Appendix C – Rapid Cumulative Impacts Assessment

PT. Domas Agrointi Prima (DAP) Oleochemical Project – Medan, Indonesia

June 2017

Prepared for Pacific Harbor Group

Appendix C – Rapid Cumulative Impacts Assessment

PT. Domas Agrointi Prima (DAP) Oleochemical Project – Medan, Indonesia

June 2017

Prepared for:

Pacific Harbor Group

Contact:

Warren Allderige

Suites 1416 – 17,

14/F Jardine House,

1 Connaught Place,

Central, Hong Kong

Contact:
international@essa.com
+1 613-798-1300

Cover Photo: View of Kuala Tanjung coast © 2015 Google Earth

ESSA Technologies Ltd.
Vancouver, BC Canada V6H 3H4
www.essa.com

Table of Contents

List of Figures

List of Tables

1 Objectives and approach

1.1 Objectives and scope of the RCIA

Cumulative impacts can be defined as the change to the environment caused by the incremental and/or combined effects of an action/project in combination with other present, past, and reasonably foreseen future actions[1]. These changes may result in significant impacts that would not be expected in the case of stand-alone projects. For practical reasons, the identification and management of cumulative impacts are limited to those effects generally recognized as important on the basis of scientific concerns and/or concerns of affected communities.

IFC's Performance Standard 1 requires clients to ensure that their assessment of environmental and social risks/impacts determines the degree to which the project under review is contributing to cumulative effects. Based on this requirement, the present Rapid Cumulative Impacts Assessment (RCIA) has been developed, according to international best practice[2], to identify the cumulative impacts on valued environmental and/or social components that the Project might contribute to and preliminarily assess the significance of these cumulative effects.

This RCIA analysis has two objectives:

- Provide a preliminary high-level assessment of how the combined effects of the Project with other projects and activities, and natural environmental drivers, could affect valued environmental and social components (VECs) in the Project's area; and
- Assess the significance of the identified cumulative risks and impacts, evaluate the Project's contribution to these impacts and suggest management measures that could be implemented to prevent unacceptable VEC condition and for which the Project could contribute.

1.2 Methodological approach and limitations

ESSA has conducted the present RCIA according to international best practice, particularly the *IFC's Good Practice Handbook on Cumulative Impact Assessment and Management* (2013), and commensurate to the significance of the anticipated impacts and the expected contribution of the Project's to these incremental impacts in the industrial estate where the DAP facility is located.

International methodologies for the assessment of cumulative impacts usually adopt a step-based approach with includes the following common steps, to be followed in a sequential manner although iterations are usually required:

1. Scoping of Valued Environmental and Social Components (VECs) and spatial and temporal boundaries
2. Scoping of other activities and external drivers
3. Establish information on baseline status of VECs
4. Assess cumulative impacts on VECs

5. Assess significance of predicted cumulative impacts
6. Management of cumulative impacts

The selection of appropriate VECs allows the assessment to be focused on those aspects of the natural and human environment that are of greatest importance to society[3]. The use of VECs also improves the effectiveness and efficiency of assessment, in part by facilitating the selection of appropriate study methods and focusing analysis on key project-environment interactions.

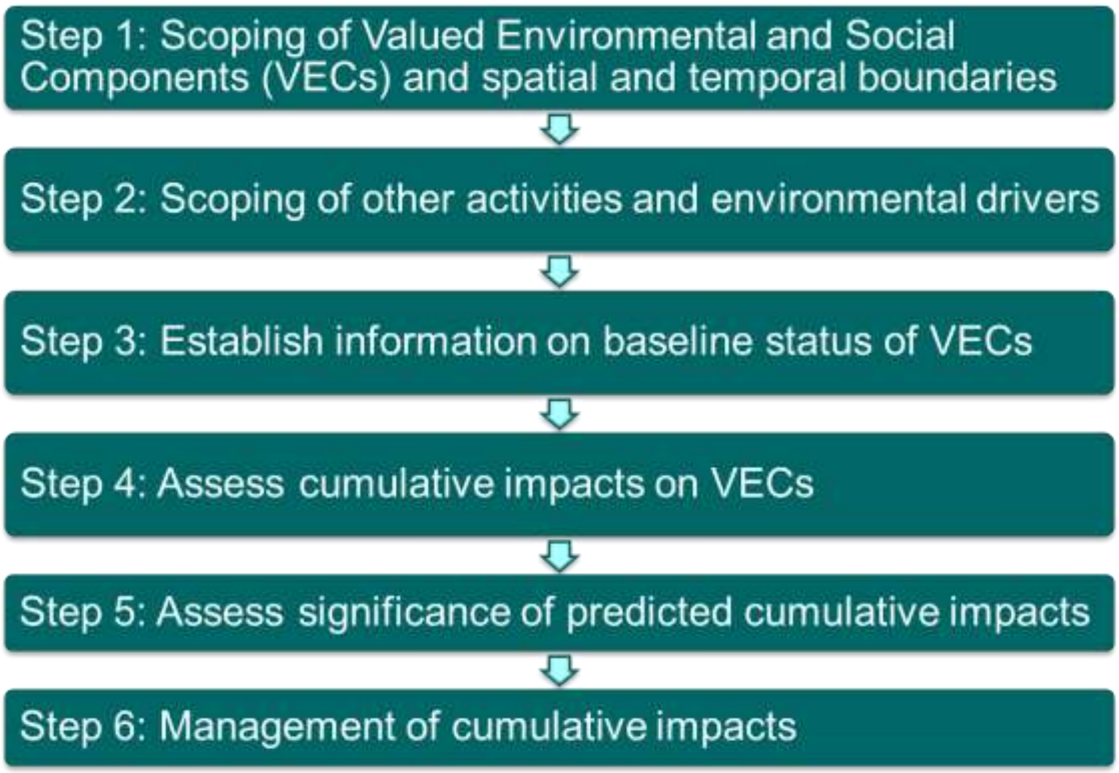

Figure 1: Process for cumulative impact assessment

1.3 Sources of information and limitations of the RCIA

This RCIA has been developed based on easily accessible information, mostly secondary data although we have also incorporated the information from the recent baseline studies conducted by PT Hatfield in 2016 for marine habitats, seawater, groundwater, and freshwater, as well as additional social baseline information compiled by the DAP team. Other sources of information included Google imagery and data from reputable online sources that provided quantitative and qualitative data about surrounding environmental, industrial and social activities at various scales. The RCIA was limited by the lack of quantitative data from the DAP complex area, particularly the lack of water flow and demand of the surrounding rivers. Estimates of the cumulative impacts of near and long-term activities were made based on the combination of quantitative and qualitative research and best judgment of potential impacts by the assessment team. It cannot be considered a detailed assessment of cumulative impacts but a screening of likely cumulative risks. It is expected that the outcomes of this RCIA will be incorporated by DAP management in their policies, procedures and monitoring systems in order to improve the environmental and social performance of the Project.

2 Selected VECs and spatial and temporal boundaries

2.1 Ecological and socioeconomic context

DAP's oleochemical complex is located on a land area of roughly 114 ha within the larger industrial state of PT Sarana Industama Perkasa in the export development zone of Kuala Tanjung, on the coast of Batu Bara district in the province of North Sumatra. This area is located on the Malacca Strait; an important shipping route that is vital to the economic and social development of Indonesia, Singapore, Malaysia, and Thailand.

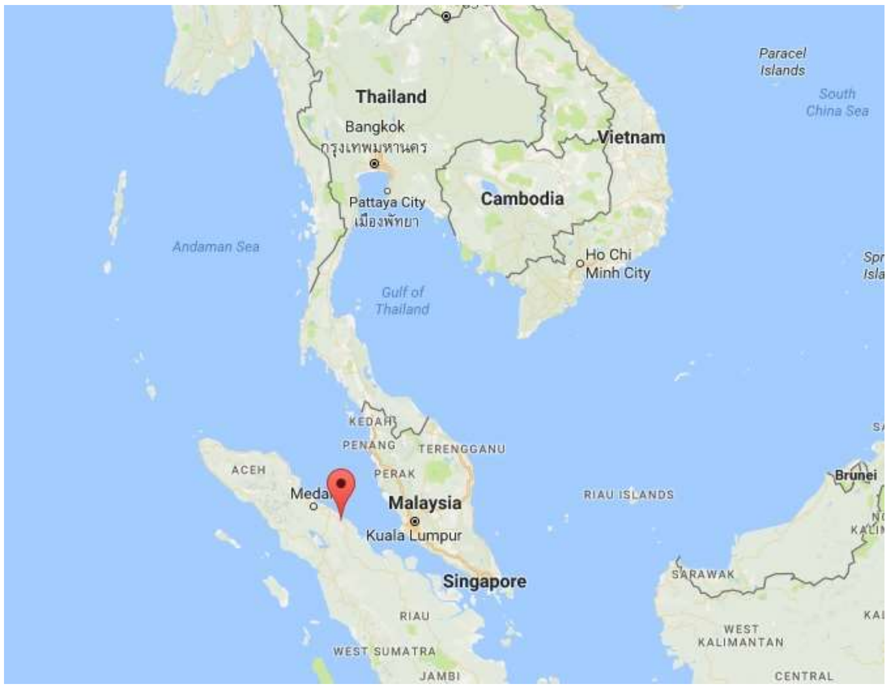

Figure 2: Regional overview, the red marker shows the DAP complex location

The area around the Project presents a mix of industrial, residential and agricultural areas in a context of rapid development. Industrial activities in Kuala Tanjung have been ongoing for decades and the construction of DAP's oleochemical complex started in 2001. The Indonesian Government has long-term plans to develop North Sumatra as a cluster for the downstream palm oil industry.

2.1.1 Ecological context

The island of Sumatra is characterized by higher elevations found throughout the center of the island, decreasing towards the Malacca Strait in the east and the Indian Ocean in the west. In terms of the types of ecoregions[14] found in the Project's area, the complex is located in There are several types of ecoregions that define the area where the DAP Complex is located in the Northern Central Sumatra – Western Malaysia freshwater ecoregion[5] (Figure 3). The province of Sumatera Utara falls almost entirely within this freshwater ecoregion. Some of the larger rivers in this ecoregion include the Belawan, Asahan, and Baramum in Sumatra. One of the most notable features is Lake Toba, the largest lake in Indonesia and largest volcanic lake in the world. The biodiversity data for this ecoregion identifies that amphibians are high in species richness, fish and turtles are moderate in richness, and crocodiles are moderate-low in richness. All four animals and animal types are not endemic to the area (moderate to low).

Figure 3. Freshwater Ecoregion – North Central Sumatra, and Western Malaysia (Source: Abell et al. 2008)

In terms of terrestrial habitats in the Project area; this flat coastal region falls in the **Sunda Shelf mangroves** ecoregion (Figure 4) found on the eastern coast of Sumatra and the coastal areas of Borneo. Mangroves provide an important habitat for the monkey and other terrestrial and marine wildlife, including vulnerable and endangered species[6], as well as preserve the shape of the coastline. These freshwater swamp forests are characterized by fertile alluvial soils. In the area around the DAP complex the original mangrove vegetation has been cleared for agriculture first and, in more recent decades, for industrial development. The habitat is highly modified and retains few of the natural ecoregion features. It is estimated that any remaining freshwater swamp forests still in existence in Sumatra will be under intensive pressure in the coming years[7].

The mangrove forests on the east coast of Northern Sumatra decreased by 59.68% between 1977 and 2006 (103,425 ha to 41,700 ha), and very little of what is left is in good condition[8].

---

[1] Ecoregions are defined as areas of relatively homogeneous species composition, clearly distinct from adjacent systems (Spalding et al. 2007).

In the interior, most of the original ecoregion - the **Sumatran Lowland Rain Forests** – is under critical status due to most of the habitat being lost to intensive agriculture and logging. The remaining intact areas are found primarily in central Sumatra

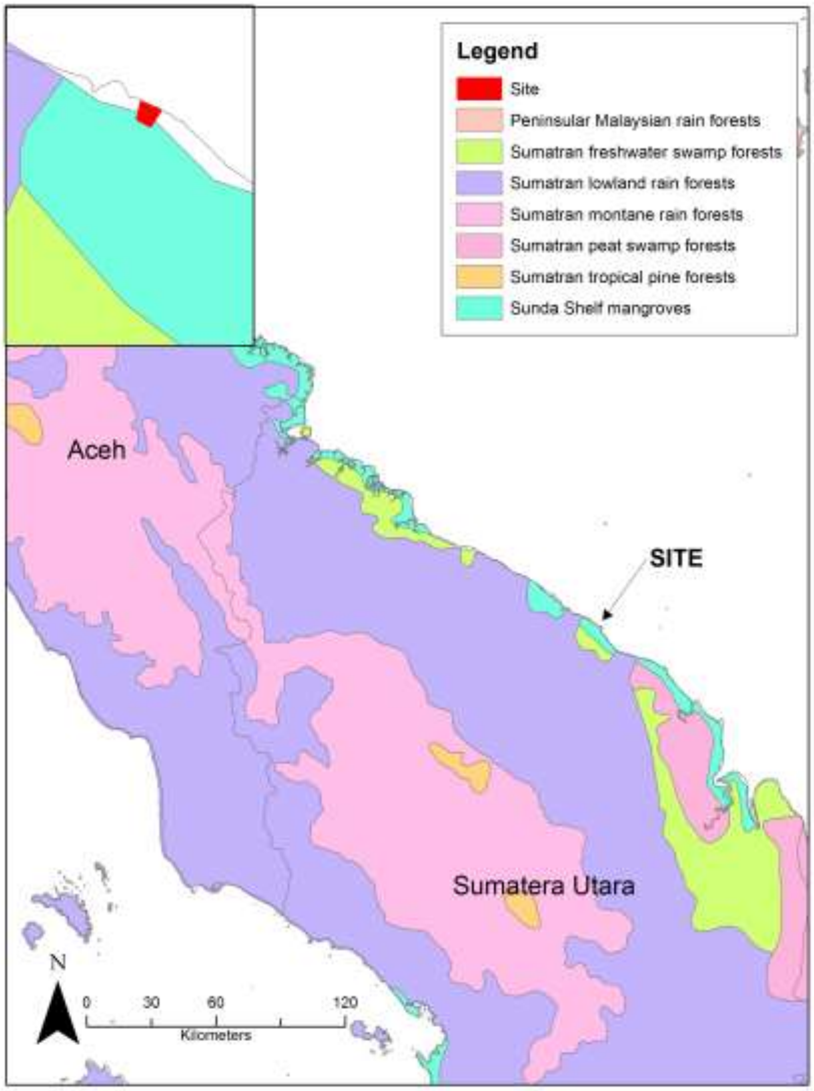

Figure 4. Terrestrial Ecoregions, the DAP complex was located within an ecoregion characterized by mangroves in 2001.

