A Multidisciplinary Review of the Bauxite-Alumina Industry in Jamaica

EXECUTIVE SUMMARY
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DISCLAIMER

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This is the Executive Summary of the document entitled *Red Dirt: A Multidisciplinary Review of the Bauxite-Alumina Industry in Jamaica*. Our study seeks to describe the history, evaluate the regulatory framework, and investigate the impact of the bauxite-alumina industry on Jamaica’s land, economy, and people over almost seven decades. The topics covered by this study are: the bauxite-alumina industry’s history, the evolution of its regulatory framework, the impacts of bauxite mining and processing on Jamaican society, public health and the natural environment, and the industry’s externalities (social costs). Readers should consult the full study for all references and source material.

The Jamaica Environment Trust (JET) worked with our long-standing partners, the Environmental Law Alliance Worldwide (ELAW) to carry out this work. We also received funding from the Grodzins Fund and Jamaica Conservation Partners (JCP) and we are grateful for their support. We contracted experts in six subject areas to research and write each chapter and we thank them for their work, which was made much more difficult by the COVID-19 pandemic. Short author bios can be found on page 221 of the main document.

We also thank the Jetters, especially Suzanne Stanley and Lauren Creary, for many months of persistent effort and creativity.
This Executive Summary was written by the Jamaica Environment Trust (JET). While it presents each chapter’s conclusions as arrived at by the authors, the framing and titling of those conclusions have been written by JET. The full study should be consulted for references and source material.

We made every reasonable attempt to ensure the contributors to this study are experts in their respective fields and that the information presented is accurate at the time of publication. We encourage readers to apply their own critical analysis and conduct their own research.

Overall, research for this study was constrained by the COVID-19 pandemic which made in-person interviews and visits to Government of Jamaica (GOJ) ministries and agencies difficult between March and August 2020. Some state agencies were helpful in organizing virtual or small, in-person meetings, but often respondents pointed to capacity challenges exacerbated by the pandemic.

We will begin by outlining obstacles experienced by most authors in conducting the study, and their common findings. A summary and the findings of each chapter is then presented.
LACK OF TRANSPARENCY

FINDING: There are significant obstacles to members of the public using the Access to Information (ATI) Act to obtain information on the Jamaican bauxite-alumina industry; this could and should be improved by proactive disclosure of all public documents.

JET submitted 27 ATI requests to the GOJ, most commonly to three primary state agencies with oversight of the bauxite-alumina industry – the National Environment and Planning Agency (NEPA), the Jamaica Bauxite Institute (JBI), and the Mines and Geology Division (MGD) within the Ministry of Transport and Mining (MOTM). A few requests were also made to the Ministry of Health and Wellness (MOHW). Find a summary of these requests in table 1 below.

Whilst the number of requests may seem modest, each contained a list of multiple documents, and in the case of NEPA, resulted in pushback due to what was described as the “voluminous nature” of the requests. Often, when requests were fulfilled, the responses raised questions and generated further requests. Only four of our requests were received within the statutory 30 days. Ten requests were extended to 60 days and five were only partially satisfied. At the time of writing, information contained in seven of the requests was neither provided, denied, nor was the request transferred to another agency. These requests have been submitted for internal review by agency heads, as provided by the ATI Act.

In conducting this study, JET and the authors were struck by the lack of basic information on GOJ websites, such as the Memorandum of Understanding (MOU) between the Natural Resources Conservation Authority (NRCA)/NEPA and the JBI, various permits and licences governing Jamaica’s bauxite-alumina industry, enforcement notices, air quality testing results, and other types of public interest information. If GOJ commitments to transparency are to be adhered to, this information should be proactively disclosed.

Table 1: Access to Information (ATI) Requests Made by JET for Bauxite-Alumina Review (January–July 2020)

<table>
<thead>
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<th>Agency</th>
<th>Total No. Requests</th>
<th>Responses Received in 30 Days</th>
<th>Requests Completed</th>
<th>Requests Outstanding</th>
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</table>
IN CONDUCTING THIS STUDY, JET AND THE AUTHORS WERE STRUCK BY THE LACK OF BASIC INFORMATION ON GOJ WEBSITES, SUCH AS THE MOU BETWEEN THE NRCA/NEPA AND THE JBI, VARIOUS PERMITS AND LICENCES GOVERNING JAMAICA’S BAUXITE-ALUMINA INDUSTRY, ENFORCEMENT NOTICES, AIR QUALITY TESTING RESULTS, AND OTHER TYPES OF PUBLIC INTEREST INFORMATION.

REGULATORY CAPTURE OF THE JBI

**Finding:** The JBI operates as a pro-industry agency and it has failed to carry out its environmental regulatory function adequately. The JBI does not appear to see itself as having a responsibility to address public interest concerns in a transparent and user-friendly manner. We note that the draft of the new National Minerals Policy (2017–2030) contemplates a transition for the JBI into a National Minerals Institute which will focus on applied research, leaving environmental oversight of the industry to NEPA. We believe this would be a welcome change and hope it can be achieved in a timely manner.

The responsibility for environmental monitoring of the bauxite-alumina industry was delegated by the NRCA/NEPA to the JBI in 1994 via an MOU. This has been criticized by environmental NGOs, due to the perceived conflict of interest presented by an agency partly responsible for the advancement of the industry also functioning as its regulator. The 1994 MOU was renewed in 2013, and we did not receive any analysis of the performance of the JBI to justify or explain this renewal. Our study concluded that there is little evidence to indicate that the partnership between the JBI and NEPA has worked to the benefit of the environment or public health. The monitoring and enforcement concerns are covered in the regulatory chapter.

JET and the authors of the study experienced resistance to our requests for information and interviews from the JBI, which initially did not seem to understand the requirements of the ATI Act, refused to meet with some members of our research team – even virtually – and subjected one author to the requirement of submitting written questions, which were then followed by slow and incomplete answers. We were particularly disappointed to be denied access to minutes or records of the Bauxite Community Development Programme (BCDP) Community Council meetings, which the industry frequently cites as evidence of positive collaboration with communities. Letters from JET to the Chairman of the JBI, the Minister of Transport and Mining and the Prime Minister requesting their intervention to resolve these hurdles received no response.
LONG-STANDING COMMUNITY CONCERNS ARE DISCOUNTED BY THE INDUSTRY AND THE STATE

**FINDING:** Although Jamaican voices have consistently been raised over many years about adverse experiences caused by bauxite mining and processing, and related concerns for public health, we were only provided with one state-sponsored health impact assessment in connection with the expansion of a single facility (Jamalco in Clarendon). This displays an egregious lack of responsiveness by the GOJ to the health concerns of citizens.

To identify the primary concerns of community members related to the bauxite-alumina industry, most authors relied heavily on interviews, either face-to-face or e-mail interchanges, or stories contained in other studies and/or newspaper articles. A search of *The Gleaner* archive for letters of complaints regarding the industry returned 721 hits. Many Jamaicans lamented bauxite’s harmful impacts to rural and community life, farming livelihoods, soil fertility, water supplies from catchments, damage to roofs, and experiences of noise, dust and illness caused by the industry. We found the response of the industry and the regulatory bodies generally to be unsympathetic; indeed, they were inclined to imply that these complaints were not genuine, made simply to get compensation, or alternatively, that any kind of dust could cause the impacts described. The industry also pointed to benefits provided to affected communities, such as scholarships, support for schools and community centres, and greenhouses, with the clear implication that these benefits outweighed the health costs and deterioration in rural community life. Despite these long-standing and vocal concerns, the GOJ does not appear to have implemented an ongoing health tracking survey for communities in proximity to the bauxite-alumina industry.

THERE ARE SIGNIFICANT DATA GAPS AND LACK OF CLARITY

**FINDING:** The authors were not able to assess the full impact of the bauxite-alumina industry due to significant data gaps which are outlined in each chapter. We can make no judgment as to whether these data exist and were simply not provided, or whether insufficient effort has been made by the GOJ to collect important data over the life of the industry. The figures presented on rehabilitation of mined-out pits, for example, vary from report to report from a low of 75 percent to a high of 85 percent. The lack of data hampers efforts, whether by regulators or the public, to verify industry claims.
Chapter 1: Mining the Land: The Past and Future of the Bauxite-Alumina Industry in Jamaica

TINA RENIER AND JORDAN HOWELL

BEGINNINGS

Chapter 1 outlines the history of the bauxite and alumina industry in Jamaica, from its beginnings in the United States of America (USA) in the 1880s, through technological improvements and growth driven by the demand for aluminum in World War II. Bauxite was discovered in Jamaica in 1942 and the island’s proximity to the US, along with the availability of suitable sites for ports, made it ideal for investment.

