Jurnal PAJAR (Pendidikan dan Pengajaran)
Volume 8 Nomor 4 July 2024 | ISSN Cetak : 2580 - 8435 | ISSN Online : 2614 - 1337
DOI : http://dx.doi.org/10.33578/pjr.v8i4.9906

The Impact of Tin Mining Activities and Its Integration in Science Learning

Tisrin Maulina Dewi[1,2*], Margareta Rahayuningsih[2], Aditya Marianti[2], Fitria Meilina[1]

[1] Science Education Study Program, Universitas Negeri Semarang, Indonesia
[2] Elementary School Teacher Education Program, Universitas Karimun, Tanjung Balai Karimun, Indonesia

tisrinmaulinadewi@gmail.com, etak_sigid@mail.unnes.ac.id, aditya.marianti.am.@mail.unnes.ac.id, fifit0305@gmail.com
corresponding author: *tisrinmaulinadewi@gmail.com*

ABSTRACT

Karimun Regency in Riau Islands Province is one of the regencies as a tin producer in Indonesia. This study aims to describe the impact of tin mining activities in Karimun Regency and its integration into science learning. The research method used is descriptive qualitative with data collection techniques through interviews, observations, and literature studies. The research results indicate that tin mining activities on land would create former tin mine pits that have positive and negative impacts. The positive impact is that these former tin mine pits could be a source of income for the community like being a source of water during the dry season and a tourist attraction. While the negative impact is that it could damage the environment and require a relatively long time to recover. Efforts need to be made to utilize these former tin mine pits properly so that they can function properly and they can benefit the community. Therefore, science learning based on the environment of tin mining activities needs to be integrated into the learning process in schools so that later it can increase students' knowledge about the importance of an attitude of protecting the environment and having sustainable environmental awareness.

Keywords*: *Karimun regency, science learning, tin mining, positive and negative impact

Submitted	Accepted	Published
05 June 2024	06 July 2024	30 July 2024

Citation	:	Dewi, T.M., Rahayuningsih, M., & Marianti, A., & Meilina, F. (2024). The Impact of Tin Mining Activities and Its Integration in Science Learning. *Jurnal PAJAR (Pendidikan dan Pengajaran), 8*(4), 385-393. DOI: http://dx.doi.org/10.33578/pjr.v8i4.9906.

INTRODUCTION

Indonesia has significant tin deposits that have been exploited for more than three centuries. These deposits are spread along an area of more than 800 kilometers, known as the Indonesian Tin Belt. This region is part of the Southeast Asian Tin Belt that stretches for about 3,000 kilometers from the Asian mainland to Thailand, across Peninsular Malaysia, and into Indonesia (R. Harahap, 2016). In Indonesia, tin resources are found on Sumatra Island and other surrounding islands, known as tin islands, such as Belitung, Bangka, Singkep, Kundur, and Karimun (Ng et al., 2017); (Irzon, 2021). Tin extraction on the mainland of Karimun Island began in the 1970s and continued until the 1990s. PT Karimun Granite is a tin mining company in Karimun that has been sending tin exports to Singapore since 1972 with an amount of about 170,000 tons per year (Irzon, 2017). Due to the reduction of tin reserves on land, tin mining activities around Karimun Island and Kundur Island currently focus more on operations at sea using dredgers and suction vessels. Former tin mining sites on land, called “kolong,” have generally been transformed into large water retention ponds.

Natural resources and the environment are central or fundamental elements in the development process which consists of two main parts: the bio-ecosystem or ecological system component and the socio-cultural component. Changes that occur to natural resources and the environment as a result of development pressures can be considered environmental risks. Development brings not only benefits but also risks or negative impacts. Usually, people often associate the negative impacts of development on natural resources and the environment with pollution and damage (Tohir, 1991). An example is tin mining on Karimun Island, where the forest ecosystem is involved with the cutting down of part of the forest land to be used as a mining area. This has resulted in a decrease in the area of forest ecosystems on Karimun Island.