2.1.2 Socioeconomic context

The DAP complex is located within the Batu Bara Regency which as of 2010 has a population of 375,885, of which 60% live rurally. The two closest town to the DAP complex is, Lalang (north of the complex) and Kuala Tanjung (south of the complex), with a combined population of 13,141[2]. Pangkalan Dodek (North of Laland), is also fairly close to the complex with a population of around 28,000.

The average annual population growth rate of North Sumatra from 2000 to 2010 was 1.10%, from 2010 to 2014 the average annual growth rate decreased to 1.05%. This decreasing trend could infer that North Sumatra's population growth rate has most likely stayed constant or dropped slightly in the last 3 years. However, the new influx of industry associated with the Kuala Tanjung shipping port may have caused an increase in population in the surrounding cities. With a lack of a recent population estimate for the province, there is the uncertainty of whether the population is increasing or decreasing, especially in the Batu Bara regency.

2.2 Priority VECs

The DAP complex, along with other ongoing and expected activities around the industrial estate, contributes to the same type of impacts on the environmental and nearby communities, including; air emissions, increased traffic (road and marine transportation), generation and discharge of solid wastes and effluents, and potential effects on the local economy. Based on the expected impacts and the information about the environment around the DAP complex, the present RCIA analysis will focus on the following VECs:

Marine habitats

The local communities surrounding the DAP complex fish in the Malacca Strait to sustain their livelihoods. It is important that this habitat is environmentally sustainable and unpolluted so not to impact the lives of the local people. The Malacca Strait is becoming an increasingly popular shipping route and will continue to be as industry amongst Thailand, Malaysia and Indonesia continue to develop. This, in conjunction with the other industrial developments along the coast, will impact the quantity and quality of fish that are caught by local fisher folk. It is, therefore, an important VEC to consider as marine habitats have a direct social, economic and environmental impact.

Air quality

The air quality in the area surrounding the DAP complex is impacted by the other industries that are also operating within the airshed. The DAP complex itself will produce substantial emissions and therefore it is a concern to the respiratory health of local people, as well as an environmental concern.

Water supplies

The DAP complex requires an input of 750 m^3/s of water from the Besar (Large) River, located 7km from the plant. The surrounding industries and communities share the watershed and sub-watershed that feed this river. The current flow of the river is unknown, so the rate of the river after the withdrawal is taken is also unknown. The intake

[2] de la Cueva Bueno, P. (2016). Environmental and Social Baseline and Compliance Review. PT. Domas Agrointi Prima (DAP) Oleochemical Project – Medan, Indonesia.

station from which the complex takes its water is 2.25 km from the Malacca Strait thereby not having a large impact on downstream activities. However, the unknown rate of river flow, various user water demand and changing climatic conditions within the watershed creates a great deal of uncertainty. It is important to assess this VEC to understand the state of the watershed in the near future.

Community Health and Safety

The DAP complex will impact the health of the local communities due to emissions associated with production and transportation. It will create an increase in road traffic in the area as trucks will transport the product once it has been refined. Many houses in the area are built extremely close to roads for convenience, commerce, and accessibility. There are many different types of vehicles on the roads surrounding the complex including, pedal bikes, motorbikes, cars, small trucks, large transport trucks, and buses. These conditions pose dangerous conditions for pedestrians and smaller vehicles.

Local livelihoods

The communities directly beside the DAP complex will be impacted by some degree due to a combination of the previously stated VECs. The local communities are small and depend largely on agriculture and fisheries to sustain their livelihood. Their health will be the first to be impacted by the growing industry outputs of emissions. Consideration for all the cumulative impacts that will negatively affect the locals is needed to prevent deterioration of their social and economic environments.

2.3 Spatial and temporal boundaries

2.3.1 Spatial

The spatial boundaries are determined so that there is a point at which to stop the pursuit of the cumulative effects. Too-small of a boundary could potentially not capture all the regional and long-term effects. There is the long-range transport of pollutants in airsheds and waterways that can cover large geographic areas[3]. The spatial boundaries set here are adaptive; as new environmental and social information becomes available during the lifetime of the project a different boundary may be required.

The direct area of impact (DAI), is located around the DAP complex. However, the environmental data determining the VECs of the area covers a much wider, generalized area off the coast and inland from the complex. The DAI is in the immediate surrounding area of the red polygon (the DAP complex), shown in figure 5. Environmental factors that were included in the analysis are widespread due to the nature of the watershed that extends west towards the centre of Sumatra. The satellite imagery in Figure 5 shows nearby industries, south of the complex, that also have an influence on environmental issues in the area. The inset map shows the broader area that is being included in

[3] CEAA. (2016). Cumulative Effects Assessment Practitioners' Guide. https://www.ceaa.gc.ca/default.asp?lang=En&n=43952694-1&offset=7&toc=hide

the analysis, the purple outlines are the main watershed and its sub-watershed. The five priority VECs will cover different geographical reaches, these spatial boundaries were established using the following logic[4]:

- A local study area in which the obvious, easily understood and often mitigable effects will occur.
- A regional study area that includes areas where VECs may interact and stakeholders affected.
- The use of several boundaries for different environmental components.
- Boundaries set at the point at which cumulative effects become insignificant.

Thep VEC boundaries include the following:

- Marine habitats: extends into the Malacca Strait, ensuring that the area around the jetty built for the complex is included.
- Air quality (defined by airshed assessment; see Appendix E)
- Water supplies: includes the main watershed and sub-watershed which also covers the industrial area south of the complex
- Community Health and Safety: covers the two towns of Lalang and Kuala Tanjung and the transportation corridor leading from the complex and through the town of Lalang.
- Local livelihoods includes the populated areas directly around the DAP complex, the town of Lalang and Kuala Tanjung.

[4] Ibid.

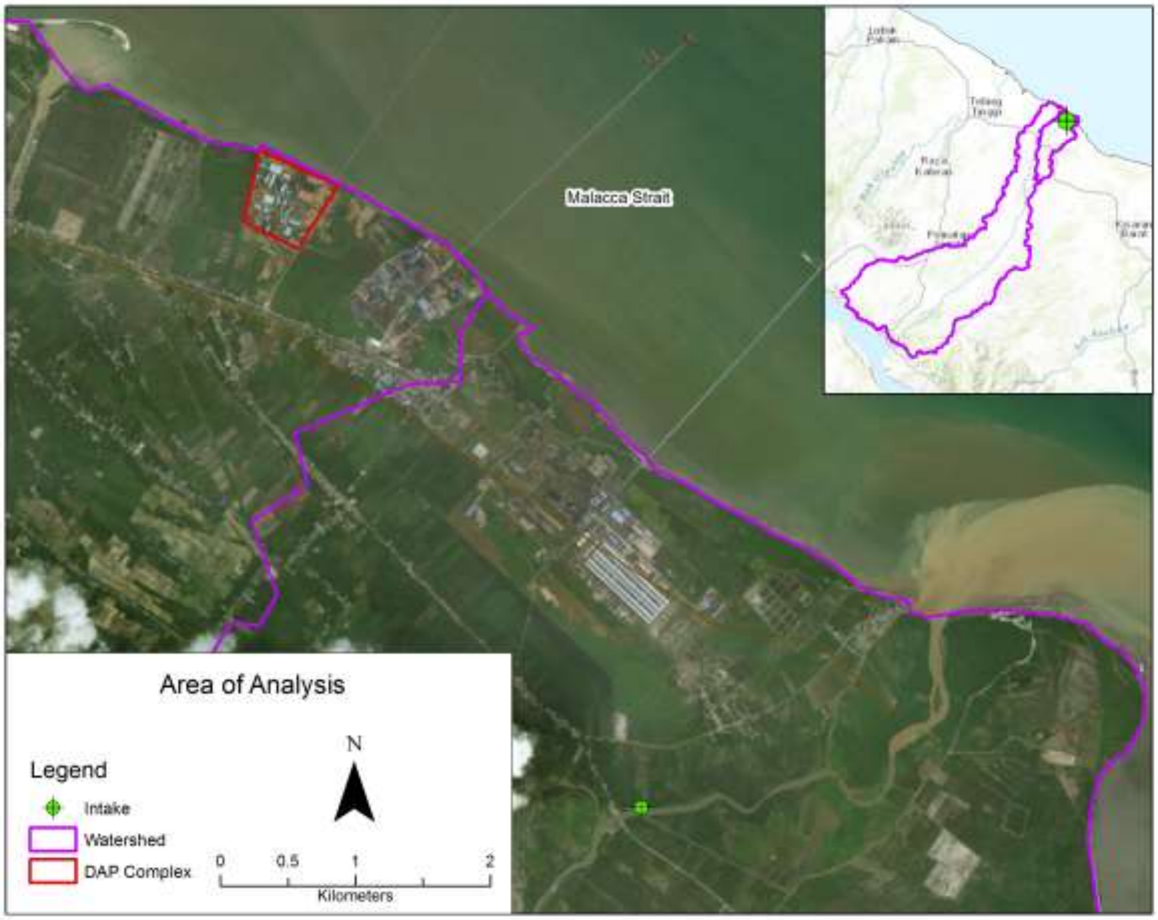

Figure 5. Area of analysis (Source: Google Earth satellite imagery)

2.3.2 Temporal

The temporal considerations for this study vary depending on the VEC. Generally, the temporal boundaries will start at the year in which the baseline information for the assessment is collected and last the lifetime of the complex, and until the VECs have recovered and the impacts become trivial[5]. A potential time constraint for a cumulative effects assessment is when the foreseeable future actions can no longer be identified or meaningfully evaluated[6]. The approach taken here to setting temporal boundaries on the VECs is centered on each value component. This

[5] CEAA. (2016). Cumulative Effects Assessment Practitioners' Guide. https://www.ceaa.gc.ca/default.asp?lang=En&n=43952694-1&offset=7&toc=hide

[6] Eccleston, C. H. (2011). Environmental impact assessment: A guide to best professional practices. CRC Press.

approach examines the unique characteristics of impacts on the VEC and takes into account the VEC's natural variation over time[7].

Marine habitats are so large that they may not feel the effects of certain environmental intrusions until decades later. A study was done to map the impact of 19 different types of anthropogenic stress on 20 global marine ecosystem types by using data in 5-year intervals to allow for an assessment of the cumulative impacts. The study found that this method of observing 5-year intervals allowed for a comparison of which areas saw high and increasing impacts from anthropogenic stressors[8]. Marine ecosystems may hold certain threshold responses to stressors, creating nonlinear cumulative impacts. The time span for monitoring the Malacca Strait near the DAP Complex should continue for at least five years after the plant is decommissioned to ensure any impacts that may have affected marine life and the quality of the water do not occur, or if they do can be properly attended to.

The assessment of **air quality** using a cumulative effects approach should take into consideration past actions that are abandoned but still may cause effects of concern, any existing, active actions, and any future actions that may yet occur[9]. The continued development of the region surrounding the DAP complex suggests that there will be a need to account for future industrial activities that may impact the air quality. For the future actions, there are three categories to consider, certain, reasonably foreseeable, and hypothetical[10]. The InAlum facility is already constructing their smelter upgrade, as well as the construction of the port is almost complete, therefore the future impacts are certain and can be taken into consideration.

The availability of **water supplies** within the spatial boundaries can be impacted immediately and throughout the lifespan of the processing plant. After the plant is decommissioned water availability should be monitored until it returns to normal. The quality of the water is likely to take more time to return to baseline conditions. The future temporal boundary for water supplies cannot be exactly set at this time and will need to consider the variability of natural cycles of change in the surrounding ecosystems as well as any unforeseen, significant environmental events that may occur[11].

To determine **temporal boundaries for community health and safety** and **local livelihoods**, those living within the area of analysis should have their health and economic well-being is taken into account. Road traffic will continue to increase as industrial expansion continues in the area. In the case of road safety, it is difficult to determine future conditions past the time in which the DAP complex ceases to operate due to unknown future industrial development. Similarly, for the local peoples, the impact on their livelihoods cannot be fully determined past the lifetime of the DAP complex due to the potential of other industries being built in the future. The best temporal boundaries for these two VECs is a past boundary starting at baseline conditions, extending the lifetime of

---

[7] CEAA. (2016). Technical Guidance for Assessing Cumulative Environmental Effects under the Canadian Environmental Assessment Act, 2012. https://ceaa-acee.gc.ca/default.asp?lang=en&n=B82352FF-1&offset=6&toc=hide

[8] Halpern, B. S. et al. (2015). Spatial and temporal changes in cumulative human impacts on the world/'s ocean. Nature communications, 6.

[9] CEAA. (2016). Cumulative Effects Assessment Practitioners' Guide. https://www.ceaa.gc.ca/default.asp?lang=En&n=43952694-1&offset=7&toc=hide

[10] Ibid.

[11] Ibid.

the DAP complex, and for five years after to assess post-facility conditions. If deemed necessary at that time, further monitoring of the VECs can be extended.

Give these considerations, two scenarios were defined:

- Scenario 1: Near-term development (2020): This scenario represents the cumulative effects in the near future, after DAP upgrade and restart of the operations.
- Scenario 2: Long-term development (2040): This future scenario considers the expected effects of climate change on the VECs and that planned and ongoing activities are fully operational.