At the time of the bauxite-alumina industry’s initial expansion in Jamaica, the meaning of development was being contested by colonized and decolonizing states. The St Lucian economist W. Arthur Lewis argued that development for Jamaica required investing in both agriculture and industry – and the two had to work together.

HEYDAY AND CONTESTATION

By 1957, Jamaica was the world’s largest producer of bauxite and this provided a powerful symbol of a world beyond the plantation, particularly for the first generation of nationalist leaders in Jamaica. There were still concerns that mining industries would not provide the number of jobs needed, and that greater employment gains were available in a modernized agricultural sector. Concerns were also raised that mining might pose a threat to sovereignty via external control of Jamaica’s resources.

Once mining began, however, discussions of alternative development pathways became muted, the debate shifted from whether bauxite should be mined to more concrete questions of how to increase foreign investment. The periods of highest economic growth in Jamaica in the second half of the twentieth century correspond to investment in large-scale construction projects in the bauxite-alumina industry – trams, ports, airports, railways, silos, equipment, and five refineries.

The People’s National Party (PNP) administration of the 1970s, led by Prime Minister Michael Manley, developed a “bauxite levy” to replace the pre-existing corporate tax system. Thousands of acres of land owned by the bauxite companies were purchased “back” by the GOJ during this period, and the industry was also partially nationalized. The levy – a 75 percent tax rate on the average price of aluminum – addressed a large deficit in Jamaica’s foreign exchange that had resulted from oil price shocks. The levy quintupled GOJ’s earnings on
bauxite. The Levy Act also provided for the creation of a Capital Development Fund (CDF) into which revenues from the levy would be paid. These funds were used by the GOJ to buy land owned by the bauxite companies, acquire partial ownership of the companies, and to establish the Jamaica Bauxite Institute (JBI); however, most of the money paid into the CDF was used to finance the government’s budget, including many social democratic initiatives.

**SLOWDOWN**

In the 1960s, aluminium corporations began to pool capital to develop new deposits in Guinea, Brazil and Australia, and by the 1980s, Jamaica had lost its competitive position in the world aluminum market.

The bauxite levy and Manley’s democratic socialism were sometimes blamed for the slowdown of Jamaica’s bauxite-alumina industry through the 1980s; however, during the period there was also a search for cheaper labour and raw materials in Asia, Australasia, and Africa, which resulted in reorganised global supply chains. The International Monetary Fund (IMF) also adopted new austerity measures that were a barrier to the kind of development policies that W. Arthur Lewis and Michael Manley had envisioned.

Over the decades, investment in the Jamaican bauxite-alumina industry has increased production but reduced the number of those directly employed in the industry from a high
of 6,900 in 1975 to roughly 4,000 in 2018. The number of wage workers has also continued to decline from 4,520 in 1975 to 1,429 in 2018, although employment in other categories grew. Exports, particularly of alumina, have shifted toward Russia and China. The share of the bauxite-alumina industry in government revenues has declined from over 25 percent in the 1970s to under 3 percent leading up to the 2008 Global Recession, and since 2002, Jamaica’s bauxite levy has been replaced by a tax regime that links state revenues to company profits. Although industry production has expanded through new investment, yield per-ton has declined, and more mining and refining is needed to maintain revenues, leading to demands for greater concessions from the GOJ by the companies.

Historically, although the bauxite-alumina industry did not contribute significantly to the number of jobs created for Jamaicans, bauxite workers enjoyed higher wages, improved working conditions, and better prospects for job security. Strong trade union involvement in collective bargaining was primarily responsible for the “privileged worker” status experienced by bauxite employees in the past. In the 1950s, NWU came to represent all bauxite workers in Jamaica, leading to the securing of decent wages, benefits, and improved working conditions...
on wage increases, closure of plants, and worker layoffs. This led to the frequent worker strikes in the 1980s and in 1995. With over 4,000 workers demanding safer working conditions and higher wages, an MOU was signed in 1998 between the companies, the GOJ and the NWU, signalling a new phase in the industry with lower wages and more precarious working conditions. Despite the industry having a positive impact on labour relations during the boom years, currently, trade unions have lost the political control they once enjoyed.

THE SOCIAL COSTS

The crisis in the aluminum industry in the 1980s began to raise questions about the social costs of mining bauxite. Economist George L. Beckford organized a study of the impact of Jamaica’s bauxite-alumina industry on the environment, the first of its kind. Beckford argued that for many Jamaicans, the land possessed a deep political, economic, and spiritual significance tied to struggles for freedom from chattel slavery. In the post-emancipation period, formerly enslaved people had acquired small plots of land to grow food for subsistence and trade. By 1938, there were 80,000 freeholds registered in Jamaica, averaging just over two acres each, and many farmers considered this family land to be inalienable.

Before Jamaica’s legislature signed the Minerals (Vesting) Act, 1947 and Mining Act, 1947 into law, the Aluminum Company of Canada (ALCAN) and Reynolds Jamaica Mines had begun purchasing properties in St Ann and Manchester. As early as 1942, prospecting and land acquisitions had become not just a nuisance, but a threat to post-plantation rural economic life.

Beginning in the 1940s, Jamaican farmers signed petitions, wrote letters to newspapers, and held community meetings to discuss and contest the effects of bauxite mining on their communities. The rise and expansion of the industry displaced alternative ways of engaging with the land. Although the bauxite companies frequently documented and publicised their agricultural initiatives, resettlement programmes and land rehabilitation efforts, the industry never acknowledged the pressure from rural communities that had produced these compromises.

The authors of this chapter contend that it is difficult to measure the scale and effect of bauxite mining on rural Jamaica. George Beckford estimated that by 1979, when the Aluminum Company of America (ALCOA) and Alumina Partners of Jamaica (ALPART) had joined Reynolds Jamaica Mines, ALCAN, and Kaiser in buying up land, the companies owned more than 210,000 acres in the parishes of Manchester, St Elizabeth, St Ann, Trelawny, and Clarendon. Over time, the government began to claw back the land owned by the companies; yet, Geologist Arthur Geddes estimated in 1990 that mining had already caused extensive damage to the natural ecology of at least 60,000 acres. At the same time, more than 200 million tons of caustic red mud had been produced by 1990. Renier and
Howell conclude that the decrease in government revenue on each ton of bauxite mined incentivised an expansion in production and continued environmental degradation.

COCKPIT COUNTRY

As it relates to Cockpit Country, the current Jamaica Labour Party (JLP) government, led by Prime Minister Andrew Holness, agreed to prohibit mining in Cockpit Country in 2017, but environmentalists, farmers, and Maroon leaders have contested the government’s designated Cockpit Country Protected Area (CCPA) boundary. The cratered and cavernous landscape of wet limestone forest is one of the most biodiverse parts of the island, and it was in Cockpit Country that Maroons, whose presence in Jamaica antedates British colonization, forced the British to sign a peace treaty in 1739. The boundary dispute has served as a catalyst for deeper debates about the future of the bauxite-alumina industry in Jamaica and Maroon sovereignty.

BAUXITE’S FUTURE – 2020 AND BEYOND

The global economic slowdown of 2008 forced deep cuts in production and employment. Doors were shut to refineries in Ewarton and Nain, which eliminated nearly 1,000 jobs and associated community services. In the decade since the crisis, production has slowly picked up, refineries at Ewarton and Nain have reopened, and exports have climbed to their pre-recession highs. Since 2010, the JBI reports that the total number of jobs has grown from 2,189 to 4,028, but the number of wage workers has remained stagnant, failing to recover most of the losses from the recession.

In 2016, UC Rusal, a Russian corporation, sold its share of the ALPART refinery at Nain in St Elizabeth to the Jiuquan Iron and Steel Group (JISCO), a Chinese mining conglomerate. Today, UC Rusal, JISCO, the Noble Group and Glencore (New Day/Noranda) are the principle investors and partners with the GOJ in the bauxite-alumina industry. As COVID-19 threatens another global economic slowdown, it is time once again to evaluate the future of the industry in Jamaica.