Jurnal PAJAR (Pendidikan dan Pengajaran)
Volume 8 Nomor 4 July 2024 | ISSN Cetak : 2580 - 8435 | ISSN Online : 2614 - 1337
DOI : http://dx.doi.org/10.33578/pjr.v8i4.9906

In the post-exploitation era of tin mining, designing a sustainable strategy is crucial to restore the exposed environment and promote inclusive economic growth. The problem of environmental damage arising from tin mining is the existence of ex-mining pits (pits) that are not followed by management efforts. The former tin mining pit in Karimun Regency is still largely abandoned, despite having the ability to be managed very well. Many studies have been conducted on the utilization of this former tin mining pit, including as a source of water that can be utilized during the dry season (Meyzilia, 2018), as a tourist destination (Meyana et al., 2015), for the cultivation of eceng plants for water hyacinth (*Eichornia crassipes*) cultivation (Meyzilia & Darsiharjo, 2017), utilized as an agricultural area (Asmarhansyah & Hasan, 2020), for fish farming (Samuel et al., 1999), vegetable planting (Dalimunthe et al., 2007) and for mangrove planting (Farhaby & Anwar, 2021).

Optimization of the utilization of this former tin mining pit is very necessary to do so that it can function properly. However, in Karimun Regency there has not been sufficient discussion regarding appropriate planning for the reuse of ex-mining areas, therefore it is necessary to conduct an in-depth review of this ex-mining land issue. The Karimun Regency Spatial Plan (Draft RTRW of Karimun Regency 2011-2031) also does not include specific planning for the reuse of ex-mining areas, so there is currently no guarantee of reclamation in these areas. In this management effort, it is necessary for the government and related parties to work together to be involved in the management planning so that the former tin mining pit can function optimally. Apart from the involvement of the government and related parties, a good understanding of the management of the former tin mining pit is also needed so that it can function properly and can foster public awareness of the environment.

Increasing public awareness of the environment is one way to prevent ecosystem damage due to tin mining. It is expected that by providing environmental knowledge and perceptions to the community, people will be more concerned and change their attitudes to maintain environmental quality so as to reduce damage due to tin mining. Knowledge and attitudes towards the environment can be given in formal institutions to students through the learning process at school. One way to foster students' knowledge and attitudes to grow their awareness of the environment is to integrate the impact of tin mining activities in science learning. Integrating the importance of environmental utilization in the learning process can make it easier for students to understand science concepts because they can make direct observations in concrete situations. It can also trigger students' curiosity about the things around them. In this learning approach, students not only understand the material abstractly through teacher lectures, but can also experience nature and the surrounding environment directly (Setiyoningsih, 2017).

There have been many studies that discuss the impact of tin mining activities such as the characteristics of soil physical and chemical properties on former tin mining land (Hamid et al., 2017; Rachman et al., 2019; Wulandari et al., 2022), community perceptions of environmental damage due to tin mining (Ferianda, 2020), the economic impact of tin mining in Indonesia (Sulista and Rosyid, 2022) and reclamation studies of tin mining impacts (Nurtjahya et al., 2017), but research on the integration of the impact of tin mining activities in science learning is still very little. In fact, this integration has the potential to increase environmental awareness among students and society in general. The research conducted has several important reasons, namely for environmental restoration, local economic empowerment, the basis for policy making and spatial planning and is expected to foster environmental awareness in a sustainable manner. The purpose of this research is to describe the impact of tin mining activities in Karimun Regency, Riau Islands Province and integration in science learning.

METHOD

Place and Time of Research

This research was conducted in February to April 2024. The place of this research is located at Karimun Regency, Riau Island Province, Indonesia.

Jurnal PAJAR (Pendidikan dan Pengajaran)
Volume 8 Nomor 4 July 2024 | ISSN Cetak : 2580 - 8435 | ISSN Online : 2614 - 1337
DOI : http://dx.doi.org/10.33578/pjr.v8i4.9906

Research Methods

The research method used is descriptive with a qualitative approach, which focuses on understanding natural or naturalistic phenomena in dealing with human and social problems. Sugiyono (2012) defines descriptive qualitative method as a research approach that focuses on natural object conditions, with the researcher as the main instrument. Data sampling is done by purposive sampling, while data collection uses triangulation techniques to get more accurate results.

Data Collection and Analysis Technique

The data used in this research is qualitative and comes from two main sources, namely primary data and secondary data. Primary data is obtained through direct interviews with sources or informants who have the potential to provide relevant and factual information about field conditions. Meanwhile, secondary data is supporting data obtained from literature, documents, and information from organizations or companies involved in the problem under study. This secondary data includes reading materials, literature references, and research reports relevant to the research location.

