (TSS) were calculated with relevant formulas (Hutagalung *et al.*, 1997). Sedimentation rate was measured according to Pastorok and Bilyard (1985).

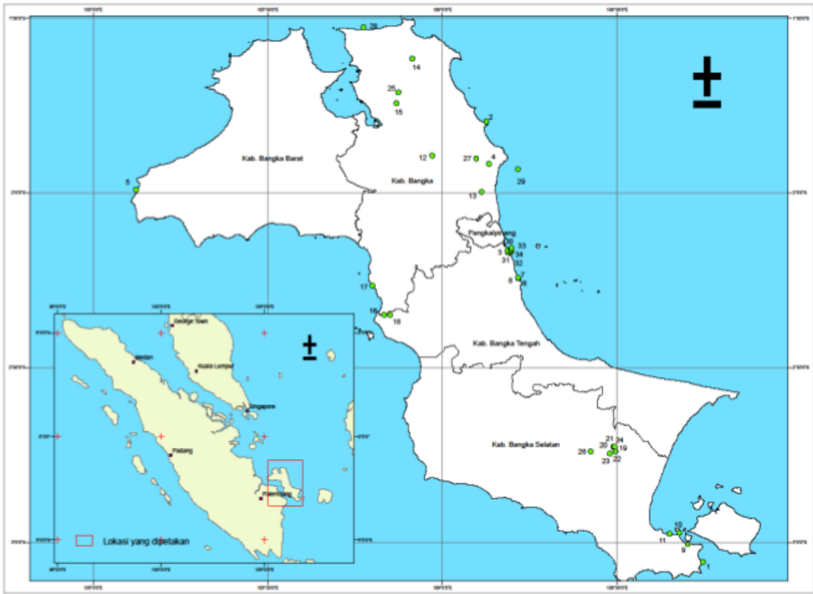

Figure 2 In land and offshore study sites in Bangka Island from primary and secondary data

2.2.3 *Biotas*

Molusks and seagrass sampling were carried out in 1 x 1 m quadrate transects during low tide. Specimen were then identified in the fishery laboratory of Universitas Bangka Belitung.

A minimum study plot 0.2 hectare per study site was determined by species-area curve (Setiadi & Muhadiono, 2001). The study was conducted on 20 contiguous plots of 10 m x 10 m at each of study sites using a modified quadrat sampling technique by Oosting 1956 (Soerianegara & Indrawan, 1995). Quadrats of 10 m x 10 m used for measuring trees that had greater than 20 cm dbh, and for poles with diameter between 10--20 cm; 5 m x 5 m for saplings with height taller than 1.5 m and diameter less than 10 cm; and 1 m x 1 m quadrats for seedlings with height less than 1.5 m. The number of individual plants for each species and diameter of stem of trees and poles were recorded, and only the number of each species of saplings and seedlings was recorded.

3 Results and Discussions

3.1 Water quality and off shore biotas

Offshore tin mining reduced water quality. TSS increased 40%, sedimentation rate 75%. Sea water pH decreased one quarter, while dissolved oxygen (DO) increased 50% (Figure 3). Other study in Tanjung Ular beach in West Bangka by Amini (2009 in Bidayani, 2010) showed the mining decreased water quality: water temperature changed from 23-25oC to 30-30.5oC; salinity from 32-35 ppt became 25-30 ppt, and the water body depth from 25 m to 5-20 m; the decrease of water clarity and current velocity. Pb content and TSS in water at Batu Belubang beach due to tin mining are above the standard according to the ministerial regulation Kepmen No. 51/MENLH/2004 i.e. <0.0001 – 0.09260 ppm, while Cd, Zn in the water, and Pb in sediment were in the normal range (Wahyuni et al. 2013).

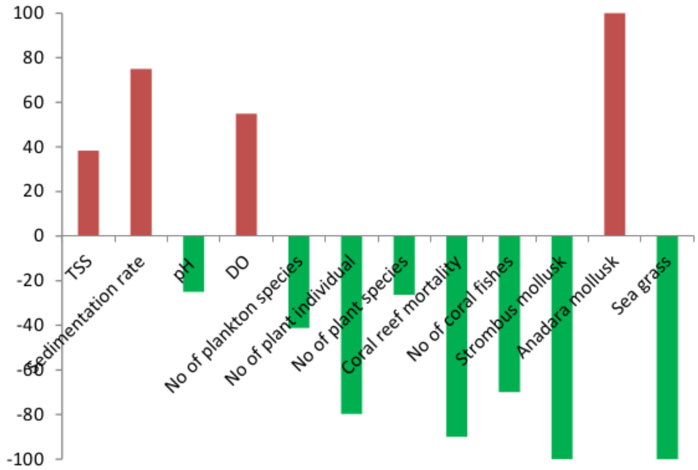

Figure 3 **Increase and decrease percentage of water quality and offshore biotas**