Economist Michael Witter has pointed to the threats posed by bauxite mining to Jamaica’s food economy, soil fertility, and water supplies. His analysis centres the historical, cultural, environmental, and political economic stakes of mining in Cockpit Country, and Witter reminds us that expansion in the bauxite-alumina industry not only ties the lives of Jamaicans to cyclical crises in the world economy, but also that its expansion undermines alternative farming economies that have “sustained the country through all economic crises.” In the context of the current COVID-19 pandemic, the chapter concludes that focus on wages and foreign exchange alone cannot tell us whether the benefits of the bauxite industry outweigh the costs.

ANTHONY GREENAWAY

OVERVIEW

Chapter 2 describes the evolution of the regulatory framework governing the bauxite-alumina industry, from the Mining Act of 1947, through various pieces of legislation which incentivized the industry, to the establishment of the JBI in 1976, and the promulgation of the NRCA Act of 1991 (with subsequent amendments). The chapter not only looks at the scope of the laws, guidelines, and regulations governing the industry, but also assesses how they have been implemented using two case studies – UC Rusal’s Bayer Plant at Ewarton in St Catherine, and the mining operations of Noranda in St Ann and Trelawny. The draft Minerals Policies of 2011 and 2017 are reviewed, as well as a 2020 study by the Intergovernmental Forum on Minerals, Metals and Sustainable Development (IGF) on Jamaica’s readiness and capacity to implement the IGF’s Mining Policy Framework.

ADEQUACY OF THE REGULATORY FRAMEWORK

FINDING: While various methods of oversight and moral suasion were applied to the industry in the early days, it was not until 2015 that the regulatory framework for the mining industry was finally adequate and enforceable by law. The bauxite-alumina industry therefore operated for 45–65 years under minimal or deficient environmental legislation, but the current regulatory framework, if followed and adhered to, seems adequate for its purpose. The IGF review found the regulations to be overlapping, sometimes conflicting, and in need of review.

When the Permit and Licence Regulations of the NRCA Act were passed in 1996, the bauxite-alumina industry was “grandfathered” in – meaning that the new requirements did not apply to pre-existing mining operations. It was not until 2006 that the NRCA (Air Quality) Regulations 2006 were passed. These regulations specify when an air pollutant discharge licence is necessary, and the requirements for applicants. Until 2015, the regulators relied on the submission of information by the bauxite companies under Section 17 of the NRCA Act and in some cases, companies are still making these submissions, despite now having permits and licences.
PERMITTING AND LICENSING

**FINDING:** The procedures in place for preparing, reviewing, issuing, and monitoring environmental permits and licences are not being conducted with sufficient attention to detail.

Detailed review of the permits and licences for the two case studies (UC Rusel’s Bayer Plant at Ewarton – bauxite processing, and Noranda’s bauxite mining area in St Ann) revealed many inaccuracies, including one permit being so deficient that it had to be revised and reissued by NEPA in 2020.

DISPERSION MODELLING AND AIR QUALITY MONITORING

**FINDING:** Jamaica’s air quality regulations rely on dispersion modelling to identify pollutants which should be monitored, those which are projected to exceed air quality standards (thus triggering a compliance plan), and where monitoring sites should be located. The two case studies suggest, however, that modelling is not being used in accordance with the Guideline Document and its results have been ignored. There are significant weaknesses in monitoring and enforcement of regulations and licences – this was also a finding of the IGF report.

Expected emissions from all sources must be disclosed to assist in NEPA’s calculation of the fees companies must pay. These emissions are then used as inputs for a dispersion model, which predicts how the pollutants will be dispersed by the wind, and where compliance monitoring sites should be located. Monitoring becomes required if the maximum modelled concentrations at ground level are greater than 75 percent of the concentrations permitted by the National Ambient Air Quality Standard (NAAQS). Where predicted emissions from sources and fugitive emissions exceed the standards, compliance plans must be submitted and approved to bring emissions into compliance.

With regard to the modelling which is meant to guide the monitoring of air quality, our review of two case studies found that the dispersion model results seemed to have little bearing on the actual monitoring sites selected and therefore gave no guidance as to compliance to the NAAQS. Indeed, few, if any, sites were within the prevailing wind plume from emissions sources.

In the case study of Noranda’s mining operations, the boundary of Special Mining Lease (SML) 165 was used as the “fence line,” in order to locate compliance monitoring sites, so all suggested compliance sites were outside the lease boundary. Using the concept of a “fence
line” is suitable for a processing facility, where it can reasonably be assumed that the public does not have access inside the “fence line.” This approach is not, however, suitable for mining in a rural area as there are many small communities inside the boundary. In fact, the guidelines require the placement of sites within “all areas accessible to the general public,” which would be the entire lease area. We also found no evidence that monitoring sites were being moved as mining areas within the lease area changed.

For both case studies, there were no background sites or compliance sites, therefore modelling results and data collected were not verified.

**FINDING:** The licence requirements for air quality monitoring in the Noranda mining areas were not fully adhered to.

Noranda’s licence for SML 165 and 172 requires an air quality monitoring plan and ambient air monitoring be conducted for Total Suspended Particles (TSP) and Particulate Matter (PM), specifically PM$_{10}$ for “24 hours every six days”. The ATI request for the monitoring plan had not been responded to at the time of writing.

The ATI request to NEPA for air quality data relevant to SML 165 and 172 for 2016 through 2019 returned only TSP data for Calderwood, Clydesdale, and Green Hill. No PM$_{10}$ data was received. The JBI’s explanation for this omission varied: “It is common to focus on PM$_{10}$ in urban areas . . . and utilize the TSP in rural areas . . .” and; “As the network goes through an approval process between government regulators, it is not considered deficient for Noranda to not have PM$_{10}$ monitoring in the mining areas.” In a follow-up e-mail, they added, “The licence AQ00020 (sic) gives the two (2) options and does not prescribe that both MUST be used”.

NEPA did not offer an explanation for why PM$_{10}$ was not required to be monitored by Noranda’s licence.

The air pollutant discharge licence requiring monitoring for PM$_{10}$ was issued by the NRCA/NEPA and monitored by both NEPA/JBI. Our study was not able to determine why monitoring for PM$_{10}$ was required in the licence if this was to be optional.

**JAMAICA’S AIR QUALITY REGULATIONS RELY ON DISPERSION MODELLING TO IDENTIFY POLLUTANTS WHICH SHOULD BE MONITORED, THOSE WHICH ARE PROJECTED TO EXCEED AIR QUALITY STANDARDS (THUS TRIGGERING A COMPLIANCE PLAN), AND WHERE MONITORING SITES SHOULD BE LOCATED.**

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AIR QUALITY STANDARDS

**FINDING:** Jamaica’s air quality standards are known to be outdated and with respect to Particulate Matter (PM), are inadequate to protect public health – the bauxite-alumina industry could and should be held to a higher standard.

In Jamaica, the bauxite-alumina industry is only required to monitor for TSP and occasionally for PM$_{10}$. According to the US Environmental Protection Agency (EPA), best practice has long required monitoring for PM$_{2.5}$, in the absence of which it is not possible to assess the impact of PM on human health. TSP was removed from the US criteria pollutants in 1987. Further, bauxite-to-alumina processing emits caustic aerosols and there is no legal requirement to quantify or monitor such aerosols in Jamaica. Indeed, the many drafts of the pending National Minerals Policy and the JBI’s mandate call for the industry to conform to international best practices, which the industry has shown willingness to do. Our study was not able to determine why a higher standard has not been required by the regulators.

**Chapter 3: A Healthy and Productive Environment?”**

The Public Health Impacts of the Bauxite-Alumina Industry in Jamaica

**PATRECE CHARLES**

**OVERVIEW**

Chapter 3 explores the public health impacts of the bauxite-alumina industry, using complaints from residents in different parts of the island reported in the media, and by reviewing three studies on the impact of the Jamalco refinery at Hayes in Clarendon on the health of nearby communities. The three studies are:

- A 2007 study conducted by Patrece Charles, the author of this chapter, entitled: *The Reported Respiratory Illnesses in Communities within the Parish of Clarendon, and its Association with Environmental Conditions, Particularly Bauxite Activity* (Charles 2007);

- A 2008 *Health Impact Assessment* (HIA) requested by the Ministry of Health (MOH) and conducted by The University of the West Indies (UWI) and Yale University for the Jamalco facility in Clarendon due to a planned expansion (Jamalco 2008);
A 2015 health survey commissioned by the Jamaica Environment Trust (JET) and carried out by Professor of Public Health, Dr. Homero Silva, entitled: *Strengthening the Capacity of Jamaican Communities to Protect their Environmental Rights: Health Survey of the Mining Communities of Ten Miles, Bull Bay, St Thomas, Hayes and New Town, Clarendon, and Control Communities of Albion, St Thomas and Lionel Town* (JET 2015).