3 Other activities and environmental drivers

This section describes, based on secondary information available at the time of this assessment, existing and planned activities and environmental factors affecting DAP's surroundings and the area of analysis.

3.1 Other activities

3.1.1 Existing industrial facilities

PT Wilmar Oil Refinery

The Wilmar Kuala Tanjung Oil Refinery is an active vegetable oil industrial complex located along the coast of North Sumatra province, 800 meters south of the DAP complex. Wilmar has been an active participant in sustainability discussions in Asia. The General Manager for Wilmar Sustainability discussed the role of oil palm plantations in maintaining forest landscapes by committing to conserve High Carbon Stock and High Conversation Value forests, as well as promoting socio-economic development through smallholder projects[12]. The Kuala Tanjung Refinery sends and receives materials from a number of mills and refineries around Malaysia and Indonesia. Some of the mills and refineries are located on Sumatra, therefore the most economical means of transporting their products is through trucks which utilize the same transportation corridor as the one proposed for the DAP complex[13].

There are many environmental issues associated with the operational phase of vegetable oil production and processing primarily include the following[14]:

- Solid waste and by-products
    - Contaminated sludge and effluent can be created and must be properly disposed of in a landfill or incinerated.
- Water consumption and management
    - The facilities require significant amounts of water for cooling purposes during product, chemical neutralization and subsequent washing and deodorization.
- Energy consumption and management
    - High amounts of energy are used at processing facilities, putting a strain on local energy resources
- Atmospheric emissions

---

[12] Wilmar. (2016). No Deforestation, No Peat, No Exploitation Policy. Quarter 3 – 2016 Update. http://www.insideindonesia.org/how-vulnerable-is-indonesia-to-future-climate-change

[13] Amnesity International. (2016). The Great Palm Oil Scandal: Labour Abuses and Behind Big Brand Names. https://amnistia.org.ar/wp-content/uploads/delightful-downloads/2016/12/ASA2151842016ENGLISH-101-148-ilovepdf-compressed.pdf

[14] IFC. (2015). Environmental, Health and Safety Guidelines for Vegetable Oil Production and Processing. http://www.ifc.org/wps/wcm/connect/1e6d9780474b37b89a2bfe57143498e5/FINAL_Feb+2015_Vegetable+Oil+Processing+EHS+Guideline.pdf?MOD=AJPERES

  - Particulate matter and VOCs are the main emissions from vegetable oil production and will decrease air quality in the vicinity of the facility.
- Greenhouse gas emissions
  - High nutrient loading of wastewater can be a source of methane when treated or disposed of anaerobically. It can also be a source of nitrous oxide emissions due to degradation of nitrogen components in the wastewater.
- Hazardous materials
  - There are bulk quantities of acids, alkalis, solvents, and hydrogen that are involved in oil processing. They are extremely flammable and create the potential for hazardous situations if not handled carefully.

PT Indonesia Asahan Aluminium Persero (INALUM)

The head office and smelting plant of PT InAlum is located along the coast of North Sumatra province, three kilometers south of the DAP complex. The state-owned aluminum manufacturing facility recently allocated US$3 billion to strengthen its processing business by 2021[15]. The investment will be used to develop smelter-grade aluminum and to expand production capacity throughout Indonesia. The first phase of development is expected to be completed by 2019, producing 1 million tons of aluminum per year and later expanding to 2 million tons per year by 2025[16]. InAlum's processing facility in Kuala Tanjung will build its capacity to produce 500,000 tons of aluminum per year, and a wire rod mill with a capacity of 250,000 tons per year. Aluminum smelters require large amounts of electricity; to meet this demand there are plans to develop hydropower plants in North Kalimantan, on the island of Borneo. The electricity needs and supply for the processing plant in Kuala Tanjung are planned to be met through the construction of a coal-fired power station[17].

Environmental issues associated with steel manufacturing primarily include the following[18]

- Air emissions
  - Steel manufacturing generates large amounts of particulate matter, nitrogen oxides, sulfur dioxides, carbon monoxides, chlorides, fluorides, VOCs and organic HAPS, dioxins, and furans as well as greenhouse gases.
- Solid waste
  - The process also produces sludge, acids, and metallic waste, most of which can be reused or recycled.
- Wastewater

---

[15] Singgih, V. (2017). Inalum sets $3b to boost smelting biz. https://www.pressreader.com/indonesia/the-jakarta-post/20170324/282067686760133

[16] Ibid.

[17] The Watch Source. (2016). Kuala Tanjung Inalum power station. http://www.sourcewatch.org/index.php/Kuala_Tanjung_Inalum_power_station

[18] IFC. (2007). Environmental, Health, and Safety Guidelines for Integrated Steel Mills. http://www.ifc.org/wps/wcm/connect/0b9c2500488558848064d26a6515bb18/Final%2B-%2BIntegrated%2BSteel%2BMills.pdf?MOD=AJPERES&id=1323161945237

    - Water is used for cooling processes generating effluent streams that need to be treated.
- Noise
    - The processes at steel plants generate a high volume of noise and should be tested to ensure they achieve ambient noise levels.

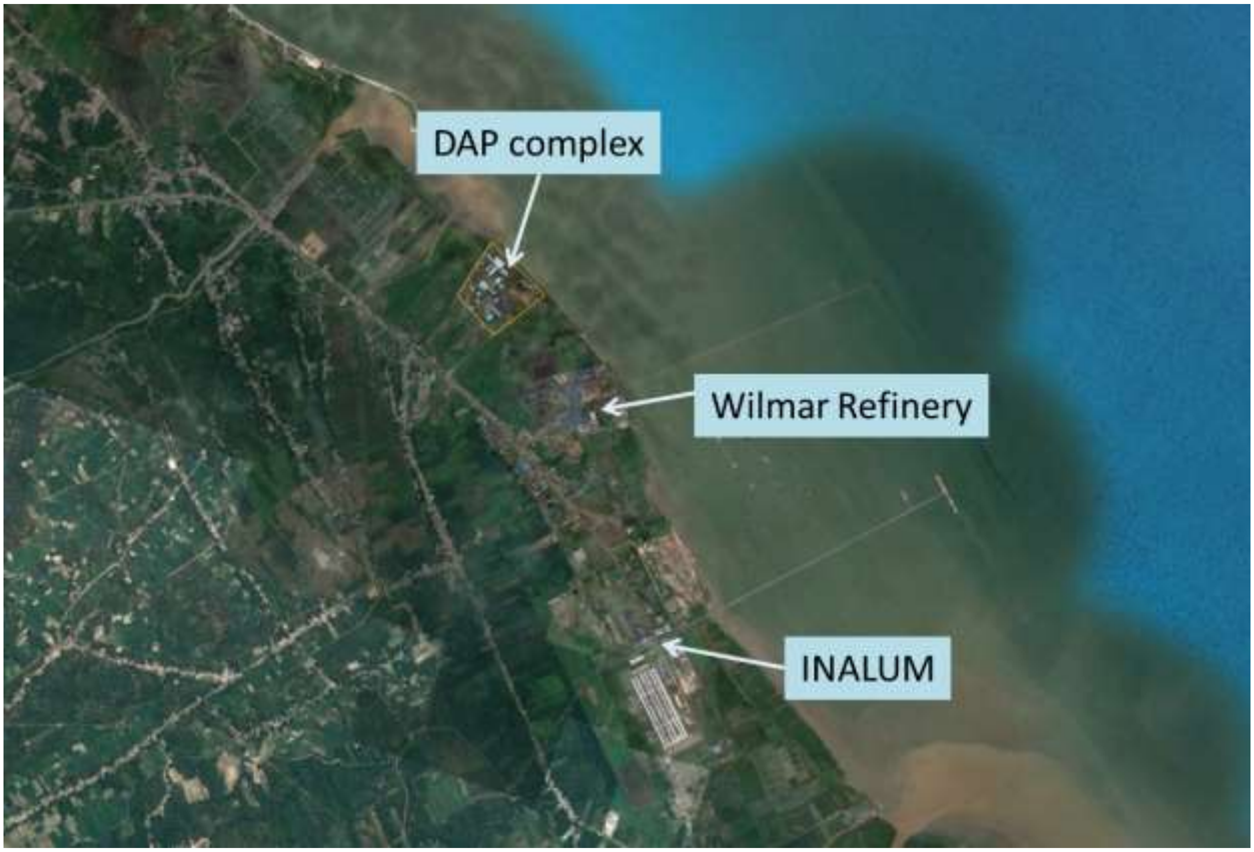

Figure 6. Nearby industries, InAlum, and Wilmar Refinery

3.1.2 Marine-based activities

Marine traffic

Marine traffic in the Strait of Malacca has become a popular route to get from the Persian Gulf to Japan and South Korea as it is the straightest and cheapest route[19]. This makes the Malacca Strait a strategic region for seaborne trade, especially for oil tankers carrying products from the oil-rich states in the Middle East[20]. The straits provide passage to more than 100,000 vessels a year, which at times can create chokepoints the more narrow areas. This is expected to worsen as traffic is predicted to double in the next ten years, making the Malacca Straits the most

[19] Lee, P. (2016). Reuters and other lies on South China Sea. Newsbred. http://www.newsbred.com/reuters-and-other-lies-south-china-sea

[20] Strasselink. (2014). Malacca Straits. http://www.strasselink.com/straits.php

congested shipping route in the world[21]. Image 2 shows marine traffic in the Strait, representing a single snapshot of the conditions of the Strait on June 6th, 2017. The red areas show the chokepoints that develop as ships enter the narrow areas of the Strait.

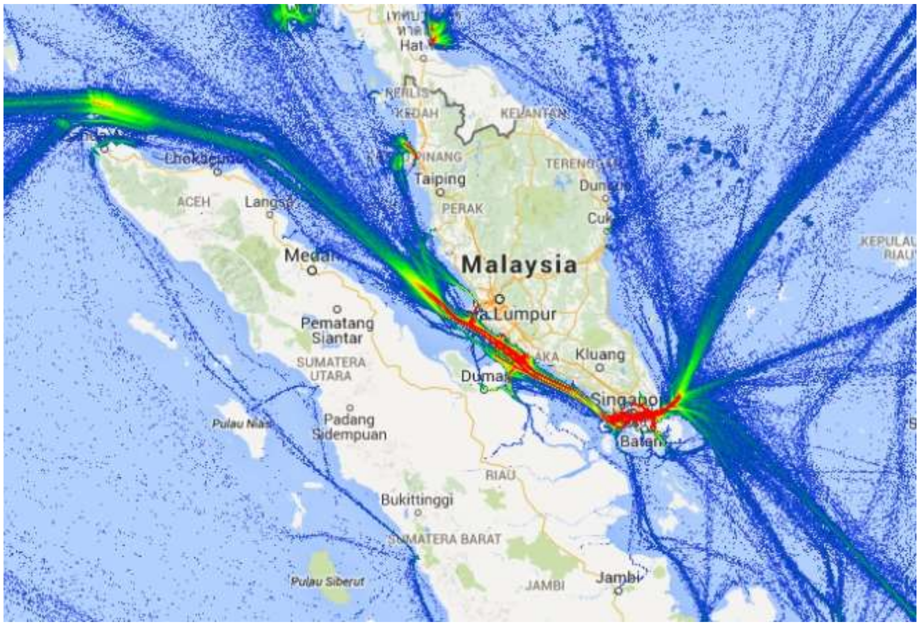

Image 1. Marine traffic in the Malacca Straits. Imagery from marrinevesseltraffic.com

The Straits of Malacca also allow for cross-strait traffic and coastal shipping. This has been increasing since 2008 and has been identified as one of the impediments to safe navigation for through traffic[22]. Haze caused by forest and plantation fires in Sumatra has at times severely affected visibility for ships passing through the area. Image 3 shows the main flow of shipping traffic, including the cross-strait traffic which adds to the congestion and potential dangers of collisions within the Strait.

Marine traffic has several environmental impacts such as the high density of boats producing air and GHG emissions. As traffic in the Strait increases the risk of collisions also increases which create the risk of effluents, such as oil, ending up in the water. Increased boat presence, emissions and any effluents from the boats will impact the quantity and quality of aquatic habitats and fisheries.

[21] Strasselink. (2014). Malacca Straits. http://www.strasselink.com/straits.php.

[22] Ibid.

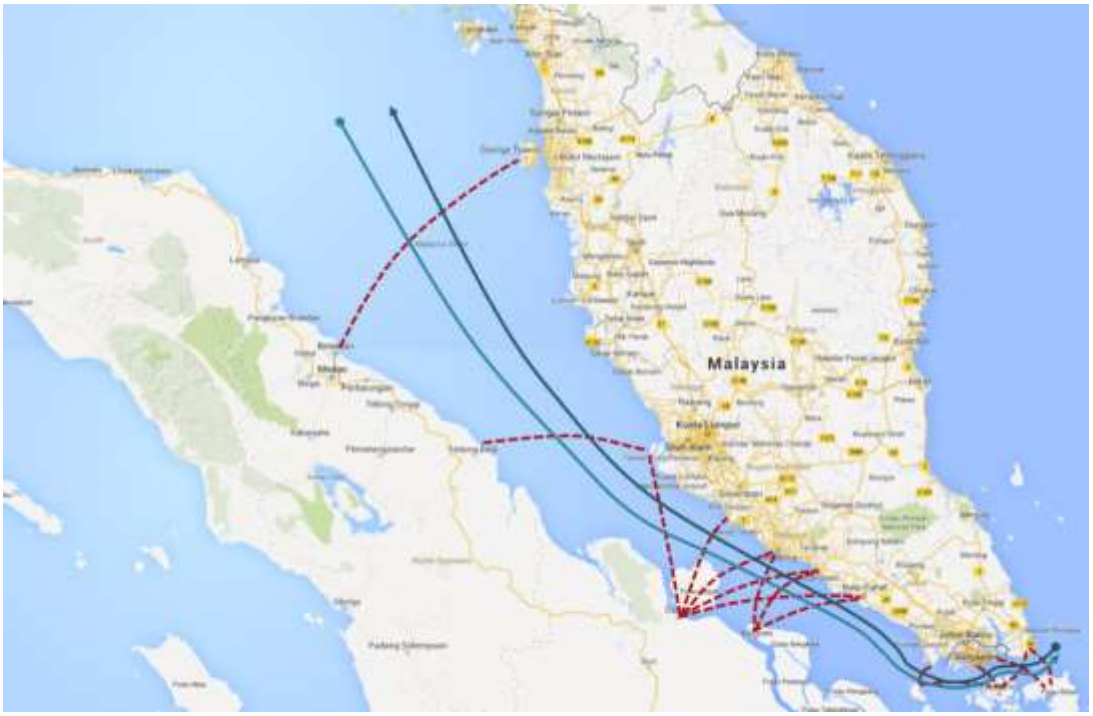

Image 2. The main shipping routes through and across the Malacca Strait[23].