In this research report, the method of determining informants uses a purposive sampling technique, where informants are selected based on the researcher's judgment as individuals with the most potential to make significant contributions to the research. This includes, in addition to supporting documents, stakeholders involved in the innovation process. Research data that can support policy making can be divided into two main sources: field research data and documentary data. Documentation data can come from previous research conducted by researchers or others. Data obtained directly from the field is called primary data, while data sourced from documents is called secondary data.

Primary data was obtained directly through interviews with informants consisting of parties such as the Karimun Regency Environmental Service, PT Timah Karimun employees and the surrounding community. Meanwhile, secondary data was obtained from various other supporting sources, including reading materials, literature references, and research reports relevant to the topic of this research. To collect these two types of data, researchers used several data collection techniques, namely: interviews by collecting data and information from various informants and by literature study of relevant references. Data analysis is done inductively, where this technique aims to extract patterns or findings from field data that has been collected and grouped, thus allowing broader conclusions to be drawn.

RESULTS AND DISCUSSION

Impact of Tin Mining Activities

Karimun Regency is one of the most tin-producing islands in Indonesia. From the 1970s to the early 1990s, onshore tin mining was conducted on Karimun Island and Kundur Island. Hutamadi (2007) states that there are at least six locations on Karimun Island and two locations on Kundur Island that show tin mine shafts. Based on the results of interviews with related agencies and the community around the former tin mining pit, it is stated that the former tin mining pit in Karimun Regency has not been well managed and maximally utilized, even though this former tin mining pit can be a source of community income, such as a source of water during the dry season. under the former tin mining activities in karimun can be seen in Figure 1.

Jurnal PAJAR (Pendidikan dan Pengajaran)
Volume 8 Nomor 4 July 2024 | ISSN Cetak : 2580 - 8435 | ISSN Online : 2614 - 1337
DOI : http://dx.doi.org/10.33578/pjr.v8i4.9906

Figure 1. Former tin mine pit in kundur (*http://karimuntoday.com*)

Figure 2. Former tin mine pit in kundur Karimun (*http://anewspatron.com*)

As for the impact of tin mining activities in Karimun Regency, one of them is from Juliana's research (Juliana et al., 2019) which examines the level of fertility of post-tin mining basin waters in Prayun Kundur Village, the results of the study can be seen in Table 1.

Table 1. Measurement Results of Water Quality Parameters of the former tin mine pit in Prayun Kundur

Parameters	Unit	Range	Average	Quality Standart
Physics				
Temperature	°C	30,1 – 31,8	31,0±0,2	Deviasi 3
Brightness	M	1,45 – 1,49	1,47±0,04	
Chemistry				
pH	Mg/L	4,2 – 4,9	4,6±0,07	6 -9
Do	Mg/L	6,6 – 7,2	6,8±0,02	4
BOD	Mg/L	1,7 – 2,2	2,1±0,02	2
Nitrat	Mg/L	0 – 0,18	0,12±0,05	10
Fosfat	Mg/L	0,19 – 0,23	0,21±0,0002	0,2
Biology				
Klorofil-a	Mg/L	2,215 – 3,596	2,964±0,73	-

From Table 1 it is obtained that the level of fertility of the waters under the former tin mining activities in Prayun, Kundur based on the TSI (Tropic State Index) value is classified into oligotrophic (less fertile). This is based on the results obtained during the study, namely the temperature value ranging from 30.1 - 31.8 °C. An important factor that affects the survival and fertility of a body of water is temperature where water temperature affects the solubility of oxygen in water. Oxygen solubility decreases with increasing temperature (Fekri et al., 2018). For the results of the brightness level shows a good value in accordance with quality standards. The pH value does not meet the quality standards, because the value obtained ranges from 4.2 - 4.9 including the very acidic category. According to Whardana (2010), low pH may be caused by tin mining, which is the result of natural oxidation of sulfide minerals, especially cassiterite compounds. The cassiterite oxidation process begins when cassiterite is lifted to the ground surface and reacts with water and oxygen, resulting in the release of acid. The DO and BOD values are in the normal category, ranging from 6.6-7.2 mg/L, which will support the life of aquatic organisms. The nitrate content is still low from the quality standard set. The low nitrate is thought to be due to the low organic matter content in the lake and due to the absence of activity around the lake, tree litter around the lake (which consists of leaves, flowers, fruits, twigs, and a number of other fallen tree parts) is decomposed into nitrates by microbial rocks (Apriadi & Hasan Ashari,

Jurnal PAJAR (Pendidikan dan Pengajaran)
Volume 8 Nomor 4 July 2024 | ISSN Cetak : 2580 - 8435 | ISSN Online : 2614 - 1337
DOI : http://dx.doi.org/10.33578/pjr.v8i4.9906

2018). The value of phosphate is in accordance with the specified quality standard of 0.2 mg/L. for biological parameters, namely from the chlorophyll-a content ranging from 2.215-3.172 µg/L Where the waters of the post-tin mining camp of Prayun Village are classified as waters with a moderate level of fertility.