The findings of the chapter were limited by lack of health data from medical doctors, recent air quality data, and the age of the reviews – two were more than 12 years old.

**PUBLIC HEALTH RISKS OF BAUXITE MINING AND PROCESSING ARE WELL-KNOWN**

**FINDING:** The risks posed by the main pollutants from the bauxite-alumina industry are well-known and well documented.

The main pollutants caused by bauxite-alumina industry are described in Chapter 3. Particulate Matter (PM$_{10}$ and PM$_{2.5}$) is a common air pollutant, consisting of solid and liquid particles suspended in the air. PM is transported by the wind from excavation, blasting, and transport. Fugitive dust is generated by tailings facilities, stockpiles, waste dumps, and haul roads. Exhaust emissions arise from mobile sources (cars, trucks, heavy equipment) and gases from fuel combustion and mineral processing.

PM$_{10}$ and PM$_{2.5}$ include inhalable particles that are small enough to penetrate the respiratory system and their health impacts are well documented. According to the World Health Organization (WHO), there is no ‘safe level’ for PM$_{10}$ and PM$_{2.5}$, and PM$_{2.5}$ (fine particles) presents a stronger risk factor than PM$_{10}$. Exposure to both PM$_{10}$ and PM$_{2.5}$ can cause emphysema, pneumonia, tuberculosis, cancer, acute respiratory distress syndrome (ARDS), respiratory distress syndrome, pulmonary oedema, and asthma. Diseases such as these, which result in reduced oxygen being delivered to the tissues of the human body, can result in damage to every major organ.

Other air pollutants, such as sulphur dioxide, cause corrosion to building materials, including “zinc” roofs, soiling of personal property (such as clothes hung out to dry) and damage to crops and vegetation.

. . . RESIDENTS FREQUENTLY AND CONSISTENTLY COMPLAIN OF ASTHMA IN CHILDREN, ALLERGIES, DAMAGE TO ROOFS, CONTAMINATED WATER SUPPLIES, DAMAGED PERSONAL PROPERTY, LACK OF SOIL FERTILITY, IMPACTS ON CROPS, NOXIOUS SMELLS, AND DUST COMMUNITIES HAVE ALSO CONTESTED THE AMOUNT OF COMPENSATION GIVEN FOR SO-CALLED “DUST NUISANCE,” . . .
EXECUTIVE SUMMARY

COMMUNITY VOICES IGNORED

FINDING: Community complaints began in the early days of the industry but have produced little change in lived experiences.

Complaints by residents who live in proximity to bauxite mining areas, Residue Disposal Areas (mud lakes), haul roads and processing facilities frequently and consistently complain of asthma in children, allergies, damage to roofs, contaminated water supplies, damaged personal property, lack of soil fertility, impacts on crops, noxious smells, and dust. Communities have also contested the amount of compensation given for so-called “dust nuisance,” how it is distributed and to whom, also citing the industry’s failure to meet promises.
WE WERE PROVIDED WITH ONLY A SINGLE PUBLIC HEALTH IMPACT STUDY ON THE Bauxite-Alumina Industry COMMISSIONED BY THE GOJ

FINDING: The GOJ has failed to take adequate steps to track or investigate the impacts of the bauxite-alumina industry on public health over the industry’s almost 70 years. Owing to this lack of data, no firm conclusion can be drawn on its impact.

Despite long-standing community concerns and well-documented health impacts of pollutants released by the bauxite-alumina industry, the GOJ provided our researcher with only one Health Impact Assessment (HIA). This was in the context of a planned expansion to the Jamalco alumina refinery at Hayes in Clarendon, in 2008.

The HIA was conducted by The University of the West Indies (UWI) and Yale University. This important document was very difficult to access, requiring ministerial intervention, despite the fact that conducting the HIA was a requirement of the NEPA permit for the Jamalco efficiency upgrade. The HIA was provided without the appendices, which limited the depth of our review. It is unclear whether the findings of this study were ever released to the public. One government source, who declined to be named, insisted that the bauxite companies resisted the release of the study.

The 2008 HIA described the demographic profile, health conditions, mortality, and morbidity patterns in communities within a 15-kilometre radius of the Jamalco refinery and control communities. The study found:

- Self-reported health symptoms collected during the personal interview process suggested a belief that plant-related health impacts were occurring. The study suggested that these complaints were an effort to get compensation.
- There was no statistically significant difference in objective measures of health outcomes between the exposed and control groups, so there was no scientific basis for the belief that the Jamalco facility was causing public health impacts in the areas studied.
- Emissions to ambient air from the proposed expansion was determined to be unlikely to have significant adverse impacts on human health.

The 2007 Charles study investigated the pattern of selected reported respiratory illnesses in communities at specified intervals within a 10-kilometre radius of the Jamalco plant. Types of air pollution and their sources were identified, as well as reported respiratory illnesses and potential sources, compared to control communities. The Charles study found:

- Thirty-six (36) percent of adults surveyed perceived both the bauxite facility and the roads to be the major contributors of air pollution within a six-mile radius of the refinery.
- The average levels of PM$_{10}$ exceeded the national acceptable average of 50µg/m$^3$ at one to
six miles from the bauxite processing plant. Exceedance of PM$_{2.5}$ was observed within the one to three and one to ten-mile radii. Further investigation revealed that mile ten was located within a rural area and the seasonal burning of sugar cane was the source of the PM$_{2.5}$ at mile ten.

- Thirty-seven (37) percent of adults and 21 percent of children living within six miles of the facility suffered sinusitis. Asthma afflicted 23 percent of adults and 26 percent of children. Allergies were markedly more prevalent among those who lived closest to the plant than in control groups.
- Particulate Matter (both PM$_{10}$ and PM$_{2.5}$) measured within the study area contained alumina and sodium particles which were both associated with bauxite mining and processing.

The Charles study recommended that an objective epidemiological study should be conducted to determine any deviations in the norm of the health status of communities impacted by industrial activities, specifically the bauxite-alumina industry. To the best of our knowledge, this has not been done.

The 2015 JET health survey was conducted in selected mining communities in Jamaica by Dr Homero Silva, a public health specialist and lecturer at the University of Technology, Jamaica (UTech, Ja.), as part of an on-going project funded by the Inter-American Foundation to empower mining communities to protect their rights to a healthy environment. Two of these communities were Hayes and New Town in Clarendon (Group 1), in proximity to the Jamalco alumina refinery. Control communities (Group 2) were Lionel Town in Clarendon and Albion in St Thomas.

The incidence of eczema, hives/rashes, asthma, allergic conjunctivitis, hay fever/allergic rhinitis, wheezing, headache, eye symptoms, cough, shortness of breath, Body Mass Index (BMI) and hypertension were all investigated.

The JET study did not carry out any monitoring or testing of air quality but did evaluate the adequacy of Jamaican air quality standards in comparison to WHO standards.

The JET study found:

- Sixty-four point seven (64.7) percent of the respondents from Hayes New Town rated the air quality as unacceptable, compared to one percent in the control communities.
- With the exception of hives/rashes and BMI, it was highly likely that mining and quarrying operations were having an adverse impact of varying degrees on the health of residents.
- Jamaican ambient air quality standards were inadequate to protect public health.

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2 The PM$_{2.5}$ standard was adopted from the United States Environment Protection agency (US EPA) standard, which determined that the annual fine particle standard (set in 1997) was not adequate to protect public health as required by law. In 2012, the US EPA strengthened the annual fine particle standard by revising the level from the current level of 15.0 μg/m$^3$ to 12.0 μg/m$^3$. 
EITHER “IT’S NOT US”, OR “IT’S NOT THAT BAD . . .”