Fisheries

The fishing industry in Indonesia has seen a trend of positive influences in the last 15 years. In 2004 the marine capture fisheries for Indonesia were 8.73% in the Malacca Strait, and total production showed a steady increase[24]. In 2015 the fishing industry in Indonesia had grown 8.37%, far above the country's overall economic growth of 4.73%[25]. There has been an increase in law enforcement against illegal fishing and an overall improvement in policies that enhance the livelihoods of fisherfolk, allowing for them to increase their catches[26]

One of Indonesia's ocean fishing harbors is located in Belawan near Medan, approximately 100km north of the DAP complex. This type of harbor has the capacity to support 18,000 landings annually[27]. Due to the improvements of policies in the fisheries industry, it is reasonable to foresee continued increase in this sector and within the Malacca Strait over the next several years. The fishing industry could be impacted by the increase in marine traffic. An example of the impacts of high traffic area occurred in November 2016 when a fishing boat sank after accidentally colliding with a product tanker off the coast of North Sumatra. Statements from the fisherman say they suffered

---

[23] Strasselink. (2014). Malacca Straits. http://www.strasselink.com/straits.php

[24] FAO. (2006). Organisation des Nations Unies pour l'alimentation et l'agriculture. http://www.fao.org/fi/oldsite/FCP/en/idn/profile.htm

[25] Global Business Guide Indonesia. (2016). Indonesia's fisheries sector: Under a New Paradigm. http://www.gbgindonesia.com/en/agriculture/article/2016/indonesia_s_fisheries_sector_under_a_new_paradigm_11566.php

[26] Ibid.

[27] FAO. (2006). Organisation des Nations Unies pour l'alimentation et l'agriculture. http://www.fao.org/fi/oldsite/FCP/en/idn/profile.htm.

rudder failure and the vessels were too close to each other to avoid a collision[28]. Fishing activities add to the issues related to marine traffic, the boats produce air and GHG emissions as well as the possibility of effluent discharge. These impacts as well as overfishing contribute to the degradation of the surrounding aquatic habitats and fisheries.

3.1.3 Land-based activities

Agriculture

Small holdings make up most of the rubber plantations in Sumatra, these plantations have a low productivity of around 600 kg/hectare per year due to poor maintenance of seedlings and the health of the old rubber trees does not allow for further growth. In 2005 North Sumatra had the largest production of rubber plantations totaling 412,000 hectares; rubber production needs large amounts of land and high rainfall to grow productive harvests[29].

Key agricultural indicators important to North Sumatra, are paddy, maize, mango, and banana production. Indonesia's rice paddy production is heavily exploited in Sumatra, 2,523,393 hectares are used for production on the island[30]. Continued production of rice crops in these areas is extremely important to the livelihood of farmers and the economics of this commodity in Indonesia.

Agricultural activities discharge effluent due to the runoff of nutrients into the water systems surrounding the fields. The agriculture products produced in this region require a high amount of water resources for adequate growth.

3.1.4 Ongoing and future developments

Kuala Tanjung Port

A new shipping port is currently under construction just south of the DAP complex in the Kuala Tanjung area. The port is expected to be open in summer 2017 with limited functionality, increasing capacity later into 2018. The port is being developed in several phases, the first phase which is 80 to 90 percent complete as of April 2017, will be a multipurpose terminal[31]. The second phase will include the development of an industrial area and then third will develop a container port and residential area. The new port will allow for an increase in economic development for the region, including an estimated reduction in the price of goods in eastern Indonesia by 20-25%[32]. Once

---

[28] Petrov, S. (2016). Fishing boat Jaya II sank after collision with product tanker Victory Prime in Malacca Strait. http://www.maritimeherald.com/2016/fishing-boat-jaya-ii-sank-after-collision-with-product-tanker-victory-prima-in-malacca-strait/

[29] Profile of rubber plantations in Indonesia. (2006, September 1). *The Free Library*. (2006). Retrieved June 07, 2017 from https://www.thefreelibrary.com/Profile of rubber plantations in Indonesia.-a0155476183

[30] Panuju, D. R., Mizuno, K., & Trisasongko, B. H. (2013). The dynamics of rice production in Indonesia 1961–2009. Journal of the Saudi Society of Agricultural Sciences, 12(1), 27-37.

[31] The Jakarta Post. (2017). Kuala Tanjung to start operations in July. News Desk. http://www.thejakartapost.com/news/2017/04/12/kuala-tanjung-port-to-start-operations-in-july.html

[32] Hermansyah, A. (2017). Jokowi proud of maritime sector progress. The Jakarta Post. http://www.thejakartapost.com/news/2017/05/05/jokowi-proud-of-maritime-sector-progress.html

completed, the Kuala Tanjung port will be Indonesia's largest transit hub, creating even greater access to the high traffic waters of the Malacca Strait[33].

During the construction phase of the port, it will produce solid waste and effluents, as well as increased noise levels. Once the port has been established it will attract a great deal of marine traffic, impacting the aquatic habitats and fisheries in the area. The boats entering the port will produce noise, air, and GHG emissions. There is a risk that effluents will be discharged while boats are docked, or if there are collisions.

Kuala Tanjung Inalum power station

A coal-fired power station is in development within the InAlum Kuala Tanjung site, located on 80 hectares of land adjacent to the aluminum refinery. The construction was scheduled to begin in 2015 but has been delayed several times, it is currently set to commence in 2017[34]. The size of the plant is proposed to output 700-megawatts of power in order to meet the demands of the increasing smelter activities that are planned to take place over the next 4 years. The proposed power station will produce air emissions such as toxic ash and GHG emissions from the coal burning process. It will release toxic solid waste such as sludge and heavy metals into the environment[35]. Any of these discharges from the plant will impact the aquatic habitat and fisheries. The plant will also create noise due to its processes and consume a large amount of water for cooling activities.

DAP Complex and jetty

A jetty is being built off the coast of the DAP complex property to transport raw materials and products servicing the Industrial Area adjacent to the jetty. An environmental and social impact assessment was done for the project in May 2017 by Hatfield. Their findings of large and important impacts include the following:

- Changes to ambient air quality during construction (mobilization of heavy equipment, material movements, foundation work, soil compaction, construction of buildings)
- Changes to noise levels during construction;
- Changes to seawater quality during construction and operation phases;
- Impacts to marine aquatic biota during construction and operation phases;
- Impacts to marine transportation during construction and operation phases;
- Work and trade opportunities leading to an increase in livelihood condition; and
- Impacts to public health

3.1.5 Types of impacts of existing, ongoing and future activities

Based on the types of activities discussed in the previous sections, the types of ongoing and expected impacts relevant for the priority VECs were identified (Table 1).

[33] The Jakarta Post. (2017). Kuala Tanjung to start operations in July. News Desk. http://www.thejakartapost.com/news/2017/04/12/kuala-tanjung-port-to-start-operations-in-july.html

[34] The Watch Source. (2016). Kuala Tanjung Inalum power station. http://www.sourcewatch.org/index.php/Kuala_Tanjung_Inalum_power_station

[35] UCSUSA. Environmental impacts of coal power: wastes generated http://www.ucsusa.org/clean-energy/coal-and-other-fossil-fuels/waste#.WUGebevyu00

Table 1: Current activities and future developments impacting the VECs

Activities	Air emissions	Solid waste	Effluents	Noise	GHG emissions	Water consumption	Aquatic habitats/ fisheries
Current activities							
Palm oil refinery (PT Wilmar)	✓	✓	✓	✓	✓	✓	✓
Aluminium factory (INALUM)	✓	✓	✓	✓	✓	✓	✓
Marine traffic	✓		✓		✓		✓
Fishing	✓		✓		✓		✓
Agriculture			✓			✓	
Future developments							
Kuala Tanjung Port	✓	✓	✓	✓	✓	✓	✓
Kuala Tanjung Inalum power station	✓	✓	✓	✓	✓	✓	✓
DAP Complex and jetty	✓	✓	✓	✓	✓	✓	✓

3.2 Climate change

A detailed screening of climate risks for the Project has been included in Section 4.2 of the main report. This section focuses on climate risks as they may affect the selected VECs. The communities of North Sumatra are extremely vulnerable to the impacts of climate change. Rising sea levels, increasing temperatures, fluctuating ground water tables and extreme events will put the health of the population at risk. Climate change will alter the distribution and productivity of fish and other marine and freshwater species. This has an impact on the sustainability of fisheries and aquaculture, especially for coastal communities whose livelihoods depend on fishing.

Temperature

There will be an **increased need for irrigation** as average annual temperatures rise. It is estimated that the largest temperature increase in Indonesia will occur on the island of Sumatra where it is likely they will see an **increase of around 4 ºC** by the end of the century[36]. Spatial climate analysis shows a consistent trend towards fewer cooler nights and more warm nights and days for Sumatra[37], increasing evapotranspiration. The projected climate change in Sumatra will likely impose critical stress on water resources.

Precipitation

The change in temperature and rainfall will affect the water balance, combined with the estimated population growth for the province, **severe water shortages are expected to occur during 2020 to 2030**[38].

Table 2: Water availability predictions for Sumatra

Area	Supply	Demand	Balance (2009)	Balance (2015)	Balance (2030)
Sumatra	111,077.65	37,805.55	73,272.10	48,420.07	-67,101.34

Despite expected water shortages, the overall change in annual precipitation for North Sumatra is expected to increase by about 20% by the 2050s[39]. The change in the timing of seasons and unpredictable rainfall patterns will have implications for food production and economic stability. In parts of Sumatra, it has already seen the wet season began up to 20 days later than the average[40].

---

[36] Triastuti, H. (2009). Indonesia Climate Change Sectoral Roadmap (ICCSR). Synthesis Report. Republic of Indonesia. http://www.adaptation-undp.org/sites/default/files/downloads/indonesia_climate_change_sectoral_roadmap_iccsr.pdf

[37] MET Office. (2011). Climate: Observations, projections and impacts: Indonesia. http://eprints.nottingham.ac.uk/2040/13/Indonesia.pdf

[38] Triastuti, H. (2009). Indonesia Climate Change Sectoral Roadmap (ICCSR). Synthesis Report. Republic of Indonesia. http://www.adaptation-undp.org/sites/default/files/downloads/indonesia_climate_change_sectoral_roadmap_iccsr.pdf

[39] Climate Wizard. (2007). Change in Annual Precipitation by the 2050s. The Nature Conservancy. http://www.climatewizard.org/

[40] GFDRR. (2011). Climate Risk and Adaptation Country Profile, Indonesia. http://sdwebx.worldbank.org/climateportal/countryprofile/doc/GFDRRCountryProfiles/wb_gfdrr_climate_change_country_profile_for_IDN.pdf

Extreme events

The east coast of Sumatra has been designated as being at **extremely high-risk** of flooding due to extreme rainfall, overloaded surface water sources or water reservoirs, and land characteristics. Floods in this region can lead to disastrous landslides. The deforestation of the island has led to an increase in landslides[41] as the forests provide natural protection from floods and landslides.

Sea level rise – DAP complex and jetty facilities

The regency of Batu Bara sits almost at sea-level and will experience a loss of land by the rising waters. The DAP complex will experience flooded land within the complex and the jetty facilities (3.4 m above high tide level) could be affected as sea level rises.

Saltwater intrusion could affect freshwater resources that are used for agricultural purposes along the eastern coast of Sumatra, causing a decrease in crop growth and yield[42]. Under a 1-meter sea-level rise scenario, rice paddy fields will be reduced by an area of about 3,170 hectares on the island of Sumatra[43].

As sea-levels rise during the 21st century, people living along the coasts of Sumatra are at risk of losing their homes and properties on which they depend upon for their livelihoods. There is an on-going sea level monitoring program that uses a network of stations around Indonesia to determine mean sea level and monitor the effect of global climate changes on Indonesian waters[44].

[41] Martine, E. (2015). Landslides could become Indonesia's worst nightmare. SciDevNet. http://www.scidev.net/asia-pacific/disasters/feature/landslides-could-become-indonesia-s-worst-nightmare.html

[42] Pisaspeak. (2016). Climate change and sea level rise in Asia: Indonesia. https://pisaspeak.wordpress.com/2016/11/08/climate-change-and-sea-level-rise-in-asia-indonesia/

[43] Förster, H., Sterzel, T., Pape, C. A., Moneo-Lain, M., Niemeyer, I., Boer, R., & Kropp, J. P. (2011). Sea-level rise in Indonesia: on adaptation priorities in the agricultural sector. Regional Environmental Change, 11(4), 893-904.

[44] Khafid. (2011). National Report to GLOSS GE XII. Indonesia Sea Level Monitoring. http://www.gloss-sealevel.org/publications/documents/indonesia_gexii2011.pdf

4 Current status and trends of selected VECs

Based on indicators informative of the status and conditions of the VEC, this section presents a description of the condition and expected trends of the prioritized VECs.

4.1 Marine habitats

The indicators to be used for this VEC are seawater, marine biodiversity, and marine traffic. Seawater and marine biodiversity are based on available baseline data surveys done in 2003 for marine habitats, 2010 for seawater and 2016 for both seawater and marine habitats. Comparatively, the data from these studies reveal the trends that phytoplankton is increasing in abundance and decreasing in diversity. The seawater has an increasing amount of suspending solids, oil and grease, and a decrease in sulfide, dissolved metals, and ammonia. The increase of phytoplankton and decrease of elements and chemical compounds could be attributed to the DAP complex closure, in which less effluent was released into the surrounding waters. Marine traffic data is readily available and shows observable trends that traffic in the Malacca Strait is increasing and is predicted to continue.