Another study that examines the impact of tin mining activities in Karimun is research conducted by (Sihombing et al., 2020) by examining the fertility status of the waters under the tin excavation in East Baran village, Meral sub-district, Karimun Regency based on the results of nitrate and phosphate measurements obtained that the waters under the tin excavation in East Baran village are mesotrophic or moderate fertility status. From these two examples we can see that tin mining activities greatly impact the fertility of the waters, this shows that if you want to utilize the former tin mining activities, it is necessary to first measure fertility in accordance with the appropriate quality standards so that later this utilization can help the welfare of the surrounding community.

Global mining operations have impacted the social and economic fabric of the mining towns in both positive and bad ways. evidently beneficial contribution in the shape of rising wages, rising employment, rapid population growth and migration, and the creation and upkeep of social facilities. In addition to its beneficial effects, mining has drawbacks such as degrading the environment, raising crime rates, displacing agricultural land and cultural assets, posing health risks, and driving up inflation (onwuka et al., 2013). According to (Nurtjahya et al., 2017), The community benefits financially from mining operations, but on the other hand, they alter and weaken environmental stability and lead to horizontal disputes. Offshore mining altered the sea bed and decreased the quality of the water, which changed the biodiversity. In addition to harming infrastructure and reducing biodiversity, onshore mining also produces floods.

Based on the results of interviews supported by literature studies, it was found that PT Timah in Prayun Kundur, Karimun Regency, started exploiting tin in the sea after the tin deposits on the Kundur mainland decreased significantly. PT Timah uses suction vessels and dredgers equipped with "bowls", which can operate from fifteen to fifty meters below sea level and can excavate more than 3.5 million square meters of material every month (Juliana et al., 2019). In order to preserve the marine ecosystem due to tin mining, PT Timah Tbk also planted mangroves on Setunak Karimun Island as an effort to maintain its sustainability. By planting these mangroves, it is hoped that marine animals such as fish, crabs, and shrimp can breed, which is expected to have an economic impact on the surrounding community (https://timah.com/news/post/.html).

The example of the positive impact of tin mining activities that have been utilized by the local community is the former tin pit located in Gemuruh Village, West Kundur Subdistrict, according to informants who are employees of PT Timah Tbk stated that the former tin pit in Gemuruh Village is used as a water tourism object which is the result of cooperation between PT Timah Kundur unit, with the Gemuruh Village government and the village community which began operating since 2020 (Figure 3).

Figure 3. a former tin pool transformed into a water park ((*http://karimuntoday.com*)

Stakeholders believe that the natural attractions of water recreation, culture tourism in the form of a tourist village, and artificial tourism in the form of edutourism are the three main forms of tourism that can be

Jurnal PAJAR (Pendidikan dan Pengajaran)
Volume 8 Nomor 4 July 2024 | ISSN Cetak : 2580 - 8435 | ISSN Online : 2614 - 1337
DOI : http://dx.doi.org/10.33578/pjr.v8i4.9906

created on former tin mining locations (Meyana et al., 2015). In addition to being used as a tourist attraction, the former tin mining pit can also be utilised for fish farming. The cage farming system can be used for catfish farming in the pit (Ira Triswiyana et al., 2019), water hyacinth plants can be used for phytoremediation of industrial mining liquid wast (Saha et al., 2017), This is of course by paying attention to physical, chemical and biological parameters in accordance with established standards. According to (Hashim et al., 2018) one way to assess the water quality of the former tin mining pit is by paying attention to the standard parameters. The parameters measured were pH, dissolved oxygen, suspended solids, biochemical oxygen demand, chemical oxygen demand and ammonia nitrogen (NH3N), while the heavy metals measured were lead (Pb), copper (Cu), zinc (Zn) and arsenic (As).