TSS gives broad effects in ecosystem i.e. reduction of light penetration so that reduced photosynthesis processes in phytoplankton and water plant. This condition reduced oxygen supply to the water body (Mukhtasor 2007). TSS at Batu Belubang beach due to tin mining was 705.4 ppm, which above the standard for sea biotas at 400 ppm (Wahyuni et al., 2013). Tailing disposal either above sea water or under sea water by small and big dredgers increased TSS. The spread of tailings disposal and the extent of marine impact is determined by weather and dredge type and the spread of total suspended solids was reported to reach 5000 square kilometres in windy season (IDH, 2014). pH at Batu Belubang beach in floating TI mining site was still normal 6.5 – 8.1 (Wahyuni et al., 2013). Water temperature increase tended to increase pH (Wahyuni et al., 2013).

Table 3 Sea water quality and seagrass and molluscs

		Tanah Merah Beach (mined water)	**Tukak Beach (less mined water)**
Sea Water Quality	Temperature (°C)	29.7	31.3
	Clarity (%)	36.7	83.3
	TSS (mg/l)	32.9	20.3
	Sedimentation rate (g/cm^2/day)	135.5	34.0
	Salinity (‰)	32.2	29.0
	pH	6.0	8.0
	DO	2.5	5.5
Seagrass and Molluscs density (ind. m^{-2})	*Cymodocea rotundata*	0	75.7
	Cymodocea serrulata	0	15.7
	Thalassia hemprichii	0	24.7
	Enhalus acoroides	0	18.7
	Halodule uninervis	0	61.0
	Laevistrombus canarium	-	+
	Anadara granosa	+	-

Table 4 Plankton, Vegetation, Coral Reef (Nurtjahya et al. 2008)

		Bubus Beach (mined water)	Rebo beach (less mined water)
Plankton	*Phormidium* sp.	388	442
	Gloeotrichia echinulata	0	127
	Anonim sp.7	0	87
	Oscillatoria putrida	33	74
	Anonim sp.4	0	74
	Anonim sp.2	0	60
	Skujaella thibauti	0	47
	Rivularia sp.	0	40
	Anonim sp.6	0	33
	Anonim sp.1	0	27
	Lemonniera aquatica	7	20
	Ophiocytium sp.	7	20
	Spirocta sp.	13	13
	Anonim sp.3	0	13
	Anonim sp.5	0	13
	Mallomonas pyroformis	47	7
	Anonim sp.8	0	7
	Oscillatoria sp.	94	0
	Rivularia mammilata	7	0
	Tabellaria fanestrata	47	0
	Skujaella sp.	74	0
Plankton Indeces	Diversity index	0.67	0.94
	Evenness index	0.67	0.76
	Domination index	0.33	0.20
	Number of species	10	17
	Abundance (ind./l)	7,000 – 380,000	7,000 – 440,000
Vegetation	Number of individual	26	128
	Number of species	14	19
	Number of families	11	14
Coral reef	Life coverage (%)	<25.0	91.6
	Mortality index (%)	>>	7.6
	Type of dominant substrate	sand and rubble	macroalga *Halimeda* sp., anemone
	Number of fishes	3	10

Offshore mining caused the 40% reduction of the number plankton species (Table 4). Tin mining was reported responsible for the damage of coral reef up to 90%, and the reduction of coral reef associated fishes. Walhi reported there are 30 mining sites in Bangka Belitung water and the use of bomb to catch fish caused 50% coral reef (Walhi 2013). The chief of Emas Diving Club (EDC) Bangka Belitung, Mr. Sakinawa mentioned that in the past fishermen catched fish in 1 - 3 miles from the beach, and because of coral reef damage made them to catch fishes above 10 miles (Tribun News 2013).

Study at coral reef community which was effected by floating TI in Tanjung Kerasak beach, South Bangka, the percentage of coral cover was 21.2% with its index mortality 39 – 86% (Sumarman, 2011). However, coral reef transplantation in Teluk Limau beach, Sungailiat shows growth rate of *Acropora digitata* in 1 m dan 3 m was 2.2 mm/month and 2.24 mm / bulan respectively (Sodikin, 2011).

In Tukak water some seagrass were identified such as *Cymodocea rotundata, Cymodocea serrulata, Thalassia hemprichii, Enhalus acoroides* and *Halodule uninervis*. In Tanah Merah water, seagrass was not found, the majority was dead or dying.