4.1.1 Marine Biodiversity

The DAP complex lies near the coast of the Malacca Strait, an ecoregion that covers the eastern half of Northern Sumatra (Figure 7). The eastern halves of Aceh, North Sumatra, and most of Riau Provinces are within this ecoregion. In ecological terms, the Malacca Strait is a cohesive unit, the area that encompasses this ecoregion shares many characteristics pertaining to biodiversity and types of ecosystems.

Indonesia's marine and coastal ecosystems in the Malacca Strait[45]:

- Mangroves – 404,606 hectares
- Coral Reefs – Some fringing reefs in Northern Sumatera
- Seagrass – East coast of Sumatera (12 species)

[45] Kaur, C.R. (2016). Biodiversity in the Straits of Malacca: An assessment of issues and challenges on environmental protection. Centre for Coastal and Marine Environment

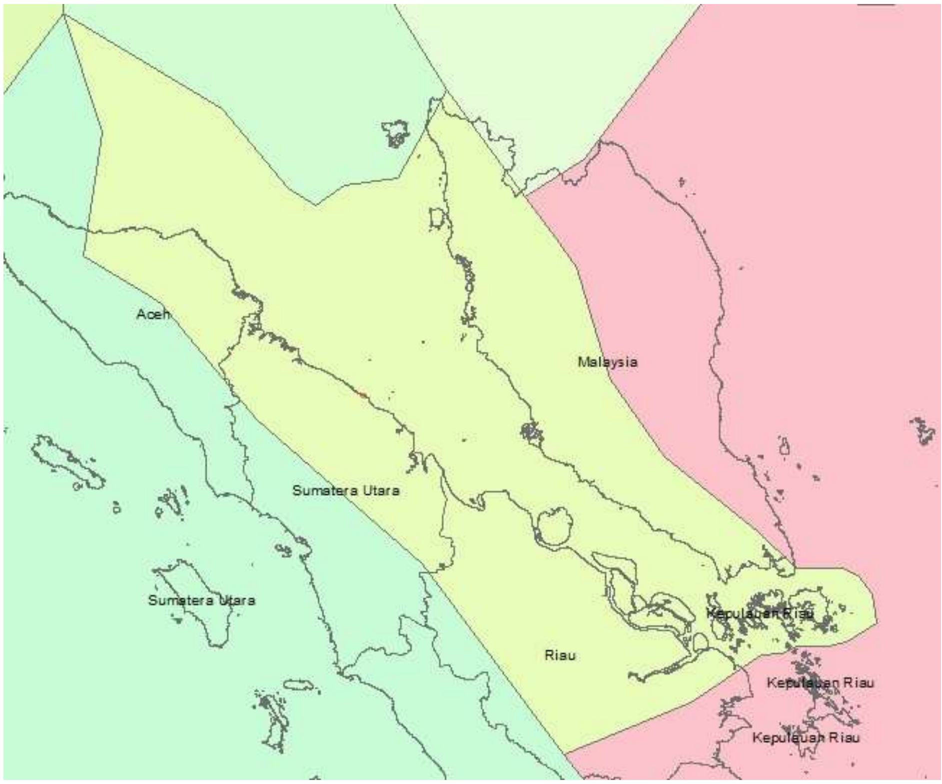

Figure 7: Marine ecoregions with the Malacca Strait shown in yellow[46]

The baseline survey conducted by the Ministry of Health Standards (DEHL) in 2010 sampled plankton and benthos at three locations; no other fish or marine fauna were described in the study[47]. The village immediately around the project site, Kuala Tanjung does practice marine fishing[48] suggesting that the species found in this ecoregion can be found in the vicinity of the DAP complex. Information on flora and fauna baseline in the area of the industrial estate is limited in the 2010 DELH. The fauna survey identified the presence of a number of protected bird species. For the marine environment, plankton and benthos were sampled at three locations; no fish or other marine fauna are described in the report.

Compared to the baseline study in 2010 there was a decrease in phytoplankton diversity and a significant increase in abundance. These differences may be due to a number of factors such as differences in nutrient input, the inactivity of the Project within this period as well as method and timing of sampling.

---

[46] World Wildlife (2007). Marine Ecoregions. https://www.worldwildlife.org/publications/marine-ecoregions-of-the-world-a-bioregionalization-of-coastal-and-shelf-areas

[47] de la Cueva Bueno, P. (2016). Environmental and Social Baseline and Compliance Review. PT. Domas Agrointi Prima (DAP) Oleochemical Project – Medan, Indonesia.
[48] Ibid.

Table 3: Phytoplankton data comparison[49]

Parameter	Unit	2016	2010
Total taxa		19-24	19
Abundance	Cell/m^3	3-8 million	±700,000
Diversity index		1.36-1.79	±2.9
Equitability index		0.43-0.61	±0.9
Dominance index		0.31-0.44	±0.05

The 2016 baseline study surveyed a total of 12 locations at different distances from the land, 7 data locations left of the jetty and 5 points on the right side of the jetty. Underwater visibility was poor, with turbidity values above the threshold limit of 5 NTU.

4.1.2 Seawater

This 2010 DELH environmental study reported substandard baseline water quality conditions in the general industrial zone. Seawater sampling was conducted in three locations and results showed exceedance for copper, oil layer, and phenol. The 2016 baseline study collected seawater samples from four sites. A number of in-situ measurements and observations were conducted, including information/data on brightness, pH, salinity, and turbidity, and temperature, the presence of floating matters and of oil film. The laboratory data shows that all of the sampling points show brightness values that are less than the minimum threshold values set by the regulation. These low brightness values are corroborated by the high turbidity values at all points and high TSS concentrations at most points.

All of the laboratory analysis for total phosphorus (P) show values that are higher than the maximum threshold value of 0.015 mg/L (values range from 0.030 to 0.085 mg/L). These high values seem to concur with the relatively high concentrations of phosphorus at both Rindam and Padang River which empties to the seawater sampling areas. All of the laboratory results for dissolved metals show values that are lower than the maximum threshold values. Most of the parameters show values that are even lower than the analytical detection limit with the exception of arsenic where values range from 0.0011 to 0.0013 mg/L. Most of the laboratory analysis for dissolved oxygen (DO) show values that are slightly lower than the minimum threshold values of 5 mg/L, with the exception of data at SWQ-2[50]. The complete results from the seawater sampling can be found in Appendix A.

---

[49] PT Hatfield Indoensia. (2016). Environmental Baseline Survey.

[50] Ibid.

4.1.3 Marine transportation

The Malacca Strait is an important shipping route, therefore the marine area of the ecoregion is at risk of biodiversity and environmental degradation from[51]:

- Increasing demand and pressure on resources from an increasing coastal population
- 70,000+ vessels passing through the Straits yearly (potential oil spills, collisions, and ship discharges)
- Decline in quality of fisheries landings
- Lower catch-per-unit-effort (CPUE)
- Loss of mangrove cover: >40% in the Straits of Malacca States
- Pollution
- Invasive species

A new shipping port is currently under construction just south of the DAP complex in the Kuala Tanjung area. The port is expected to be open in August 2017 with limited functionality, increasing capacity later into 2018. The new port will allow for an increase in economic progress for the region, including an estimated reduction in the price of goods in eastern Indonesia by 20-25%[52].

4.2 Water supplies

The Project takes water from a river located approximately 7 km from the DAP complex (Figure 8). The DAP complex is located in a large watershed that flows from the mountainous central area of North Sumatra out to the east into the Malacca Strait. The watershed has tributaries that branch off into smaller, sub-watersheds. The DAP complex uses a water intake site that is outside of the larger watershed. The indicators to be used for this VEC are water quantity and quality. The current state of the watershed is not fully known due to a lack of data on water demand and water flow of regional rivers. The continued trend of population and industrial growth within the region surrounding the DAP Complex will put additional stress on water resources. The following section provides details of the state of water quantity, quality, water governance, and the main water stressors in the area.

---

[51] Kaur, C.R. (2016). Biodiversity in the Straits of Malacca: An assessment of issues and challenges on environmental protection. Centre for Coastal and Marine Environment

[52] Hermansyah, A. (2017). Jokowi proud of maritime sector progress. The Jakarta Post. http://www.thejakartapost.com/news/2017/05/05/jokowi-proud-of-maritime-sector-progress.html

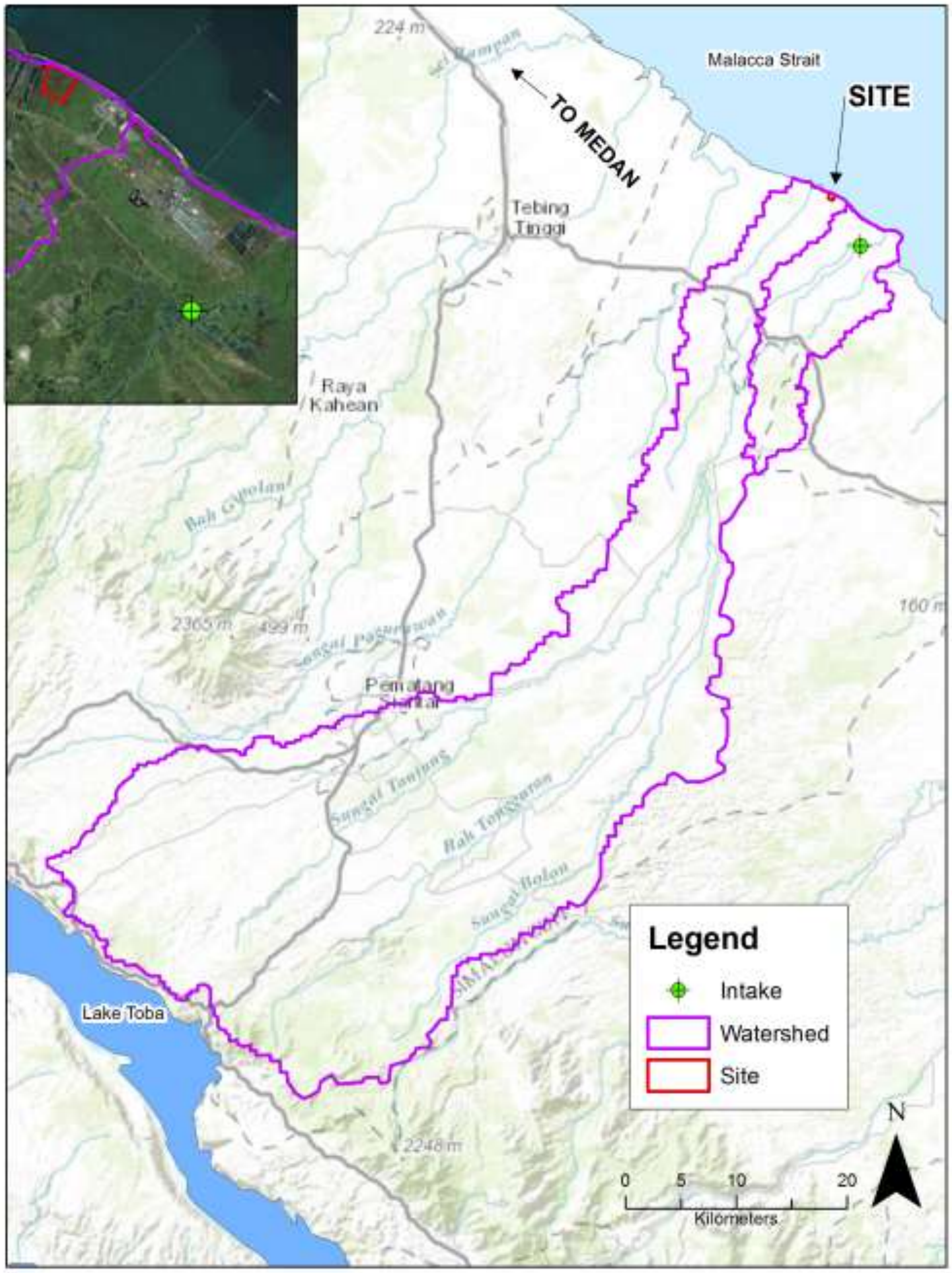

Figure 8: The watershed that the DAP complex is within and the sub-watershed where the complex's water supply comes from (Source: Google Earth)

4.2.1 Water quantity

The region the DAP Complex is in receives an annual average of 2,263mm of rain[53] which helps to replenish aquifers and irrigation supplies. Uncertainties surrounding the impacts of climatic changes on the island of Sumatra leave many unknowns about the state of the watershed as predicted higher temperatures will impact water resources and could decrease available water resources. Data from the Aqueduct project (Figure 9) measures and maps global water risk using a baseline water stress (BWS) indicator that measures the ratio of total withdrawals to the annual available renewable surface water supply[54]. The dataset uses a time series of supply (1995-2010) in order to reduce the effect of climate cycles and short-term water storage. Therefore the data measures chronic stress rather than drought stress. The area the DAP complex is in has a moderate BWS, however, as stated in the mapping tool, if current use in a catchment is low, any new withdrawals could easily create high-stress conditions, pushing them into a critical state. Given that the latest data measured for this project was in 2010 it is likely that the conditions have changed.