Environment-Based Science Learning Affected by Tin Mining Activities

Natural or Scientific Science is an academic discipline that studies nature and all of its components. It derives its knowledge of cause-and-effect correlations from natural events (Wenno, 2010). In the process of learning science is identical to studying the problems that exist in the environment around students so that students become more familiar with their surroundings. because this environmental problem will later lead to environmental changes and has the potential to cause the extinction of living organisms (Semenova, 2020). Some of the environmental issues that students learn about in their studies are pollution and environmental harm. Pollution and environmental harm become significant issues that must be brought up and connected to education when they are around schoolchildren. One of them is the local environmental issue in Riau Island Province's Karimun Regency, which is a result of tin mining operations that harm the ecosystem both on land and at sea.

Karimun Regency ranks among Indonesia's top producers of tin and makes a significant contribution to the global tin market. In addition to being done on land, floating unconventional (TI) mines are also conducted at sea. But environmental care is not yet the foundation of mining operations. The mining process continues to harm the ecosystem and cause pollution. Although there have been several efforts to care for the area, such as planting mangroves on the coast, the use of undersea areas resulting from tin mining activities on land is still neglected and not managed properly. Additionally, it results in a loss of soil function and fertility, which makes it challenging to repurpose as plantation land. Ex-mining land is said to cause a loss of soil fertility, which limits the types of plants that can grow there, such as shrubs and herbs. It also takes a long time to add micro material, enhance the quality of soil microconditions, and increase soil fertility (Nurtjahya et al., 2009).

Even now, there is little discussion of the issue of environmental harm caused by tin mining on the island of Karimun. It is linked to education, particularly scientific instruction in junior high schools on Karimun and other similar islands. This prevents children from being aware of the environmental harm caused by nearby tin mining. However, the development of these attitudes and behaviors can be achieved by including environmental education into the classroom curriculum and fostering in students a firsthand awareness of the value of environmental protection. One of the best ways to promote environmental knowledge, skills and awareness is through integrating learning about their environment such as the impact of tin mining activities into science learning. When students are exposed to actual environmental events and circumstances, environmental learning becomes more authentic and accurate (Fua et al., 2018). Children should be introduced to the value of environmental protection from an early age. When the material about the impact of tin mining activities is integrated into science learning, students will have environmental literacy about it. so that it is hoped that students will have environmental knowledge and form good environmental attitudes and awareness in the future.

CONCLUSIONS AND RECOMMENDATION

Based on the result, tin mining activities in Karimun Regency have positive and negative impacts on the environment. The positive impact is that the former tin mining pits can be a source of income for the community, such as a source of water during the dry season and a tourist attraction. While the negative impact

is that tin mining activities can damage the environment and require a relatively long time to recover. Efforts need to be made to utilize these former tin mine pits properly so that they can function properly so that they can benefit the local community. Therefore, Environment-Based Science Learning Affected by Tin Mining Activities is needed so that later it can increase students' knowledge about the importance of maintaining the environment and having sustainable environmental awareness.

ACKNOWLEDGMENT

The first author of this paper would like to express his cincere thanks to the Higher Education Financing Center and the Education Fund Management Institute (LPDP), Ministry of Education, Culture, Research and Technology of The Republic of Indonesia for sponsoring the doctoral scholarship.

REFERENCES

Apriadi, T., & Hasan Ashari, I. (2018). Struktur Komunitas Fitoplankton pada Kolong Pengendapan Limbah Tailing Bauksit di Senggarang, Tanjungpinang. *Majalah Ilmiah Biologi Biosfera : A Scientific Journal*, *35*(3), 145–152. https://doi.org/10.20884/1.mib.2018.35.3.761

Asmarhansyah, A., & Hasan, R. (2020). Reklamasi Lahan Bekas Tambang Timah Berpotensi sebagai Lahan Pertanian di Kepulauan Bangka Belitung. *Jurnal Sumberdaya Lahan*, *12*(2), 73. https://doi.org/10.21082/jsdl.v12n2.2018.73-82

Dalimunthe, S., Nurhayati, Herman, & Suheiti, K. (2007). Pemanfaatan Lahan Bekas Penambangan Timah Dengan Penanaman Tanaman SayuranDi Bangka Belitung. *Prosiding Lokakarya Percepatan Penerapan Iptek Dan Inovasi Teknologi Mendukung Ketahanan Pangan Dan Revitalisasi Pembangunan Pertanian Jambi*.