**FINDING:** The industry has not so far accepted responsibility for impacts to air quality and, therefore, public health.

The industry’s response has been (a) it’s not our dust, there’s lots of dust from other sources, e.g. cane fires, (b) deflection about the benefits provided to communities from the industry, as if this should eradicate the public health concerns; and (c) denial of the experience of communities, while at the same time paying “dust nuisance” compensation to those living within a specified radius of the plant.

DESPITE LONG-STANDING COMMUNITY CONCERNS AND WELL-DOCUMENTED HEALTH IMPACTS OF POLLUTANTS RELEASED BY THE BAUXITE-ALUMINA INDUSTRY, THE GOJ PROVIDED OUR RESEARCHER WITH ONLY ONE HEALTH IMPACT ASSESSMENT.
Chapter 4: “New terrain, far from fambly an fren”: The Social Impact of the Bauxite-Alumina Industry in Jamaica

HORACE LEVY AND PETA-ANNE BAKER

OVERVIEW

Chapter 4 explores the social dimension of the impacts of the bauxite-alumina industry on Jamaican communities, primarily in the populated, rural, hilly areas where mining takes place. The authors examine the effect of resettlement on the lives and livelihoods of small farmers as they see it, relate the experiences of those living in areas affected by the industry, investigate the impacts of mining on livelihoods and community, evaluate the response from mining communities to the measures that the companies agreed to, including the emergence of Community Councils, and review other social consequences. In-person interviews were constrained by the COVID-19 outbreak, but through visits by telephone and online methods, 57 people were interviewed from nine areas affected by four bauxite companies. Farmers accounted for 32 respondents and the other interviewees were from a range of occupations, including education. Very few respondents were from areas close to processing facilities, so this chapter focuses primarily on the industry’s social impact in rural communities near open-pit mining operations. Interviewees are not named except in a few cases, due to fears of victimization. The researchers were unable to source data on displacement/relocation numbers or reductions in population size in bauxite areas from the Statistical Institute of Jamaica (STATIN) or the JBI, and did not interview representatives from the two bauxite companies (UC Rusal and Noranda) to which interview requests were made, due either to outright refusal (Noranda) or repeated delays (UC Rusal).

RELOCATION OF SMALL FARMING COMMUNITIES

FINDING: Many resettled people found the experience extremely disruptive and painful. While a few were able to continue farming, most found themselves in semi-urban situations and/or in lower level bauxite jobs, resulting in reduced small farming production.

Open cast mining of bauxite in Jamaica occurs in the populated countryside, often on hillsides or valley bottoms, on land held by large and small farmers who are typically the descendants of formerly enslaved people who had been pushed to these areas after Emancipation in 1838. With the exception of Reynolds Jamaica Mines, which acquired land from large
estates, it was these small farmers who the bauxite companies had to resettle. Historically, there was resistance to resettlement from some individuals – termed “hold-outs” – which led to relocation of entire communities.

The JBI was established by the GOJ in 1976 to carry out regulatory, monitoring, advisory and research functions of the bauxite-alumina industry in Jamaica. The JBI was also tasked to manage dispute mediation between companies and workers and communities, with the objective that bauxite companies should have the land, but with the least disruption of community life. The JBI proposed and negotiated a model resettlement programme with many communities, although in most cases the company made the final decisions. The resettlement experiences in various communities in St Ann, St Elizabeth and Trelawny are described in this chapter.
Over the years, the experiences of Jamaican communities resettled by the bauxite-alumina industry have varied. The cohesive community of Village in eastern St Ann included about 15 “hold-out” families. After decades, resettlement of the entire community to Schwallenburg was successfully negotiated in 1981. The relocated residents received concrete and steel houses, as well as employment opportunities with ALCAN. The community of Mocho in Clarendon put up greater public resistance. After confrontation and legal action, resettlement eventually occurred in the late 1970s. In Lime Tree Garden in St Ann, many families were reluctant to sell their land. Eventually, 60 households were moved in the early 1980s by Kaiser en bloc to Retreat, only seven miles away by road and a mile away from Brown’s Town, in order to preserve access to friends and family and a rural town. It was only after years, however, that facilities such as water and electricity were provided. Some Lime Tree Garden residents were relocated to Trelawny’s distant Fontabelle and Windsor, with vastly different topography and crops.

In general, relocated communities in St Ann, St Elizabeth and Trelawny were often dissatisfied with the fertility of the soil in the new area, access to schools and clinics, and the loss of their fruit trees. They framed displacement as “having to start life over.” Those who stayed behind, close to the mining areas, suffered negative impacts from mining, while some who accepted resettlement welcomed freedom from the dust and noise, and better facilities, such as concrete houses, indoor plumbing, and kitchens. Interviewees also pointed to delays in providing promised titles to new land. More recently, Noranda’s offers to buy the land of small farmers near Watt Town in St Ann are regarded as below current market prices.

**RURAL POPULATION DECLINE**

**FINDING:** Small farming communities insist they suffered because of bauxite mining, losing size and sense of community. We were not able to find data on displacement, resettlement, or population decline of the mining communities.

According to the Agricultural Census 2007 (STATIN), “active farmland” declined across the country by 22.2 percent between 1996 and 2007. The 30 percent decline in St Ann and the 22.5 percent decline in St Elizabeth (11.4 and 9.2 percent of the national total respectively) therefore contributed significantly to the national decline, amounting to about 20 percent of the total.

The national decline in active farmland is generally attributed to the rural-to-urban trend occurring globally, due to the pull of urban social amenities and employment opportunities. While rural-urban drift cannot entirely be attributed to the impact of bauxite mining, farmers are adamant that fertile farmland (and therefore farming) has been reduced because of bauxite mining, which probably pushed many towards urban areas.
The authors of Chapter 4 were unable to source numbers on population decline due to relocation because of bauxite mining, but they offer the experience of Lime Tree Garden as a typical example. According to resident Alvin Gallimore, Lime Tree Garden was a district of over 3,000 people, reduced to a village of roughly 600. Attendance at the primary school shrank from 480 students in the 1970s to about 170 currently.

ADVERSE SOCIAL OUTCOMES

**FINDING:** Interviewees believed that mining had a role in adverse social trends (increased poverty, crime, gambling) but this could not be proved.

Interviewees believed the removal of farmland from farming and consequent loss of livelihoods have had negative social and economic impacts. Respondents complained of increased poverty and social ills, although outcomes varied depending on the existence of alternative employment opportunities (such as tourism in St Ann), the length of time mining had occurred and its extent, and existing community cohesiveness. However, petty theft, loss of community, and gambling are islandwide problems for Jamaica, so the authors were unable to conclusively link these effects to the impact of bauxite mining.

COMPANY RESPONSE: EFFECTIVENESS OF RECLAMATION EFFORTS

**FINDING:** Farmers were adamant that soil fertility was lost owing to bauxite mining, and not restored by reclamation.

After mining is completed, reclamation is required by the Mining Act to the level of agricultural or pastoral productivity or of utilization for afforestation purposes or other uses approved by the Commissioner or the Town and Country Planning Authority. This chapter looked at the lands held by Kaiser, later Noranda, in St Ann, and by JISCO, formerly ALPART, in St Elizabeth and Manchester, and by Jamalco in Manchester and Clarendon. Farmers reported that the amount of topsoil replaced was too shallow and unable to resist heavy rainfall, unsuitable for most crops, especially fruit or other trees with deep roots but, to some extent, suitable for pasture. Government inspectors were criticized for failure to supervise reclamation contractors adequately. A 1981 survey reported 82 percent of farmers perceiving mined-out land to be worse than pre-mined.
COMPANY RESPONSE TO DUST AND OTHER QUALITY OF LIFE IMPACTS

FINDING: Communities found the “dust nuisance” compensation offered by bauxite companies to be inadequate – between JMD7,000 and JMD8,000 per household per incident. At 2020 rates of exchange, this is between USD50 and USD55.

Interviewees consistently complained about changes to climate, including reduced rainfall, due to removal of trees. They deplored the impacts of dust from the “mud lakes,” haul roads, loading at ports, and from the mining itself because they were sure the dust affected their crops and quality of life. They distinguished between the types of dust – red and white. The red dust came from the mines and roads, while the white dust came from plant emissions. The red dust was believed to have almost destroyed citrus production in parts of St Ann, South Manchester and North Clarendon. The white dust was reported to affect human health and “burn” sweet peppers, tomatoes, and other produce.