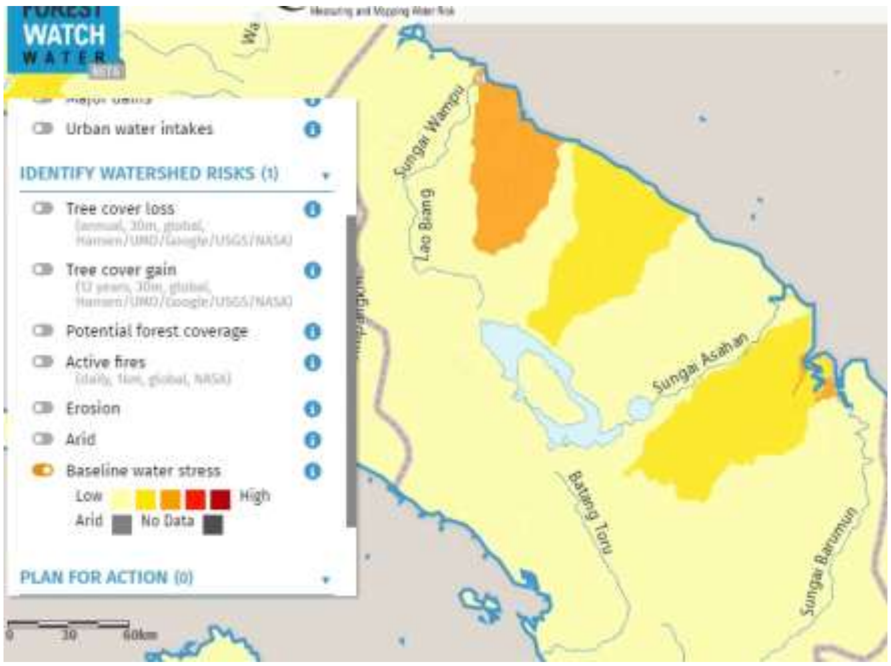

Figure 9: Map of the baseline water stress in North Sumatra, higher values indicate more competition among users. The DAP Complex is located within the darker yellow area seen in the middle of the figure (Source: Aqueduct project[9])

53 World Weather Information Service–Medan. (2015). World Meteorological Organization. Retrieved June 18, 2015.

[54] Forest Watch (2014). Baseline Water Stress. Global Forest Watch, Water. http://water.globalforestwatch.org/map/

4.2.2 Water quality

The water in the Besar River has a large amount of suspended solids which can be seen from satellite imagery and photos taken on the ground. The river originates roughly 100 km away from the intake site, at Lake Toba. It passes through several towns and agricultural plots of land before reaching the intake site and the Malacca Strait, allowing for debris and sediment to accumulate within the flow. Baseline studies show that total suspended solids are above the maximum threshold in the Besar and Rindam Rivers in 2010 and increased further in the 2016 study of the Rindam River.

Figure 10: The Besar River mouth as it drains out into the Malacca Strait. Retrieved from Google Earth, taken by Ruli Indra, titled, Sungai di sekitar Inalum Kuala Tanjung (River around Inalum Kuala Tanjung).

Figure 11: DAP's water intake point along the Besar River. Imagery from Google Earth, taken in 2014

The 2016 Baseline Study used three sites for freshwater sampling from streams and/or water bodies around the plant. Total phosphorus was found to be higher than the maximum threshold, which is likely due to the plantations upstream of the Rindam and Padang Rivers which use fertilizers. The high levels of suspended solids could be attributed to the rainy conditions. All the parameters with corresponding IFC guideline values show values that are lower than the maximum threshold values for both Criterion Maximum Concentration and Criterion Continuous Concentration. For full results of the water quality study refer to Appendix A.

4.2.3 Water demand and main stressors for water resources

The water demand within the watershed the DAP Complex is located is not entirely known. It can be determined from qualitative research that there are several towns and villages located within the watershed, and that water resources are largely used for rice paddy farming and other agricultural practices.

The Besar River provides water for several cities and towns located upstream from the complex, as well as for the other industries in the area. The complex water intake site is mostly downstream from other users. It is possible that the water flow needed by the plant may not be plentiful and consistent since it is a downstream user. The watershed will have increased pressure from an added user needing 750 m^3/s of water flow, and this may dry out the lower reaches the of the Besar River depending on seasonal flows, changes in climatic conditions, and user demand.

Current upstream pressures include:

- Agricultural fields – palm and rice paddies are known to be in the surrounding areas and are an important economic commodity for small-holder farms.
- The town of Inderapura is upstream of the river that the DAP complex takes its water from. The population is unknown, however, on satellite imagery, it looks larger than the two small towns surrounding the DAP complex.
- Pematang Siantar City lies partially in the larger watershed that feeds the Besar River

There are two larger local industries that are south of the DAP complex, also located on the coast of the Malacca Strait, InAlum, an aluminum smelter plant and Wilmar Refinery, an oil palm refinery. These two plants, which can be seen in figure 6, may also share in some of the water resources that the DAP complex relies on since they are all in close proximity to the Besar River. InAlum and the Wilmar Refinery are within the smaller sub-watershed that is fed by the larger watershed in which the DAP complex is in. The building plans for a coal fire power plant within a kilometer of the DAP complex will create a higher demand for water resources due to the large amounts of water needed for cooling processes at the plant.

Watershed management in the region is unknown; it is likely that there is no formal system in place to guide water withdrawals. Water supply in Indonesia is decentralized, allowing for local governments to control their supplies, however, this is challenging as they often do not have the capacity to plan and develop their resources properly[55]. Governmental reforms over the past two decades have resulted in inefficient or non-existent management of water

[55] International Water Centre. Indonesian water governance field work underway. http://www.watercentre.org/news/indonesian-water-governance-field-work-underway

resources. Water resource responsibilities are distributed throughout various levels of administration including, national (within Public Works, Forestry, Environment, Bappenas (regional development and planning agency), Agriculture, and Home Affairs), provincial (under the Provincial Water Resources Management Agency), and locally (managed by districts and municipalities)[56]. The decentralized approach and numerous changes in government and its policies over the years have left water resources unprotected and poorly utilized throughout Indonesia.

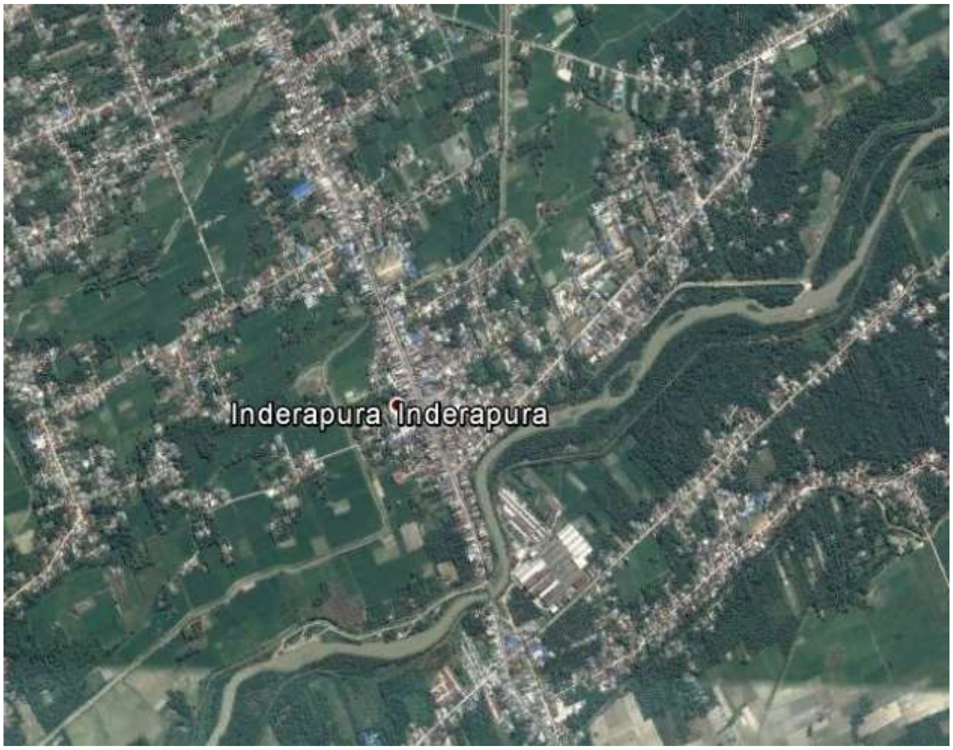

Figure 12: The city of Inderapura, the Besar River is seen running through the middle of the image. Imagery from Google Earth.

4.3 Air quality

The indicators to be used for this VEC are Nitrous Dioxide, Sulphur Dioxide, and total suspended particles based on data collected from the 2010 and 2016 baseline studies. Between these two studies, all three indicators decreased, this could be attributed to the plant being out commission during these years.

The 2010 study determined that in terms of air quality, conditions at the industrial site and in the nearest residential housing were reported as good; with all the measured parameters showed concentrations under the maximum national standards. The test values from the 2016 Environmental Baseline Survey seen in Table 6 are below the maximum threshold values stated in national regulation as well as in IFC guidelines. These include concentration for gaseous as well as particulate parameters. In general, particulate concentrations in AQ-2 (a residential area close to the road) are slightly higher than those in AQ-1, which is probably due to particulate generated by traffic. It

[56] Wieriks, M. (2011). Water Governance and policy networks in Indonesia The challenges of a decade of water sector reformation, MSc Thesis

is worth noting, however, that sampling at both sampling points were conducted during wet season with the significant amount of rain and as a result, the values are expectedly low. For full results of the air quality study refer to Appendix A.

4.4 Community Health and Safety

The indicators used for this VEC are the number of hospitals or doctors per person, road related fatalities, population growth, and noise levels. Regional and local health-related data and road-related fatality data is scarce or unavailable; quantitative data on these indicators is important to further understand the changes in health and safety in the area.

4.4.1 Community health

At the time of the 2010 DELH, local health facilities were generally inadequate for the population size. The communities did not have hospitals, doctors or public health clinics. They were serviced by one small auxiliary clinic, a total of seven nurses and a small maternity hospital serviced by the nurses and midwives. In the time since the report, like the school system, the healthcare system has been improved in order to provide better services to the local communities and BSP has committed to its top practices in this regard, as broadly described in the BSP Sustainability Report.

4.4.2 Road safety

The roads around the complex are used by varying types of vehicles. Many houses in the area are built extremely close to roads for convenience, commerce, and accessibility. Google Street View imagery gives insight into the average modes of transportation used along the surrounding roads. The imagery is from December 2015 and shows various locations along what will be the main transportation corridor to and from the complex.

Figure 13 shows the proposed transportation corridor along a secondary road. This type of road is wide enough for two-way traffic at moderate to slow speeds. The imagery seen on the figure in location 2 is located directly outside of the gated road that leads to the DAP complex. There are local curbside shops that are set up here and will see a considerable increase in truck traffic. Location 5 on the figure shows local traffic pulled over to the small side shoulder of the road. If this is a frequent occurrence safety issues could arise due to overcrowded streets that do not allow space for trucks passing each other. Pedestrians must use the roads to access side-road shops. Location 9 on the figure is where the road runs through the town of Lalang. In this imagery from 2015, at a time when the DAP complex was closed and the international shipping port has not yet become operational, the volume of traffic is significant. By using the Street View imagery, it can be seen that along this section of road the traffic becomes heavy, and there are many types of vehicles on the road. The single snapshot of Location 9 shows cyclists, a truck, motorcyclists, a bus and a car.

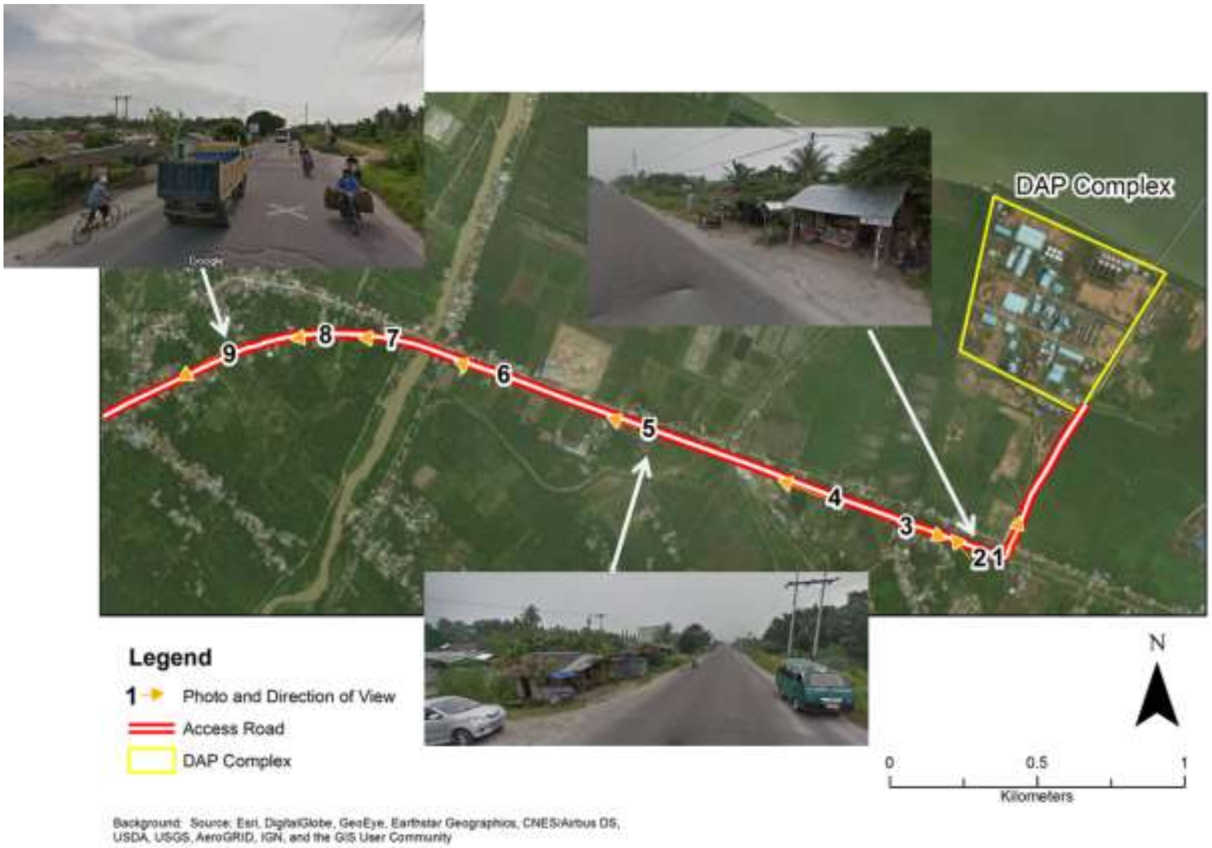

Figure 13: The proposed transportation corridor to the DAP facility. Inset images show the street view conditions (Source: Imagery from Google Earth and Google Street View).

