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A review of the first revision of the Terms of Reference (TOR) of Environmental Impact Assessment for The Proposed Mining and Beneficiation of Lanthanide Element Ion-adsorption Deposit on 3 Mining Leases with a Total Area of About 660 Ha, in Mukim Ulu Jelai, District of Lipis, Pahang Darul Makmur by Global Environment Centre focusing on possible impact on water body

Overview

Aras Kuasa Sdn. Bhd. (AKSB) is proposing in situ leaching mining and beneficiation of ion-adsorption lanthanide or also known as rare earth element (REE) deposit. AKSB is to mine lanthanide through physical and chemical processes involving extraction and beneficiation of ion-adsorption lanthanide deposit at the site. The project site is located on 3 parcels of land covering a total area of about 660 ha, in the Mukim of Ulu Jelai, District of Lipis, Pahang Darul Makmur, some 35 km to the east of Tanah Rata, Cameron Highland. The Ringlet – Sungai Koyan Road is located about 3.2 km to the southwest of the project site. Based on the Proposed Mining and Beneficiation of Lanthanide Element Ion-adsorption, in Mukim Ulu Jelai, District of Lipis, Pahang Darul Makmur. After going through the document in details, the proposed project does not include further processing to separate and refine the mined lanthanide elements. Overall GEC would like to raise following concerns:

1) Unsuitability of study boundaries

The proposed project is located within Ulu Jelai Forest Reserve which covers an area of about 660 ha. The 660 ha Ulu Jelai Forest Reserve is the primary water catchment area with major river (Sg Telum) flowing across the proposed project site, with several minor streams within the site. This river plays an important role by carrying water from upstream of the site originated from the catchment area of about 804 km^2. Moreover, these rivers are also the main source of water intake for the community every day for a variety of purposes. The proposed project has become a major concern among the Orang Asli community since the project will affect the river water quality at the native settlement as it is located nearer to the project site. It is also stated that the proposed project site is located within Rank 2 Environmental Sensitive Area based on *Rancangan Fizikal Negara Ketiga* (RFN *ke*-3). Despite all these concerns, yet this project has been proposed to carry out. Hence by taking into consideration of all the concerns Department of Environment (DOE) should not even consider about this project under any circumstances and REE mining should never be carried out.

2) TORs methodology not fulfilled

The proposed TOR does not fulfil many basic requirements in the methodology including:

i) Parameters

The parameters listed have to be revisited. Important parameters such as the riverine bioindicator or biodiversity of the area too need to be taken into consideration. Biological monitoring provides remarkable insight into the functional quality of the environment studied. By applying biological monitoring, it can reveal

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important changes in the composition of biological communities caused by human activities. It is a relatively inexpensive and reliable method of acquiring an indication of the water quality and uses simple and inexpensive tools. Bio indicators such as macroinvertebrates are crucial to monitor the short term side effect of the mining activity to the water quality of the river.

ii) Sampling site

The study boundary based on the TOR is limited. The impact from proposed activity will not only affect the environment within the site but also the environment around it. Most of the sampling sites proposed in the TOR only focused on the boundary of the project site, however there was inadequate sampling sites at the downstream. The water quality of the river after the project site have to be taken as well to monitor the impact of the activity to the downstream of Sungai Telum. Therefore the sampling points need to increase significantly to cover the surrounding project site including before and after mining sites. Moreover, the assessment of secondary impacts was also not covered in the TOR.

iii) Duration

Based on the TOR, a limited duration of sampling proposed to be conducted as baseline. Considerations of the different hydrological conditions of the river need to be highlighted as well.

3) Insufficiently described mitigation measures

Although there were various mitigation measures that has been included, two (2) grey areas identified from the mitigation plan proposed. The TOR failed to address the detail maintenance plan especially on the maintenance of the silt trap. Another issue that is not highlighted is the social and behavioral element of people that going to involve in the mining project. Looks like the consultant assuming that all the contractors and workers involved will follow the mitigation measures which in reality not the case.