Bauxite-alumina companies do provide compensation for what is called “dust nuisance” to those living within a certain proximity, but respondents complained the compensation was too low for the range of impacts they said they experienced, which, along with public health, included damage to crops, roofs, clothes drying outdoors, and water stored in tanks (collected via open rainwater catchments).

COMPANY RESPONSE – DIRECT BENEFITS TO COMMUNITIES

FINDING: Communities saw and valued the benefits provided by the bauxite companies at a community level, but we were not able to evaluate relative weights assigned to benefits vs. costs. Communities also appreciated the national benefits of the industry but maintained that insufficient benefits were returned to the communities in which bauxite-alumina companies operate.

Companies have provided a range of direct benefits to mining communities. These have included replacement of pit latrines with flush toilets in schools; tuition grants and scholarships; support for income generating projects such as chicken and goat rearing, bee keeping, and other types of small businesses; technical skills training opportunities; and assistance for sports, e.g. the provision of playing fields.

With funding from the Jamaica Social Investment Fund (JSIF), the JBI spearheaded the construction of greenhouses in Manchester and St Ann to compensate for some of the...
farming losses associated with bauxite mining there. One hundred and sixty farmers in eight communities have benefited at a cost of JMD245 million over the lifetime of this project which began in 2014. This has not been without its problems, however, as some Community Council members reported non-functioning greenhouses – 24 out of 24 in one location for 18 months, and three out of three for four years – although new greenhouses are set to be constructed. Greenhouses are easily damaged in high winds, and the farmers may lack resources to complete repairs themselves.

Communities clearly value these initiatives, but it was not possible to evaluate the relative weights assigned to benefits vs. costs, with individuals often expressing a lack of choice – the mining was going to happen regardless, and they sought to secure at least some benefits. Requests to review the minutes of the Community Council meetings to inform an assessment of the value of the projects, and how well they were implemented and maintained, were denied by the JBI.

Those community members who appreciate the benefits offered by the industry by way of employment, foreign exchange earnings, sports, training, scholarships, greenhouses, and other initiatives are nonetheless critical of the failure of successive governments to channel sufficient funds back into mining communities.
COMPANY RESPONSE – THE EMERGENCE OF COMMUNITY COUNCILS HAS BROUGHT GAINS FOR COMMUNITIES, INCLUDING AVENUES FOR MEDIATION AND COMPROMISE

FINDINGS: The creation of Community Councils was a major achievement with its many activities and the fostering of democratic approaches. They were not, however, successful in restoring agricultural productivity to the land or eliminating pollution impacts.

The first Community Council emerged in 1990. It was born at the ALPART Sports Club in St Elizabeth following a protest of 2,000 people at the plant gate over dust from a “mud lake.” This first Council grew to represent 45 communities and was followed two years later by another in South Manchester representing 33 communities. Through its Bauxite Community Development Programme (BCDP), the JBI then aligned with community interests and promoted another 15 councils of 17 that were eventually launched in other bauxite areas. The JBI maintains that 15 Community Councils are still active, and that prior to COVID-19, they were still holding monthly meetings. The authors contacted nine Community Councils.

The Councils have provided an avenue for local people to be heard by the companies and have fostered democratic processes in the participating communities. For the companies, the Councils have helped avert strikes or productivity losses, and provided a forum for mediation. Our study found that over the years, much depended on whether the Chairperson of the Council was from the community or was a company representative. Some residents felt that some Chairpersons acted in their own interests, rather than for the good of the community.

The Councils have produced other community-based organizations, such as the non-profit Essex Valley Community and Associates (EVCA), which enabled plant workers to get construction contracts funded by the company and contributed to student tuition and back-to-school needs.

The spirit and intention of the Councils has been to defend two main community interests – the restoration of mined-out areas to their original productivity and the control or elimination of dust pollution to protect public health and livelihoods. While there have been efforts to mitigate dust pollution and some compensation was (and still is) offered, our respondents felt the Councils have so far failed to protect broader community interests.

THE SPIRIT AND INTENTION OF THE COUNCILS HAS BEEN TO DEFEND TWO MAIN COMMUNITY INTERESTS – THE RESTORATION OF MINED-OUT AREAS TO THEIR ORIGINAL PRODUCTIVITY AND THE CONTROL OR ELIMINATION OF DUST POLLUTION TO PROTECT PUBLIC HEALTH AND LIVELIHOODS.
COMMUNITY LIFE IN ST ELIZABETH OUTSIDE THE AMBIT OF THE Bauxite-Alumina INDUSTRY

**FINDING:** The farming communities of St Elizabeth provide an opportunity to compare economic and quality of life outcomes with those affected by bauxite mining or processing, and this research should be conducted.

Most of the land in St Elizabeth is untouched by mining, because after mining a limited area in this agricultural parish, ALPART turned to the South Manchester plateau for its ore and JISCO has so far continued there. For many farmers and small business people in St Elizabeth, the bauxite-alumina industry is of lower value compared to farming. Where mining has not interfered, they contend, it is small farming that brings better income and quality of life. These small farmers are those in the farming belt to the South of the parish around Junction, Top Hill and Ballards Valley, as well as those in the South of the Essex Valley, around Comma Pen and New Forest. St Elizabeth respondents said that tradesmen, such as welders, masons and carpenters, can earn more working for other types of business, compared to bauxite workers. Farmers now use technology their parents did not have access to – the low-tech mist-blower, plastic water tanks, weed whackers, drip irrigation tubing – as well as traditional dry grass mulching to make a prosperous living from a few acres. The current demand in the parish is for land and irrigation systems.

ASSESSING SOCIAL IMPACTS OF INDUSTRY

**FINDING:** State agencies responsible for protecting the public interest have not carried out the necessary data collection or research to assess the impacts of this major industry on rural communities, and they have not provided strong oversight and guidance to the bauxite-alumina industry. Owing to this failing from the very institutions established to protect the public interest, the rural communities interviewed were adamant that the industry has inflicted clear and long-lasting damage on small farmers, their culture, and potential for enriching the agriculture of Jamaica and the country’s prospects for self-reliance.

The authors of this chapter contend that any government engaging foreign transnationals to develop a major industry has a basic duty to assess the social impact on its citizens. In the case of the bauxite-alumina industry, such an assessment would track the number of farmers, the effects on farmers, the size and productivity of their plots, any exodus to urban centres, and alternative livelihoods taken up. It would also track differences in these parameters from community to community and from company to company, as well as any accompa-
nying changes in population, community structure and lifestyles, or other indicators of vibrant rural life. While vocal complaints, over many decades, from communities about the bauxite-alumina industry’s impact on their lives underscore the urgency for such assessments, Levy and Baker were not able to discover how many people had even been displaced by the industry.

In the view of the authors, resistance to such vital work has come from the very agencies responsible for the public interest, particularly the JBI. The JBI’s published research has focused on the financial side of Jamaica’s bauxite-alumina industry, and to some extent its social benefits, such as greenhouses, with little focus on the social impacts.

Chapter 5: Degradation of Ecological Heritage – The Impact of Bauxite Mining on Karst Ecosystems in Jamaica

SUSAN KOENIG

OVERVIEW

This chapter reviews the impact of open-pit bauxite mining on Jamaica’s natural environment, specifically the removal of agricultural vegetation or native forests, impacts to soils, the physical reshaping of landforms, and the changes to ecological processes. The processes considered are formation of new soils, regulation of microclimates, movement of water within and beyond mining areas, and the growth of new vegetation. These processes provide ecosystem services of value to humans, such as food, water supplies and climate regulation, and mining can arrest any of them. The extent to which ecosystem services can or have been rehabilitated to a functional, self-sustaining condition in Jamaica has never been rigorously assessed in the over 70 years of bauxite mining on the island. Moreover, because much of the historic and current mining in Jamaica occurs in areas where the native forest covering the ore had already been converted, mostly to agricultural-pastoral activities, assessing the impacts of deforestation on forest-dependent biodiversity was beyond the scope of this review.