4.4.3 Noise levels

Noise measurements were taken at the plant and residential area in 2010 and 2016. General noise measurement results in October 2010 are higher than results from November 2016. Noise level inside plant area in 2010 exceeded the maximum threshold value of 70 dBA while noise level in 2016 is lower than the threshold value. Noise level in residential area from the two measurement period seems to show values that do not differ significantly.
For full results of the noise measurement study refer to Appendix A.

4.5 Local livelihoods

The indicators to be used for this VEC are percentage of population farming or fishing for their livelihood and the unemployment for the region or towns. These indicators will help track and quantify the impacts of local livelihoods from the operation of the DAP complex and external factors such as population growth, climatic changes, and shifts from rural to urban living. Unsustainable land use practices have led to degraded agricultural fields, and many rice paddy fields have been converted to non-agricultural land use[57]; this loss of land will lead to fewer people being able to support themselves through farming. Overfishing in Indonesia is increasing, causing problems for small-scale fisherfolk who depend on good catches for their livelihood. In the Malacca Strait, demersal fish and shrimp are overfished and small pelagic fish have been fully exploited[58]

Population growth is unknown for the immediate vicinity of the DAP complex, however country-wide growth is at an annual 1.2%, which has been decreasing since 1970[59]. Indonesia's current unemployment rate is 5.5%, however, the national definition of an employed person is loosely applied making the rate artificially low[60].

4.5.1 Population and Employment

The area immediately around the Project, and considered by the 2010 DELH report, is composed of 2 sizable villages or desas – **Lalang** with a population of 6,641 and **Kuala Tanjung** which has an equivalent size of 6,500. Population density is high in the area with the 2 desas averaging close to 950 people per square kilometer; more than twice the density of the regency as a whole. Marine fishing and freshwater fishing to a lesser extent are practiced in the village of Kuala Tanjung.

The land surrounding the DAP complex is very fertile, and therefore agriculture is an essential part of local livelihood. The agricultural mentality does not favour conservation as the cultivation of single crops or monocultures provide quicker returns to farmers. The FAO lists 5 key agricultural indicators as being important to North Sumatra, they include paddy, maize, mango, and banana production, as well as fisheries.

Indonesia's rice paddy production is heavily concentrated on Sumatra and Java, therefore continued production of rice crops in these areas is extremely important to the livelihood of farmers and the economics of this commodity in Indonesia.

Both desas are rural agricultural communities with approximately 60 % of the residents engaged in smallholder wet rice (sawah) farming with a scattering of household orchards. This is typically organized by village-based cooperatives that manage irrigation and commercial logistics. A substantial portion of the Lalang residents are fishermen including off-shore, fresh water river, and some aquaculture. The greater area produces 261,000 tons of fish annually. A smaller sector of the communities, about 10 percent, engage in the typical house front or stall service and commercial activity.

Vulnerable groups

Through their initial community engagement activities, the project's community relations team has identified subsistence-level fishing families and female-headed households as vulnerable stakeholders. They have included

---

[57] Suprapto, A. Land and water resources development in Indonesia. FAO. http://www.fao.org/docrep/005/ac623e/ac623e0g.htm

[58] Cribb, R. et al. (2009). Indonesia beyond the Water's Edge: Managing an Archipelagic State.

[59] WorldOMeters. (2017). Indonesian Population. http://www.worldometers.info/world-population/indonesia-population/

[60] Indonesia Investments. (2017). Unemployment rate Indonesia Falls to 5.5% of Labor Force. https://www.indonesia-investments.com/news/todays-headlines/unemployment-rate-indonesia-falls-to-5.5-of-labor-force/item6788?

special consultation activities in the Stakeholder Engagement Program (SEP) for these groups. The project may expand these vulnerable categories as stakeholder mapping deepens. The project will also consider special projects for these groups through their CSR activities to assist them in accessing appropriate benefits.

4.6 Summary of VEC status and trends

Table 4 summarizes the information discussed in the previous sections about the status and trends of the prioritized VECs. An additional column provides information on the availability of information on the VEC and the main uncertainties detected by the team.

Table 4: Summary of VEC status and trends

VEC	Current status	Trends	Indicators of VEC status	Availability of information and uncertainties
Marine habitats	▪ Mangroves have disappeared due to past activities ▪ Very little fish or marine fauna observed ▪ Suspended solids, phosphorus and nitrate concentrations are above thresholds ▪High density area of marine traffic	Between the Sept 2010 and Nov 2016 study there was: ▪Increase in phytoplankton abundance ▪Decrease in phytoplankton diversity Between the Oct 2010 and Nov 2016 study there was: ▪Increases in suspended solids, and oil and grease ▪Decreases in sulphide, dissolved metals and ammonia ▪Increasing annual marine traffic	▪Seawater ▪Marine biodiversity ▪Marine traffic	Based on baseline studies done in 2003 (marine habitat), 2010 (seawater), and 2016 (seawater and marine habitat). The decreases could be due to the plant being out of commission during these years. Data on marine traffic easily accessible.
Water resources	▪High amounts of rainfall in the area ▪Watershed has a moderate baseline water stress ▪High amounts of suspended solids in surrounding rivers. ▪Exact water demand unknown	Between the Sept 2010 and Nov 2016 baseline study there was: ▪Increases in suspended solids, NO_3 ▪Decreases in Biochemical oxygen demand, oil and grease. ▪Increase water demand as population and industry in the area grow	▪Water quality ▪Water quantity	Based on baseline studies done in 2003 and 2016, qualitative observations of imagery, online data from Forest Watch. Uncertainties in water demand and flow of rivers
Air quality	▪Chemicals in ambient air surrounding the plant and residential areas are below national regulations ▪Higher concentrations of particulate in the residential area close to the road	Between the Oct 2010 and Nov 2016 study there was: ▪Decreases in NO_2, SO_2, and total suspended particulates	▪NO2, SO2, total suspended particulates	The decreases could be contributed to the plant being out of commission during these years. Sampling was conducted during the wet season, resulting in lower values. The studies were conducted during different months which may have caused differences in climatic conditions that affected results.
Community Health and Safety	▪Local health facilities are inadequate for populate size, lack of hospitals, doctors, and public health clinics ▪Roads have moderately heavy traffic at times, utilized by a variety of vehicles types (cars, trucks, bicycles, pedestrians) ▪Noise levels are below thresholds	▪Since the 2010 study the healthcare system has been improved ▪Population and industry has been increasing steadily leading to increased road use ▪Between the Oct 2010 and Nov 2016 study there was a decrease in noise levels around the plant and residential areas	▪Number of hospitals or doctors per person ▪Road related fatalities ▪Noise levels	Regional data for population and health care facilities are infrequently updated. Quantitative and qualitative population and road related data is scarce in the region.

VEC		Current status	Trends	Indicators of VEC status	Availability of
Local livelihoods		▪High population density, 950 people/km^2 between the two villages ▪Rural, agricultural communities ▪Livelihoods mostly involve rice farming and fisheries, a small percent own road side stalls ▪Fishing families and female-headed households are the most vulnerable stakeholders in the community	▪Annual population growth rate of Indonesia is 1.2%, the rate has decreased since 1970 ▪Urbanization in Indonesia is steadily increasing ▪Increased competition for agriculture and aquatic resources due to environmental changes	▪Percentage of population farming or fishing for livelihood ▪Unemployment rate	Data unavailable at regional and local scales, inferences are made from national statistics.

5 Cumulative impacts on selected VECs

The cumulative impacts on the VECs estimate the "future baseline" conditions of the VECs—i.e., the condition of VECs as affected by the other projects, human activities, and natural drivers. This estimation is done with the effects of planned project mitigation included. The near-term scenario uses the temporal time frame of within the next 10 years, from 2017 to around 2030. The long-term scenario uses the temporal time frame of 30 years, using 2050 to be able to take into consideration the effects of climate change. The methods chosen for the analysis are compatible with the information available for the analysis and that can provide, whenever possible, a quantitative estimate of the cumulative impact. Qualitative estimates have been made where there is a lack of quantitative data based on a consensus and professional judgement of the assessment team.

5.1 Marine habitats

The estimate of the future baseline conditions of marine habitats in the near-term is that there will be a decrease in fish biodiversity due to increased marine traffic, overfishing, and increased effluent from industrial activities. Based on present conditions seawater nutrient levels will continue to be above the threshold value due to the on-going industrial activities in the area. The cumulative impacts in the near-term will cause degradation to marine habitats, including the quality of the seawater and the abundance of fish species.

The estimate of the future baseline conditions of marine habitats in the long-term will have similar stressors as the near-term but with the added impact of climatic changes to the area such as sea level rise and warmer ocean temperatures as estimated by the IPCC[61]. The cumulative effects in the long term will be a reduction in marine habitats available in the Malacca Strait and increased pollution as the level of industrial activity and marine traffic increase.

5.2 Water supplies

Water supply for the industrial estate comes from the Great River, located approximately 7 km from DAP complex, and from deep wells located in the estate for some activities. Community water supply for the nearby village of Lalang comes from local wells.

Vegetable oil facilities require significant amounts of water for crude oil production (cooling water), chemical neutralization processes, and subsequent washing and deodorization. The plant will require 750 m^3/s (current requirement is 600 m^3/s) at the water intake in Large River. The industry in this area has been increasing steadily and with the building of the international shipping port, it can be expected that this trend will continue.

---

[61] IPCC. (2014). Scenarios of the 21st Century. http://www.ipcc.ch/ipccreports/tar/wg2/index.php?idp=29

It is estimated that in the near-term baseline water stress of the watershed and sub-watershed will increase as a result of the cumulative use from the DAP complex, InAlum, Wilmar Refinery, local inhabitant's personal use, and agricultural use. These activities will also increase the amount of effluent in the surround water resources. There is a high probability that with the opening of the international shipping port in late 2017 in this area that continued development of this area will also add stress to water resources. The cumulative impacts of these water demands will put additional pressure on water resources, which are currently under moderate stress. There is a risk that increased effluent will cause water contamination in the area. These impacts create an unstable water supply that may be depleted at times and is of poor quality.

Climatic changes will impact water availability due to changes in precipitation and seasonal patterns. Impacts will be an increased frequency of droughts, contamination of freshwater resources and unpredictable water recharge. Future conditions of water resources in the area surrounding the DAP Complex are estimated to be limited, groundwater aquifers will be under increased pressure and freshwater further polluted.

5.3 Air quality

In the near-term, there will be an increase of transportation trucks using the roads surrounding the DAP complex to facilitate moving materials from the site to the next stage of production. The added use of trucks in the area will increase emissions. It is estimated that these emissions will contribute to deteriorating the air quality within the direct vicinity of the proposed transportation corridor. The DAP complex and other industries in the area will produce air pollutants, combined with increased vehicles emissions, this will have an impact on public health, and may cause respiratory issues in the local population. The near-term future condition of air quality surrounding the complex will see a rise in contamination.

The long-term scenario estimates a continued increase in industry and number of vehicles in the area contributing to air pollution and GHG emissions, as well as an increase in average temperatures[62]. Cumulative impacts from poor air quality and increased temperatures will be, continued respiratory issues in the local population, heat waves, and higher air quality related deaths. The future condition of air quality stands to be poor.

5.4 Community Health and Safety

In the near-term scenario, the transportation corridor will see an increase in traffic and a continued variety of vehicle types using it. The surrounding industries will also use this road, and as the shipping port opens, more connectivity through this road may occur. Future industrial activities and the reopening of the DAP complex will increase the noise levels in the area. Population growth is estimated to increase, there will be a need for more health care facilities to aid in community health and safety issues. The cumulative impacts use of the road by the surrounding industries will create more hazardous situations for pedestrians and smaller vehicles, as well as increase emissions. Combined with a growing population and lack of health care facilities the quality of life for the

[62] IPCC. (2014). Scenarios of the 21st Century. http://www.ipcc.ch/ipccreports/tar/wg2/index.php?idp=29

surrounding communities will decrease as they face noise conditions, dangerous roadways and poor air quality on a daily basis.

The long-term scenario for this VEC will see similar stressors, but also feel the impacts of climatic changes such as higher temperatures leading to heat-related illnesses. The constant exposure to these conditions without adequate health care facilities could lead to the deterioration of community health conditions.

5.5 Local livelihoods

The near-term stressors on local livelihoods are the increase in population that will put a strain on already stressed resources, combined with overfishing and land degradation situations, unemployment in the region could increase. There will be less land for agricultural production and less high yield catches for small-scale fisherfolk. The future near-term condition of this VEC will see a lower quality of life and poor environmental quality. There may also be an impact on the livelihoods of fisherfolk as marine biodiversity is at risk from the increase of traffic in the Malacca Strait. However, recent governmental policies favoring Indonesian fisheries will contribute to higher catches and improved economic return. Population growth will continue to steadily grow as the area attracts more industry, offering jobs for local peoples. Further development in the area may also increase the percentage of storefronts along the transportation corridor and within the nearby towns.

In the long-term scenario, local livelihoods will see a shift as climate change will impact resource production. Seasonal changes will affect the timing of crop cycles, and as temperatures increase more irrigation will be needed. Good quality agricultural land will continue to disappear as more industry arrives in the area and uses the land for single crop cultivation[63]. Soil conditions will worsen for smallholder farmers using the land for quick returns. These future conditions will lead to less agricultural outputs, especially in rice cultivation for the region, and force farmers to find other means of income. The estimated temperature increase[64] will have an impact on fishing in the Malacca Strait, the quantity and quality of fish capture could decrease. A transition from traditional livelihoods (agriculture and fishing) to the industry and services sector is very likely.