4) Technological uncertainty

The proposed mining adapts the technologies that has been used in China to extract the REE. Although various technologies have been implemented in China, however, the use as well the significant impact of the technologies are not well proven in Malaysia as there are not many literature reviews available regarding the subject. For instance, the variation of climate in Malaysia and China could possibly impact these technologies as the rainfall pattern varies in both the countries. Perhaps the high rainfall pattern in Malaysia could readily impact the seepage of the chemical into the ground. Moreover, it was also stated in the TOR that water quality modelling shall be carried out using the numerical software, e.g. MIKE Ecolab. However, there are not enough literature available if this modal can be calibrated into the local climate or not.

<u>Gaps Identified in Reducing Impact of Mining Activities to our Water Bodies</u>

Identified gaps in knowledge include (government needs to assure that these have been thoroughly tested for before any mining operations been consider or begin):

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- For evaluation of potential hazard of anthropogenic Ln to the aquatic ecosystem, long term eco-toxicity data from environmentally relevant exposure conditions are required
- High bioaccumulation of Ln is observed in aquatic plant species is a warning sign- more information on Ln bioaccumulation potential at all food chain levels is needed
- It is highlighted that more attention is required in:
  - Ln with lower atomic mass bio-accumulative capacity than heavy Ln
  - Adverse effects of Ln to bottom-dwelling species as Ln accumulate in sediments
- Urgent need for additional knowledge on the behavior of Ln in the aquatic environment

Finally after seen overall scenario, there are many gap and issues identified with the proposal. Please refer to annex 1 on the possible impact of this project on water bodies, community especially Orang Asli and biodiversity in general. Therefore GEC think, DOE should not consider the proposal and reject it.

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Annex 1

Effects of Rare Earth Element (REE) Mining on Water

Streams and lakes may be impacted by the construction and use of access roads, leakage of drilling fluids, and increased sediments that may alter the water chemistry, causing acid to drain from the rock. Acid drainage can harm the local aquatic environment such as the river or lake fish. Mining activities can also impact deep ground waters that may supply wells and drinking water systems.

Processing ore to remove the REE typically uses water that must then enter a waste water stream to be contained or reused. A proper waste water system is a critical aspect of most mining operations. The ore that contains the REE can also contain radioactive or heavy metal materials, which needs to be properly managed to ensure it does not enter water sources. Discharge limits for concentrations of metals and other constituents (radioactive materials, sediments, chemicals, etc.) must be met before any waste water can be released into local surface waters.

1. Presence of Lanthanides in the Environment

The distribution and bioavailability of lanthanides in the aquatic environment (water and sediment) depends on the lanthanide speciation, which is influenced by physicochemical parameters, i.a. pH-value, alkalinity, and ionic strength, and the presence of different organic and inorganic complexing agents (Moermond et al., 2001; Elderfield et al., 1990)

The natural lanthanide pattern of suspended load in small rivers depend mainly on the geological catchment area and could show huge differences, while that of major rivers is relatively uniform (Goldstein and Jacobsen, 1988). Lanthanides in river waters are fractionated between colloidal and suspended particles, and solution phases. Because of the high affinity of lanthanides to colloids and particles, these are mainly responsible for lanthanide transport and distribution (Sholkovitz, 1992). In organic-rich rivers, the lanthanide transportation via colloids can cover up to 100% (Tang and Johannesson, 2003; Pourret et al., 2007). Generally, the lanthanide load in rivers decreases from riverine to brackish to seawater, since mixing processes from fresh and saltwater in estuary zones result in coagulation of colloidal and particulate-bound lanthanides and subsequent sedimentation.

Lanthanides also show different speciation patterns between river, surface and pore water on one hand and seawater on the other. A speciation modeling for lanthanum conducted by Moermond et al. (2001) described a speciation gradient from riverine to sea water. The model that also addressed complexation with dis-solved organic matter showed that lanthanum formed pre-dominantly complexes with humic substances in riverine waters, followed by carbonates and bicarbonates, whereas in seawater the order for lanthanum species was La-carbonates, bicarbonates, and then free ions. An increase of the pH-value (from 6 to 9) was followed by a decrease of the free ions and of lanthanum bound to humic ligands, and an increase of lanthanum carbonate- and bicarbonate-complexes. Lanthanides have a high affinity to sediments and are enriched in fine grain size fractions.