Benthic mollusks *Laevistrombus canarium* L. (siput gonggong) of family Strombidae were replaced by *Anadara granosa*. The dead seagrass, which is good habitat for *L. canarium* effected the mollusks population. Siput gonggong eat detritus besides seagrass. The offshore mining and excessively exploitation threatened mollusks population (Yulianda, 2009). Sea bed changed from macroalga with *Halimeda* sp., and anemone to sand and rubble. Siput gonggong observation in Teluk Klabat, Bangka and Lepar Pongok islands, showed the effect of floating TI towards siput gonggong population (Dody 2011). Substrate which was always labil due to offshore tin mining causes the reduction of nutriets in the surface stirred or covered by tailing, and siput gonggong covered by sediment made siput gonggong difficult to find food and enough oxygen. This condition may ends up to the death of siput gonggong (Dody, 2011; Dody & Marasabessy, 2007). As filter feeder, *A. granosa* can live in silty sediment, not depended on sea grass litter, and can live in the extreme condition with food. *A. granosa* can live in sediment, even consumes sediment and can absorb heavy metal (Debenay, 1994).

3.2 Inland biotas

Inland mining changed soil fertility. There are differences of soil fertility in forest, abandoned farmed-land, and abandoned mined sites at 0, 7, 11, and 38 years (Table 5). Inland mining caused the decrease of the number of individual plant up to 80% and the species up to 26%. From studies in several locations in Bangka island, mining activity changes the vegetation structure and composition. The vegetation structure of 38-year old tin-mined land was less than 2% similar to the vegetation structure of a riparian forest. It can be predicted that the appearance of poles and then trees in natural regeneration of tin-mined land may need much longer time (Nurtjahya et al. 2009).

Table 5 Soil properties of riparian forest, abandoned farmed-land, 38-year old tin-mined land, 11-year old tin-mined land, 7-year old tin-mined land, and 0-year barren tin-mined land

Study sites	Depth	Texture			pH	Soil organic matter			HCl 25%		Cation-exchange (NH₄ - Acetate 1 N, pH 7)							KCl 1 N
		Sand	Silt	Clay	H_2O	Walkley &Black C	Kjeldahl N	C/N	P_2O_5	K_2O	Ca	Mg	K	Na	Total	CEC	B	Al^{3+}
	cm	%				%			mg/100g		cmol(+)/kg						%	cmol (+)/kg
Forest	0-20	78	13	10	4.7	1.6	0.2	10	22	5	0.2	0.1	0.1	0.1	0.4	5.8	7	2.0
	20-40	66	18	16	4.7	1.2	0.1	14	20	5	0.1	0.1	0.1	0.1	0.4	5.2	7	2.0
Abandoned farmed-land	0-20	47	22	31	4.5	3.2	0.3	12	35	8	0.3	0.2	0.1	0.0	0.7	14.7	4	4.8
	20-40	48	22	31	4.6	1.7	0.1	12	36	7	0.3	0.2	0.1	0.1	0.6	9.6	6	3.7
Tin-mined land 38 yrs	0-20	96	2	2	5.1	0.3	0.0	14	5	2	0.2	0.1	0.0	0.1	0.4	1.0	40	0.2
	20-40	95	2	3	5.0	0.2	0.0	10	4	2	0.1	0.1	0.0	0.1	0.3	0.9	31	0.2
Tin-mined land 11 yrs	0-20	83	5	13	4.9	0.2	0.0	10	11	4	0.2	0.1	0.0	0.0	0.3	2.0	28	0.9
	20-40	80	3	18	4.8	0.3	0.0	10	11	4	0.2	0.1	0.0	0.0	0.4	2.3	30	0.9
Tin-mined land 7 yrs	0-20	94	4	3	4.8	1.0	0.1	13	49	3	0.2	0.1	0.0	0.1	0.3	3.3	16	0.6
	20-40	93	6	2	4.8	1.2	0.1	14	71	3	0.2	0.1	0.0	0.1	0.4	3.9	19	0.7
Barren tin-mined land	0-20	94	2	4	4.8	0.2	0.0	15	2	3	0.1	0.2	0.0	0.0	0.3	0.4	73	0.3
	20-40	97	1	2	4.5	0.1	0.0	13	3	3	0.3	0.2	0.0	0.0	0.6	1.4	40	0.1

Source: Nurtjahya et al. (2009)

Table 6 Number of individuals, species, and families in forest, abandoned farmed-land, 38-year old tin-mined land, 11-year old tin-mined land, 7-year old tin-mined land, and 0-year old barren tin-mined land