Farhaby, A. M., & Anwar, M. S. (2021). Tingkat Keberhasilan Penanaman Mangrove Pada Lahan Bekas Tambang Timah Di Desa Rebo Kabupaten Bangka Sebagai Bentuk Pemanfaatan Lahan Dalam Wilayah Hutan Mangrove Di Pesisir Timur Pulau Bangka. *Bioma : Berkala Ilmiah Biologi*, *23*(2), 143–148. https://doi.org/10.14710/bioma.23.2.143-148

Fekri, L., Affandi, R., Rahardjo, M. F., Budiardi, T., Simanjuntak, C. P. H., Fauzan, T., & Indrayani, I. (2018). The effect of temperature on the physiological condition and growth performance of freshwater eel elver Anguilla bicolor bicolor McClelland, 1844. *Jurnal Akuakultur Indonesia*, *17*(2), 181. https://doi.org/10.19027/jai.17.2.181-190

Ferianda, A. (2020). Persepsi Masyarakat terhadap Kerusakan Lingkungan Akibat Penambangan Timah di Kecamatan Koba, Kabupaten Bangka Tengah. *Jurnal Studia Administrasi*, *1*(1), 30–40. https://doi.org/10.47995/jian.v1i1.12

Fua, J. L., Wekke, I. S., Sabara, Z., & Nurlila, R. U. (2018). Development of Environmental Care Attitude of Students through Religion Education Approach in Indonesia. *IOP Conference Series: Earth and Environmental Science*, *175*(1). https://doi.org/10.1088/1755-1315/175/1/012229

Hamid, I., Priatna, S. J., Studi, P., Lingkungan, P., Universitas, P., Tanah, S. F., & Tanah, S. K. (2017). Karakteristik Beberapa Sifat Fisika dan Kimia Tanah pada Lahan Bekas Tambang Timah. *Jurnal Penelitian Sains*, *19*(1), 23–31.

Hashim, M., Nayan, N., Saleh, Y., Mahat, H., Mat Said, Z., & Fhei Shiang, W. (2018). Water quality assessment of former tin mining lakes for recreational purposes in Ipoh city, Perak, Malaysia. *Indonesian Journal of Geography*, *50*(1), 25–33. https://doi.org/10.22146/ijg.15665

Ira Triswiyana, Ayu Permatasari, & Ardiansyah Kurniawan. (2019). Utilization of Ex Tin Mine Lake For Aquaculture: Case Study Of Muntok Sub District, West Bangka Regency. *Samakia : Jurnal Ilmu Perikanan*, *10*(2), 99–104. https://doi.org/10.35316/jsapi.v10i2.534

Irzon, R. (2017). Geochemistry of late Triassic weak peraluminous A-type Karimun Granite, Karimun Regency, Riau Islands Province. *Indonesian Journal on Geoscience*, *4*(1), 21–37. https://doi.org/10.17014/ijog.4.1.21-37

Irzon, R. (2021). Prospeksi dan Masalah Lingkungan Akibat Penambangan Timah di Pulau Karimun. *Jurnal Lingkungan Dan Bencana Geologi*, *12*(3). https://doi.org/10.34126/jlbg.v12i3.367

Juliana, J., Retna Melani, W., & Kurniawan, D. (2019). Tingkat Kesuburan Perairan Pasca Tambang Timah di Desa Prayun Kecamatan Kundur Kabupaten Karimun. *Jurnal Akuatiklestari*, *3*(1), 18–22. https://doi.org/10.31629/akuatiklestari.v3i1.974

Meyana, L., Sudadi, U., & Tjahjono, B. (2015). Direction and Strategy of Former Tin Mining Area Development as Tourism Area In Bangka Regency. *Journal of Natural Resources and Environmental Management*, *5*(1), 51–60. https://doi.org/10.19081/jpsl.2015.5.1.51

Meyzilia, A. (2018). Pemanfaatan Air Kolong Bekas Tambang Timah sebagai Penambah Sumber Air Tanah Menggunakan Lubang Kompos di Bangka Belitung. *Jurnal Pendidikan Ilmu Sosial*, *27*(1), 22–30.

Meyzilia, A., & Darsiharjo. (2017). Pemanfaatan Kolong Bekas Galian Tambang Timah untuk Budidaya Eceng Gondok di Provinsi Kepulauan Bangka Belitung. *Jurnal Pendidikan Geografi*, *17*(2), 153–158.