The amount of metal, which can be accumulated by aquatic organisms, is determined by two main dynamic processes both changing with environmental conditions: the bio-accessibility (environmental availability) and the bioavailability. Lanthanides (Ln) as non-essential elements can be detected in nearly all biota and the accumulation pattern in biota as in other environment samples follows generally the Oddo–Harkins rule (Weltje et al., 2002b) with lanthanum (La) usually being the second most common lanthanide after cerium (Ce) (Weltje et al.,2002b; e.g. Moermond et al., 2001).

In freshwater plants, greater accumulation was observed in emerged plants in comparison with submerged plants and the suggested main uptake route was via the roots from sediment. Benthic organisms are likely to be exposed to La through sediments due to the high adsorption of La to sediment particles (Tijink and Yland, 1998; Weltje et al., 2002b) and to fine particulate organic matter (FPOM) (Schaller, 2013). Uptake depends mainly on the grain size of contaminated particles.

2. Effect of Lanthanides [Ln] (REE- Rare Earth Element) on Water Body

The lanthanide or lanthanoid series of chemical elements comprises the 15 metallic chemical elements. Large gaps in research of the impact of Ln elements in aquatic systems i.e. environmental exposure levels, bioaccumulation and eco-toxicity (Blinova et al., 2020).
Potential hazard on water:

a. Erosion and Sedimentation

i. If effective prevention and control measures are not applied, erosion of exposed soil can carry significant amounts of sediment into streams, rivers, and lakes.
ii. Incautious management of tailing, soil heap, and mineral stockpiles always have the ability to result in water runoff containing excessive suspended solids into surrounding waterbodies.
iii. As a result,
    - Increase in the Total Suspended Solids (TSS) in water bodies.
    - Degrade habitat quality of aquatic organisms and clogs the riverbeds.
    - Increased flooding due to reduced river channel capacities.
    - Reduced light penetration which affects the photosynthesis of aquatic plants.
    - Can impair aquatic species' vision, making it more difficult for them to find food.
    - Can clog fish gills and suffocate the benthic organisms.
    - Impacts domestic water supplies, irrigation, and other uses of streams.
    - Affects survival, reproduction, and behaviours of aquatic animals.

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iv. Rare earth element (REE) mining in Southern China has resulted in significant soil degradation and contamination in that area (Chen et al., 2019).

b. Chemical pollution

i. Chemical pollution occurs when the chemicals agents for the in-situ leaching method to extract lanthanide spill, leak, or leach from the mining site into nearby water bodies (SafeWater.Org, n.d.).
ii. As a result,
   - Increases the risk of the chemicals to contaminate ground water.
   - Contaminate the drinking water which is highly toxic to humans and wildlife
iii. Mines could also have pools of wastewater that may leak into nearby rivers.
   - For example, China Water Risk reported that at an abandoned mine in Ganzhou, untreated chemicals flow from leaching ponds when it rains (Earth.Org, 2020).
iv. The risks posed by chemical pollutants discharged into the aquatic environment can be determined by the following factors:
   - Persistence
   - Toxicity to specific aquatic organisms
   - Bioaccumulation and biomagnification
v. Have secondary impacts such as health due to contact with polluted water and loss of livelihood.

c. Acid Mine Drainage (AMD)

i. AMD is the largest source of environmental problems caused by the mining industry.
ii. AMD is the result of tailings and overburden being exposed to air and water.
iii. The high acidity in the water can:-
   - Destroy living organisms, and corrode culverts, pumps, and other metal equipment in contact with the acid waters.
   - Render the water unfit for drinking or recreational use.
   - Severely degrades water quality and can kill aquatic life.

d. Disturbance in Hydrological cycle

i. Plants play an important role in the hydrological cycle via evapotranspiration and contributes significantly to the atmospheric water leading to precipitation.
ii. Clearance of the forest over a wide area for mining activities could greatly affect the hydrological cycle.

3. <u>Potential hazard on ground water</u>

a. In-situ leaching of target minerals

i. Mine-water drainage and tailings-dam seepage activating pollution sources and potentially impacting groundwater quality.