Study site	Number of individuals / ha					Number of species					Number of families				
	seed lings	sap lings	poles	trees	total	seed lings	sap lings	poles	trees	total	seed lings	sap lings	poles	trees	total
Forest	2,665	4,155	305	170	7,295	42	66	24	11	85	24	30	14	8	44
Abandoned farmed-land	1,640	5,495	40	0	7,175	48	47	4	0	71	27	25	4	0	38
Tin-mined land 38 yrs	2,125	55	0	0	2,180	15	1	0	0	16	12	1	0	0	13
Tin-mined land 11 yrs	1,675	45	0	0	1,720	7	2	0	0	8	4	2	0	0	5
Tin-mined land 7 yrs	890	0	0	0	890	6	0	0	0	6	4	0	0	0	4
Barren tin-mined land 0 yrs	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

Source: Nurtjahya et al. (2009)

3.3 Social economy

Offshore mining by any dredge type reduced fish catch. Although it has not been studied scientifically, at some places caught fish was reporte smaller. The increase of coral reef mortality index due to water quality decrease was suggested to influence the fish catch by fishermen.

Floating TI in Batu Belubang beach, Central Bangka caused the small pelagic caught decreased 58.44% or 2,503.4 MT in 2010 compared with 4,282.7 MT in 2009. The use of small pelagic fishes has not been overfishing overfishing biologically or economically as effort actual 214 units and actual production 3,435.8 still under maximum sustainable yield (MSY) and maximum economy yield (MEY) i.e. 245 units dan production at 3,959.2 MT. Floating TI caused catch device productivity in 2010 decreased 26.2% or 6.4 MT/unit compared to year 2007 i.e. 24.3 MT/unit (Octarini, 2011). TI mining at Rebo beach, Bangka caused the decrease of fish catch 13.8% from 2007 to 2010 for small pelagic and 55.8% for demersal fishes (Sucita, 2011). Floating TI in Tanjung Ular beach, West Bangka caused the reduction of small pelagic catch 24% from 1998 to 2008, and the decrease of demersal fishes 70% at the same period of time (Bidayani 2010) (Table 7).

Table 7 Small pelagic and demersal fishes production in offshore mined sites

Site	Regency	T0 - T1 Period	T 0 (MT)		T 1 (MT)		Diff. (%)	References
			Small pelagic	Demersal	Small pelagic	Demersal		
Batu Belubang Beach	Central Bangka	2009 - 2010	4,282.9		2,503.4		-58.4	Octarini 2011
Rebo Beach	Bangka	2007 - 2010	3,531.2	448.1	3,184.1	233.5	-9.8%; -47.9%	Sucita 2011
Tanjung Ular Beach	West Bangka	1998 - 2008	4,538.5	4,070.1	3,476.4	1,179.6	-24%; -70%	Bidayani 2010

Siput gonggong population replacement effected fishermen. Siput gonggong is the main raw material for siput gonggong cracker which is the expensive seafood snack in Bangka Belitung, which reachs Rp.250.000,- per kg or USD 25 per kg.

The current mining can be called as big harvest at a short period of time without saving the stock for next generation, may cause horizontal conflicts due to mining site. It is reported that in several locations, tension took place between local malay with immigrant from Sumatera, Java, and East Nusa Tenggara islands. Walhi (2013) reported 12 conflicts between local fishermen and miners in 2006 – 2011 (Walhi – Friends of the Earth Indonesia, 2013).

It has demonstrated the importance of integrated agriculture in order to solve problems of land use in mined areas. Apart from rice field cultivation on ex-mined lands, considerable effort should now be made so as to be able to repay the environmental loss and achieve real benefits from the rice fields. As they are major costs, soil amendment or land preparation procedures need to have some modifications (Nurtjahya et al., 2009).

4 Conclusions

Offshore mining reduced water quality as TSS increased and pH lowered. The change of sea bed caused the change of benthic flora and fauna, plankton diversity, and the increase of mortality index of coral reef and coral reef associated fishes. Fish caught in the offshore mining site decreased. Inland mining activity reduced soil fertility and flora and fauna diversity. Inland mining reduced the number of individual, species, and plant families.

Although differ from the conclusion of Tin Working Group study which identified that many of the sustainability issues are derived from the local and national operating environment and are not directly intrinsic to the business and practices of mineral exploitation and trade, the Electronic Industry Citizenship Coalition® (EICC®) and Friends of the Earth (FoE) may participate in pushing mining process and export process follow the law in order to support sustainable development in the province.

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