Because of the extensive data gaps, the author of Chapter 5 was restricted to a web-based literature review to determine to what extent the characteristics of karst systems are being considered by authorities to minimize and/or eliminate environmental degradation caused by bauxite mining in Jamaica.
ABSENCE OF CRITICAL DATA FOR MINED-OUT ORE BODIES

**FINDING:** Spatial-based analysis and field verification surveys of rehabilitated mined-out pits were not possible owing to absence of ore-body boundary data.

The original approach of this research was to: (a) review existing literature to identify post-mining rehabilitation practices from the inception of the industry in Jamaica; (b) obtain printed maps or electronic files of spatially-explicit, geo-referenced boundaries of all bauxite ore bodies which have been mined-out in the parish of St Ann; (c) obtain records of the reclamation status and rehabilitation land cover status for every mined-out ore body in St Ann; and (d) undertake field assessments to evaluate the current land cover status of rehabilitated ore bodies since certification by the Commissioner of Mines.

While the Mines and Geology Division (MGD) was able to provide data on the rehabilitation status (including land cover designation) of mined-out ore bodies under current Special Mining Leases (SMLs), the Division was unable to provide boundary data for other mined-out ore bodies. A request to the JBI for boundary data remained unanswered at the time of this report. This precluded computer-based spatial analyses and verification field surveys.

THE EARLY DAYS

**FINDING:** Bauxite mining interests gained the upper hand very early and this has remained the case, even as social and environmental values have changed.

Jamaican bauxite has unusual properties relating to its susceptibility to erosion, water absorption, slickness, and texture. Although large reserves on the island were quickly confirmed, mining did not proceed immediately, because overseas plants at that time did not have the ability to process Jamaican bauxite, which has a very fine grain. There was strong interest in exporting bauxite from Jamaica, owing to post-World War II industrial expansion.

Legislation was passed in 1947 to vest the ownership of ore bodies in the Crown along with regulations to govern exploration and mining on the island. Mining and exploration leases were issued for up to 40 years, which locked in practices that later became contested, as social and environmental values changed.

ALCAN and Reynolds Jamaica Mines began purchasing the largest bauxite-bearing properties in Manchester and St Ann in 1944 and 1945, and the third entrant, Kaiser Bauxite Company, obtained access to some 136,472 acres (55,228 hectares) or 5.7 percent of Jamaica’s land area. This was followed by the construction of refineries which could handle the qualities of Jamaican bauxite to process bauxite ore into alumina using the Bayer Process.
From its first export in 1952 through 2018, approximately 626 million metric tonnes (by dry-weight) of bauxite-bearing earth have been extracted from Jamaica.

HOW BAXRITE IS MAPPED, EXTRACTED, AND REHABILITATED

**FINDING:** The process of extracting Jamaican bauxite has changed little since the 1940s and has harmful effects on the land, ecosystems, and ecological processes.

The positions of ore bodies are mapped and numbered on topographic maps, initially by hand, and then tracked as they are mined-out, rehabilitated, and certified. Archiving this mapped information is critical to ensure compliance with mining regulations and to ensure that new mining leases are not granted on already mined-out ore bodies. From the early 1970s, Geographic Information System (GIS) software meant that ore body data could be computerized, and since at least 2000, GIS technology has been used in Jamaica.

Field surveys and subsequent mining reveal the complex variations of ore body size and shape which result from the pockets, sinkholes, and troughs of the underlying karst surface of the White Limestone Formation in which Jamaica’s bauxite deposits occur.

Once the sequence of mining is determined, a network of spur and haul roads is mapped and constructed to connect pits to the mine terminus.

Before mining commences, surface vegetation is stripped away, and the topsoil and remaining overburden are mechanically removed to expose the bauxite ore. The Mining Regulations, 1947 (last updated in 2006) stipulate that “topsoil to a depth of not less than fifteen centimetres” must be removed and stacked aside for subsequent return to the pit after mining operations are over. Guidelines created by the National Restoration Committee (NRC) recommend that stripping should not be less than 30 centimetres (12 inches) but legal enforcement will be to the regulations, not to guidelines. Once all overburden is removed, the ore is mechanically extracted down to the limestone substrate.

After commercially extractable bauxite is removed, the resulting steep-sided depressions must be smoothly graded and unsightly mounds and dumps avoided. Backhoes scrape down nearby limestone hillsides to generate fill material for the void created by mining, making the depressions steeper-sided and increasing the surface area of the original ore body, while decreasing forested areas on the hillsides. This increase to the original ore body is called “swell” and, while averaging 60 percent, can exceed 100 percent of the surface area of the pit. To reclaim the pit, sometimes twice as much land must be disturbed.

Reclaimed pits remain identifiable by their vertical faces. Current reclamation guidelines specify that “vertical faces shall not exceed three metres (10 feet)”, but an exemption may be
granted by the Commissioner of Mines. Once the contours of the re-shaped pit are set, the stockpiled overburden, described as “topsoil,” is returned by heavy mechanized equipment. Because of the increase in surface area from pre-mined to post-mined, the depth of soil will always be thinner unless topsoil from somewhere else is used. Critically, while the Regulations specify that prior to mining, topsoil to a depth not less than fifteen centimetres must be removed, the Regulations do not explicitly state depth requirements for soil reconstruction during rehabilitation, only that the topsoil removed must be replaced.

There is no legislative requirement to rehabilitate haul roads, nor any forest disturbed by road construction or pit reclamation, although appropriate conditions could and should be required by both NEPA and the Commissioner of Mines. There are no indications that areas of forest-covered limestone hillside destroyed during haul road construction and/or pit reclamation have ever been accounted for under the “every hectare of land disturbed for mining” rehabilitation requirements, even though there is an agreed policy of “no net forest loss” caused by mining.

**EXTENT OF DISTURBANCE OF LANDFORMS**

*FINDING: In the absence of GIS data for ore bodies and haul roads, the author could not calculate or independently verify claims made by the JBI as to how much of Jamaica’s land surface has been impacted by bauxite mining, or quantify the effects of creation of forest fragments on hillsides. An argument could be made that the default assumption should be that the entire area of all Special Mining Leases (SMLs) issued since 1947, or 17 percent of Jamaica’s land surface, has been or will be directly and indirectly impacted.*

At the time of writing, the MGD had not provided any geo-referenced spatial data under an Access to Information (ATI) request for GIS shapefiles of the boundaries of all mined-out bauxite ore bodies for the period October 13, 1947 to February 29, 2020, although the shapefile extension *.shp appears on maps used for certification results at least as early as 2000.

Without these maps or electronic files, the public (or, indeed, NEPA) cannot independently verify what percentage of “every hectare disturbed by mining” has actually been rehabilitated in accordance with The Mining Regulations. At a minimum, nearly one quarter of mined-out ore bodies have not been reclaimed since bauxite mining began in Jamaica.

Spatially explicit, geo-referenced data on bauxite reserves which the Cartographic Unit at the JBI reportedly maintains must have been provided to the bauxite companies because they would have needed this data to construct volumetric models, to calculate bauxite tonnage and thickness, to develop and report their mining schedules to the JBI, and to map surface land ownership.
ASSESSING LAND USE CHANGES

**FINDING:** In the absence of GIS files and maps discussed above, we could not assess the extent of land use change caused by bauxite mining.

Until maps and GIS files become available, and with every mined-out ore body identified by its uniquely assigned alpha-numeric coding, it is impossible to assess land use changes over the short or long term. Additionally, assessments of whether natural forest regeneration is occurring in any areas planted with Napier (Elephant) Grass (*Pennisetum purpureum*) cannot be undertaken without the mapped locations of rehabilitated pits.

ASSESSMENT OF THE NATIONAL RESTORATION COMMITTEE (NRC)

**FINDING:** The National Restoration Committee took too long to be established (2009), has failed to designate “no mining” areas or areas to be reforested, and has not met since 2016. It exists in name only.

The National Restoration Committee (NRC) was created in October 2009, due to the recognition that there had been varying levels of compliance with rehabilitation regulations and guidelines. It is chaired by the Commissioner of Mines, with representation from industry, academia, and government. At the time of writing, the NRC had not met since 30 June 2016.

Although the problems associated with the return of only 15 centimetres of soil were known since experimental field trials were conducted by ALCAN in the late 1960s, the NRC has not addressed this issue.

The NRC is yet to present a comprehensive list of trees suitable for reforestation or designated areas to be reforested. The Forestry Department’s policy objective to strengthen the capacity of the NRC to address requirements for restoration into forest cover, and to have Forest Reserves and specially-identified Forest Management Areas declared as “no go areas” for the purpose of mining, has yet to be communicated in any meeting of the NRC.