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ii. Risk of strongly acidic or alkaline leachate carrying extracted minerals polluting groundwater (International Association of Hydrogeologists, 2018).
iii. In some cases, previously innocuous mine waste deposits have suddenly begun to generate acidic and/or metalliferous leachate many years after they have been revegetated and left unattended (Karmakar & Das, 2012).

b. Subsidence

i. Local depression caused by taking out the rocks, minerals or even fluid from below the earth's surface.
ii. Subsidence depression often induce, disrupt, and divert the flow of water on earth's surface and therefore may adversely affect catchment areas.
iii. The changes in the in-situ permeability around the cracking zone has a great bearing on study of impact on ground water (Karmakar & Das, 2012).

4. <u>Potential hazard of Ln Mining to Aquatic Ecosystems</u>

a. Toxicity to Aquatic Biota

i. Long-term exposure of *Daphnia magna* (crustacean) to natural REE-enriched mine tailing leachates resulted in larger number of offspring that was smaller in size when compared to the control, indicating that Ln might induce adverse effects in natural conditions
ii. Significant adverse effects in long-term studies with crustaceans and fish at 10-100 mg Ce/L. It also has been shown that Ln can change the microbial community's structure: a 15-day exposure to CeO2 NPs (nanoparticles) increased the proportion of algae and decreased the proportion of bacteria in the biofilm. Gills and liver of fish may also be adversely affected upon long-term exposure to CeO2 (Cerium is a lanthanide element) (Blinova et al., 2020). So this will effect food supply of Orang Asli.

c. Bioaccumulation of Ln

i. Ln may be classified as elements with low bioaccumulation potential in aquatic organisms. The highest reported bioconcentration and bioaccumulation factor values for bivalves were between 23 and 357, which are well below 2000—the threshold to classify substances as bioaccumulative by REACH legislation (REACH legislation (Registration, Evaluation, Authorisation and Restriction of Chemicals) is a European Union regulation dating from 18 December 2006. REACH addresses the production and use of chemical substances, and their potential impacts on both human health and the environment.

d. Environmental Exposure levels of Ln

i. Knowledge gaps even on ln release from mine wastes (the oldest Ln pollution source), given the variety of Ln industrial applications and lack of the experimental data on Ln behavior in aquatic ecosystems
ii. Comparison of Ln concentration in surface waters and reported toxicity values allows for concluding that, although even in contaminated waters Ln concentrations are still lower

than the reported toxic concentrations for aquatic organisms, in certain cases (e.g. treated water bodies or mine waste water) Ln may already disturb normal function of ecosystem.

5. Potential hazard of Ln Mining to Biodiversity

1) Destruction of habitat due to deforestation

- Poses greatest threat to species
- Wildlife can be dislocated
- Reduced diversity and abundance of various animal and plant species in a given setting.
- Higher risk of becoming extinct.

2) Habitat modification

- E.g.: pH and temperature modification
  - Native organisms are particularly vulnerable because they need very specific environmental conditions to thrive.
  - Destruction or slight modification of their habitat put them at the risk of extinction.

3) Animals can be poisoned after drinking contaminated water in tailings ponds or nearby water bodies.

- Mainly from surface runoff, spill or leaching of chemicals into water bodies.
- Higher risk for this occurs when contaminants are mobile or bioavailable in the water.
- E.g., Spills and drainage for the defunct Richmond Mine have killed fish and plants along miles of the Sacramento River, which provides drinking water for 80,000 residents of Redding, California (Western Mining Action Network, 2004).

4) Increase in sedimentation can kill other aquatic organisms.

- The suspended solids will clog fish gills, causing them to die or reduce their growth.
- The deposition of suspended sediment to the bottom may smother bottom-dwelling organisms, cover breeding areas, and smother eggs (water.mecc.edu, n.d.)

5) Loss of wetlands

- Wetlands are vulnerable to land use because of their sensitivity and dependence on water.
- Changes in land use cover can greatly disturb these watersheds.
  - Leads to dirtier water downstream
  - Exacerbated flooding in some cases
  - Regional loss of biological diversity and ecological productivity (Klemow, n.d.)

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