---

[63] Suprapto, A. Land and water resources development in Indonesia. FAO. http://www.fao.org/docrep/005/ac623e/ac623e0g.htm

[64] IPCC. (2014). Scenarios of the 21st Century. http://www.ipcc.ch/ipccreports/tar/wg2/index.php?idp=29

Table 5: Cumulative impacts identified for the prioritized VECs

VEC	Scenario 1: Near-term development (2020)			Scenario 2: Long-term development (2040)		
	Stressors	Impacts	Future condition of the VEC	Stressors	Impacts	Future condition of the VEC
Marine habitats	▪Increased marine traffic, overfishing, effluent from current industries and the DAP Complex	▪Decreased fish biodiversity, increase in polluted waters	▪Increased degradation compared to baseline conditions	▪Increased marine traffic, overfishing, climatic changes (sea level rise, warmer ocean temperatures), effluent from continued industrial growth	▪Loss of fish species in the Strait, polluted waters	▪Loss of quality habitat
Water resources	▪Increased water demand from DAP complex ▪Increased effluent	▪Less water resources available for local agriculture, towns and industries ▪Freshwater contamination	▪ Adequate water supply unavailable at times ▪Continued increase turbidity, water quality diminishes	▪Increased water demand from future industrial developments ▪Increased effluent Increased water demand from growing population ▪Climatic changes	▪Increased frequency of droughts ▪Contaminated freshwater ▪Unpredicatable water resources	▪Deterioration of water quality ▪Water resources under additional stress
Air quality	▪Increase in industries that produce air pollutants and GHGs	▪Respiratory issues and public health concerns	▪Increased contamination in the airshed	▪Increase in industries that produce air pollutants and GHGs ▪Warmer air temperatures	▪Respiratory issues and public health concerns ▪Contribution to climate change ▪Heat waves ▪Higher air quality related deaths	▪Poor air quality due to high levels of contamination
Community Health & Safety	▪Increase in road traffic ▪Increased emissions from vehicles ▪Lack of health care for growing population ▪Increased noise levels	▪Increased road fatalities ▪Respiratory issues and public health concerns	▪Deterioration of air quality ▪Increased road unsafety	▪Increase in road traffic ▪Increased emissions from vehicles ▪Lack of health care for growing population ▪Increased noise levels ▪Increasing tempertures	▪Increased road fatalities ▪Respiratory issues and public health concerns ▪Contribution to climate change	▪Increased road unsafety ▪Increased incidence of respiratory conditions
Local livelihoods	▪Increasing population ▪Overfishing, land degradation	▪Loss of livelihoods ▪Land loss, decreased yields and catches ▪Potential job creation in the industrial sector	▪Stress on resources (water, land, fisheries) ▪Workers influx	▪Population growth ▪Temperature increase, seasonal changes	▪Stress on resources (water, land, fisheries) ▪Job opportunities in industrial and services sector	▪Sunstantial decrease in traditional activities (agriculture, fishing) ▪Transition to industrial and services occupations

6 Significance of predicted cumulative impacts

6.1 Marine Habitats

The marine habitat will likely see a decrease in fish biodiversity and an increase in polluted waters in the near-term due to the industrial activities and marine traffic in the area. However the marine area surrounding the DAP Complex is already in poor condition due to past industrial activities, therefore the near-term consequences are minor.

The likelihood of the long-term scenario occurring is possible in some circumstances depending on future industrial activities and climatic changes. If industry continues to grow in the area without mitigating the effluent going into the Malacca Strait it could have a serious impact on the ecosystem. Sea level rise could affect coastal activities, inundating agricultural land and impacting infrastructure. Changes in ocean temperatures may also have serious impacts on the marine habitats, which could altogether create areas that are inhabitable by marine life.

Mitigation activities could include, frequently measuring and monitoring effluent coming from the DAP complex on an annual basis to ensure threshold levels are not exceeded, observing ocean climate trends and create a plan for sea level rise scenarios so that the complex is prepared for increased flooding and loss of land.

6.2 Water Supplies

Water supplies will likely decrease in the near-term project plan as the DAP complex requires 750m3/s of water withdrawal from the Besar River. This will have a moderate impact on local activities, there will be less freshwater available for agricultural, industrial and community users. There is likely to be an increase in effluent in the water resources as plant operations resume. In the long-term, the water resources are almost certain to become stressed as there are plans for continued development near the DAP complex. Increasing population will also put a strain on the watershed, and as climatic changes become more apparent, the probability of droughts and contaminated or lack of water supplies will have an extreme impact on the surrounding communities and industrial activities.

Mitigation efforts to monitor water quality should continue throughout the lifetime of the complex's activities and for five years beyond, adapting as needed when conditions change such as climatic events or measurements exceed thresholds. Additional efforts could include collecting data on water users in the area, and overall water demand to enable a clearer outlook of future water demand.

6.3 Air quality

Air quality in the area will decrease in the near-term due to the emissions the DAP complex will add into the airshed. It is possible that local people will be impacted and see a rise in respiratory issues. It is likely that over the long-term air quality will continue to deteriorate due to the continued industrial activities planned for the area, including the coal-fired power plant that will be built within a kilometer of the DAP complex. The combined GHG emissions from the activities in this area will contribute to atmospheric climatic changes. The air pollutants from the plants are likely to create smog, the impacts of which are exacerbated on high heat days. This is likely to have a serious impact, where there will be an increase in heat-related illnesses as well as respiratory issues in the local communities.

Mitigation efforts to monitor air quality should continue throughout the lifetime of the complex's activities and for five years beyond, adapting as needed when conditions change such as climatic events or measurements exceed thresholds. Further action that can be taken is to put in place preventative measures that will reduce air and GHG emissions from the plant. An assessment could be made of what activities at the plant are producing air and GHG emissions, this will allow for a better examination of what actions can be taken to reduce the emissions. Although the plant activities do not involve cultivation of the palm plant, efforts could be made to promote sustainable cultivation methods, and deter farmers from using the slash and burn technique that adds GHGs to the atmosphere. This could be done through promotional campaigns or reach out directly to agricultural producers.

6.4 Community Health and Safety

It is likely that there will be an increase in road fatalities and public health concerns such as respiratory illnesses as stated in the air quality sections. The continued development of industrial activities in the area is likely to cause this increase in the near and long-term. Climatic changes such as increased temperatures are likely to cause a rise in heat-related illnesses. Over the long-term, this will have an extreme impact on community health. A continued increase in the number of health facilities in the area will help to mitigate these problems. Additional efforts taken could be to run health campaigns to raise awareness of smog and air pollution, and ensure that local communities are well informed about the risks of high temperature and high smog days.

Increased traffic safety precautions and signage along the roads should be considered. Speed policies should be implemented for the transport truck drivers of the DAP complex to ensure they do not exceed a set speed when driving on secondary roads and to take extra precautions when approaching and transiting through Lalang. Pedestrians and those who use bicycles or motorcycles should be made aware through billboards or signage that there will be an increase of large vehicles on this road.

6.5 Local Livelihoods

It is possible under some circumstance activities from the plant will contribute to a loss of land and a decrease in agricultural yields and marine catches. Water extraction by the DAP complex will contribute to creating a limited water supply, impacting agriculture in the near and long-term. Effluent discharged into the marine habitat by the complex and the building of the jetty could disrupt fisher folk's aquaculture activities. In the long-term climatic changes are possible in some circumstances to add to these impacts, reducing resources even further. The population in the area will be unable to sustain themselves, having an extreme impact on their livelihoods.

Efforts should be made to create or partake in community development activities that focus on sustainable growth. Education on climate impacts could help the community collectively tackling these possible impacts on the agriculture and fisheries sectors. An action plan could be created to ensure that laborers from the local communities are hired to work at the DAP complex. This could include specific training for locals so that they have the necessary skills to work at the plant. This effort will help to avoid a serious drop in employment in the area if agriculture or fisheries decline significantly in the long-term.

6.6 Summary of identified impacts on prioritized and their significance

To assess the significance – or level of risk - of the identified impacts, we considered the likelihood of the identified impact and the severity of the consequences to the VECs (Figure 14). Table 6 provides a summary of the significance of the identified cumulative impacts, as well as some suggestions on how the Project could contribute to the mitigation of these impacts.

Likelihood	Consequence				
	Minor impact	Moderate impact	Serious impact	Extreme impact	Catastrophic impact
Almost certain: expected to occur in project plan	M	H	C	C	C
Likely: probably will occur in project plan	M	H	H	C	C
Possible: might occur in some circumstances	L	M	H	C	C
Unlikely: may occur at some time	L	L	M	H	C
Rare: only in exceptional circumstances	L	L	M	H	H

Figure 14: Likelihood and level of impact matrix (Source: Hardner et al. 2015[10])

Table 6: Significance of impacts on VECs

Valued Environmental or Social Component	Scenario 1: Near-term development (2020)			Scenario 2: Long-term development (2040)			Project contribution	
	Likelihood	Consequences	Risk level	Likelihood	Consequences	Risk level	Mitigation	Additional efforts
Marine habitats	Likely: probably will occur in project plan	**Minor impact** ▪Decreased fish biodiversity, increase in polluted waters	M	Possible: might occur in some circumstances	**Moderate impact** ▪Loss of fish species in the Strait, polluted waters	H	Continued water quality monitoring	Adapt a Climate action plan, and/or carbon offsetting plan
Water resources	Likely: probably will occur in project plan	**Moderate impact** ▪Less water resources available for local agriculture, towns and industries ▪Freshwater contamination	H	Likely: probably will occur in project plan	**Serious impact** ▪Increased frequency of droughts ▪Contaminated freshwater ▪Unpredicatable water resources	H	Continued water quality monitoring	Data collection on water users in the area, overall water demand and estimates of future water demand
Air quality	Possible: might occur in some circumstances	**Moderate impact** ▪Respiratory issues and public health concerns	M	Likely: probably will occur in project plan	**Moderate impact** ▪Respiratory issues and public health concerns ▪Contribution to climate change ▪Heat waves ▪Higher air quality related deaths	H	Continued air quality monitoring	Preventative measures to reduce plant emissions, assess plant emission activities , promote sustainable sourcing methods
Community Health & Safety	Likely: probably will occur in project plan	**Moderate impact** ▪Increased road fatalities ▪Respiratory issues and public health concerns	H	Likely: probably will occur in project plan	**Moderate impact** ▪Increased road fatalities ▪Respiratory issues and public health concerns ▪Contribution to climate change	H	Road Safety Action Plan and community support on health initiatives	Health campaigns to raise awareness of smog/air pollution, create a smog alert system road safety campaigns for plant drivers and locals

Valued Environmental or		Scenario 1: Near-term development (2020)			Scenario 2: Long-term development (2040)			Project contribution	
		Likelihood	Consequences	Risk level	Likelihood	Consequences	Risk level	Mitigation	Additional
Local livelihoods		Possible: might occur in some circumstances	**Moderate impact** ▪Loss of livelihoods ▪Land loss, decreased yields and catches ▪Potential job creation in the industrial sector	M	Possible: might occur in some circumstances	**Moderate impact** ▪Stress on resources (water, land, fisheries) ▪Job opportunities in industrial and services sector	M	Local hiring and community action plan	Collaborate with regional inititives for local economy development

Endnotes

[1] Hegmann, G., C. Cocklin, R. Creasey, S. Dupuis, A. Kennedy, L. Kingsley, W. Ross, H. Spaling and D. Stalker. 1999. Cumulative Effects Assessment Practitioners Guide. Prepared by AXYS Environmental Consulting Ltd. and the CEA Working Group for the Canadian Environmental Assessment Agency, Hull, Quebec.

[2] International Finance Corporation. 2013. Good Practice Handbook Cumulative Impact Assessment and Management: Guidance for the Private Sector in Emerging Markets
https://www.ifc.org/wps/wcm/connect/3aebf50041c11f8383ba8700caa2aa08/IFC_GoodPracticeHandbook_CumulativeImpactAssessment.pdf?MOD=AJPERES

[3] Environmental Assessment Office (British Columbia). 2013. GUIDELINE FOR THE SELECTION OF VALUED COMPONENTS AND ASSESSMENT OF POTENTIAL EFFECTS

http://www.eao.gov.bc.ca/pdf/EAO_Valued_Components_Guideline_2013_09_09.pdf

[4] Spalding, M. D., Fox, H. E., Allen, G. R., Davidson, N., Ferdana, Z. A., Finlayson, M. A. X. & Martin, K. D. (2007). Marine ecoregions of the world: a bioregionalization of coastal and shelf areas. BioScience, 57(7), 573-583.

[5] Abell, R., M. Thieme, C. Revenga, M. Bryer, M. Kottelat, N. Bogutskaya, B. Coad, N. Mandrak, S. Contreras-Balderas, W. Bussing, M. L. J. Stiassny, P. Skelton, G. R. Allen, P. Unmack, A. Naseka, R. Ng, N. Sindorf, J. Robertson, E. Armijo, J. Higgins, T. J. Heibel, E. Wikramanayake, D. Olson, H. L. Lopez, R. E. d. Reis, J. G. Lundberg, M. H. Sabaj Perez, and P. Petry. 2008. Freshwater ecoregions of the world: A new map of biogeographic units for freshwater biodiversity conservation. BioScience 58:403-414

[6] World Wildlife Fund (2017). Sumatran freshwater swamp forests. www.worldwildlife.org/ecoregions/im0157

[7] World Wildlife Fund (2017). Sumatran freshwater swamp forests. www.worldwildlife.org/ecoregions/im0157

[8] Halim, A. (2013). Indonesia: Mangroves for Life. World Rainforest Movement. http://wrm.org.uy/articles-from-the-wrm-bulletin/section1/indonesia-mangroves-for-life/

[9] Aqueduct. (2014). Watershed Analysis. Global Forest Watch. http://water.globalforestwatch.org/map/

[10] Hardner, J., R.E. Gullison, S. Anstee, M. Meyer. 2015. Good Practices for Biodiversity Inclusive Impact Assessment and Management Planning. Prepared for the Multilateral Financing Institutions Biodiversity Working Group.

https://publications.iadb.org/bitstream/handle/11319/7094/Good_Practices_for_Biodiversity_Inclusive_Impact_Assessment.pdf?sequence=1