Ng, S. W. P., Whitehouse, M. J., Roselee, M. H., Teschner, C., Murtadha, S., Oliver, G. J. H., Ghani, A. A., & Chang, S. C. (2017). Late Triassic granites from Bangka, Indonesia: A continuation of the Main Range granite province of the South-East Asian Tin Belt. *Journal of Asian Earth Sciences*, *138*, 548–561. https://doi.org/10.1016/j.jseaes.2017.03.002

Nurtjahya, E., Franklin, J., Umroh, & Agustina, F. (2017). The Impact of tin mining in Bangka Belitung and its reclamation studies. *MATEC Web of Conferences*, *101*(March). https://doi.org/10.1051/matecconf/201710104010

Nurtjahya, E., Setiadi, D., Guhardja, E., Muhadiono, & Setiadi, Y. (2009). Succession on tin-mined land in Bangka Island. *Blumea: Journal of Plant Taxonomy and Plant Geography*, *54*(1–3), 131–138. https://doi.org/10.3767/000651909X475491

onwuka, S. U., Duluora, J. O., & okoye, C. O. (2013). Socio-Economic Impacts of Tin Mining in Jos, Plateau State, Nigeria. *International Journal of Engineering SCience Invention*, *2*(7), 30–34. www.ijesi.orgwww.ijesi.org

R. Harahap, F. (2016). Restorasi Lahan Pasca Tambang Timah Di Pulau Bangka. *Jurnal Society*, *VI*(1), 61–69.

Rachman, L. M., Baskoro, D. P. T., & Bayu, H. H. (2019). The Effect of Tin Mining on Soil Damage in Pedindang Sub-Watershed, Central Bangka Regency. *IOP Conference Series: Earth and Environmental Science*, *399*(1), 0–8. https://doi.org/10.1088/1755-1315/399/1/012026

Saha, P., Shinde, O., & Sarkar, S. (2017). Phytoremediation of industrial mines wastewater using water hyacinth. *International Journal of Phytoremediation*, *19*(1), 87–96. https://doi.org/10.1080/15226514.2016.1216078

Samuel, Said, A., & Aida, S. N. (1999). Penelitian Biolimnologi Sumber Daya Perairan Baru Bekas Tambang Timah di Pulau Bangka dan Belitung untuk Budidaya Ikan. *Penelitian Perikanan Indonesi*, *V*(1), 20–30.

Semenova, G. (2020). Global environmental problems in the world. *E3S Web of Conferences*, *217*, 1–8. https://doi.org/10.1051/e3sconf/202021711004

Setiyoningsih, T. (2017). Pengelolaan Pembelajaran IPA Berbasis Lingkungan Di SMPN 1-Grobogan. *Jurnal Manajemen Pendidikan*, *12*(1), 1–9.

Sihombing, E. S., Dahril, T., & Asmika Harnalin Simarmata. (2020). Status Status Kesuburan Perairan Kolong Galian Timah di Kelurahan Baran Timur Kecamatan Meral Kabupaten Karimun Provinsi Kepulauan Riau berdasarkan Nitrat dan Fosfat. *Electoral Governance Jurnal Tata Kelola Pemilu Indonesia*, *12*(2), 6. https://talenta.usu.ac.id/politeia/article/view/3955

Sulista, S., & Rosyid, F. A. (2022). "The economic impact of tin mining in Indonesia during an era of decentralisation, 2001–2015: A case study of Kepulauan Bangka Belitung Province." *Extractive Industries and Society*, *10*(March), 101069. https://doi.org/10.1016/j.exis.2022.101069

Jurnal PAJAR (Pendidikan dan Pengajaran)
Volume 8 Nomor 4 July 2024 | ISSN Cetak : 2580 - 8435 | ISSN Online : 2614 - 1337
DOI : http://dx.doi.org/10.33578/pjr.v8i4.9906

Wenno, I. H. (2010). Pengembangan Model Modul IPA Problem Solving Method Berdasarkan Karakteristik Siswa dalam Pembelajaran di SMP/MTs. *Jurnal Cakrawala Pendidikan*, *2*(2), 176–188. https://doi.org/10.21831/cp.v2i2.338

Wulandari, D., Agus, C., Rosita, R., Mansur, I., & Fikri Maulana, A. (2022). Impact of Tin Mining on Soil Physio-Chemical Properties in Bangka, Indonesia. *Jurnal Sains &Teknologi Lingkungan*, *14*(2), 114–121. https://doi.org/10.20885/jstl.vol14.iss2.art2