Within the rehabilitation guidelines prepared by the NRC, the terms “biodiversity,” “functional forest,” “ecosystem,” “karst,” or “watershed/water catchment” do not appear, thus failing to establish the conditions for new development and maintenance of healthy soils for agriculture and forest communities.
CHANGES IN SOIL STRUCTURE AND FUNCTION, IMPACTS ON FORESTS

**FINDING:** Bauxitic soils can retain considerable amounts of water, which in turn allows the growth of large trees and forests on bottomlands. This function is lost when soils are removed – the extent of this loss cannot be calculated in the absence of maps/GIS data for mined-out ore bodies. There has been a near-total absence of effort to rehabilitate ecological processes, or to restore any kind of functional forest to mined-out land.

During exploration and mining, company representatives describe a “nuisance” water-holding capacity in Jamaican bauxite. This results from the particle size, particle shape, and particle density of the bauxite.

This water-holding capacity drives the topographic variation seen in the species composition and physical structure of tropical karst limestone forests around the world, including in Jamaica. This variation shows:

- the largest trees are found in bottomland depressions and valleys, where deep clays and organically derived soils accumulate;
- trees become smaller in stature as one ascends the slope to the hilltop/ridgeline; and
- species composition also varies with topography, soil and limestone porosity, and exposure to wind, with those species adapted to drier conditions found on slopes and hilltops.
Studies in the Brazilian Amazon, South America, Australia, and other places have revealed the importance of water held deep in the soil for the survival of forests occurring on karst landforms during drought conditions. Trees use a deep network of fine roots to extract this water from depths of at least 11 to 18 metres.

Other than studies of nutrient cycles which examined the upper 10–15 centimetres of topsoil, and although Jamaica’s Forestry Department collects measurements of “Effective Soil Depth” during biophysical inventories, no published information was found on the deep root architecture of Jamaican trees. The author assumes, however, that the roots of Jamaican trees on karst limestone function as elsewhere.

The elimination of the structural-functional component of bauxite ore, which had the capacity to hold 19–25 percent water, means that:

- we have already lost the extent and complexity of pre-Columbian forests in Jamaica;
- even if post-mining rehabilitation to functioning forests of native tree species were to become an objective, the best that could be achieved is the smaller-stature forests of peripheral limestone hills, due to the loss of the water holding capacity of the soil;
- with smaller trees, the capacity to capture and sequester carbon, both above-ground and below-ground in roots and in the soils, is forever reduced on the island; and
- until maps and/or GIS polygons of mined-out ore bodies are made available, we cannot tell how much capacity for carbon sequestration has been lost due to mining.

**TREE PLANTING AND AGRICULTURE ON RECLAIMED BAXITE LANDS**

**FINDING:** The majority of rehabilitated mined-out ore pits have not met the standard of restoring agricultural productivity. Attempts at restoring tree crops or forests are limited. Based on rehabilitation data provided by MGD, under the currently active SMLs, less than 0.5 percent of mined-out ore bodies have been planted with a forest land use designation.

Regardless of whether attempting rehabilitation of native forest, the production of biofuels or commercial forestry of hardwoods and agricultural fruit trees on reclaimed bauxite land, planting must either be done in the rainy season or irrigated, otherwise seedlings die. If watered, seedling survival improves but growth is stunted. The reason is simply that post-mined soils are too shallow for trees. Research has shown that only grass will establish on 15 centimetres of reconstructed soil. Farmers agree that 15 centimetres of reconstructed soil can produce grass to maintain a few tethered cows, but root crops, legumes, and cash crops require soil greater than 30 centimetres in depth.

Most nutrient recycling occurs in the upper 15 centimetres of topsoil, so why has this
The quality of the soil material stockpiled and returned during reclamation is also important, as well as the fact that this material is returned to a compacted limestone substrate rather than to a moisture-holding bauxite foundation.

When the stored topsoil is eventually returned to a reclaimed pit, it is mixed with larger fragments of limestone pebbles and rocks. The reconstructed material is physically bulkier, has larger pore spaces, and therefore is unable to retain water as well as un-mined topsoil.

Beyond changes to water-holding capacity, soil degrades while stockpiled owing to losses of organic inputs from plants, and changes in soil microorganisms and soil fauna. Even after 20 years post-mining, a study of soil fertility in reclaimed pits found indicators of reduced soil quality compared to un-mined soils.

**GROWING GRASS IN PERPETUITY AND FACILITATING THE SPREAD OF INVASIVE SPECIES**

**FINDING:** The construction of artificial ponds to provide irrigation to greenhouses and the use of Napier grass in reclamation are in contravention to Jamaica’s responsibilities under the 1992 United Nations (UN) Convention on Biological Diversity (CBD).

Rehabilitation efforts in Jamaica include a shift to the construction of greenhouses in reclaimed pits, but greenhouses are susceptible to strong winds and Jamaica is in the hurricane belt. External water storage is also needed, which has been created by placing impermeable liners at the bottoms of reclaimed pits to create artificial ponds. This creates conditions for ponds to become breeding reservoirs for disease-transmitting mosquitoes and invasive alien cane toads. The latter ranks in the top 10 of the world’s 100 most invasive species.

Since 2003, Napier grass has been the primary post-mining treatment utilized. Napier grass is tolerant of drought conditions and able to grow on marginal, well-drained soils. The land use is then designated as “grass” or “pasture.” For an estimated 60 to 70 percent of pits which have been rehabilitated under the currently-active Special Mining Leases, Napier grass was planted purportedly to stabilize the movement of reclaimed soil, but no published data could be found to verify this claim.

**REHABILITATION EFFORTS IN JAMAICA INCLUDE A SHIFT TO THE CONSTRUCTION OF GREENHOUSES IN RECLAIMED PITS, BUT GREENHOUSES ARE SUSCEPTIBLE TO STRONG WINDS AND JAMAICA IS IN THE HURRICANE BELT. EXTERNAL WATER STORAGE IS ALSO NEEDED, WHICH HAS BEEN CREATED BY PLACING IMPERMEABLE LINERS AT THE BOTTOMS OF RECLAIMED PITS TO CREATE ARTIFICIAL PONDS.**
The classification of Napier grass as “pasture” is misleading. While young growth can be harvested and fed to cattle as fodder, mature plants are nutritionally inadequate for maintaining animals. The use of Napier grass does not, therefore, represent compliance under the Mining Regulations for pastoral productivity.

While it has been suggested that Napier grass is a “pioneer species” and therefore, useful in establishing processes of natural regeneration of forest, this grass is globally recognized as an invasive species. In Jamaica, NEPA designates Napier grass as a “Category 2 – Highly Invasive” species.

Promoting the usage of invasive alien plants, with no succession planning to ensure there will be turnover to native species, is counter to Jamaica’s responsibilities to the Convention on Biological Diversity (CBD) and directly contradicts the goals of the country’s National Strategy and Action Plan on Biological Diversity.

SOIL MANAGEMENT AS AN ELEMENT OF REHABILITATION

**FINDING:** Virtually no attention is paid to the rehabilitation of the processes which produce healthy soil.

There are no published figures for natural rates of soil formation in Jamaica, but it is thought unlikely to exceed one millimetre per year. Soil serves as the foundation for terrestrial ecosystems – whether agrarian or forest – so a soil management plan is a critical element in reclaiming surface-mined lands. In Jamaica, efforts can barely be described as salvage. At an absolute minimum, rehabilitation needs to be directed towards ensuring that the processes which enable soil development, create the conditions for vegetation establishment, and ensure vegetative survival and growth during natural drought cycles, are functioning before certification is granted, if the objective is to rehabilitate pre-mining productivity.

To achieve environmentally sustainable, healthy soils, Jamaica must shift from the inadequate quantity metric of 15 centimetres to one of quality. This would almost certainly require that an ore body is not mined-out to the underlying limestone, as is currently practised.

**TO ACHIEVE ENVIRONMENTALLY SUSTAINABLE, HEALTHY SOILS, JAMAICA MUST SHIFT FROM THE INADEQUATE QUANTITY METRIC OF 15 CENTIMETRES TO ONE OF QUALITY. THIS WOULD ALMOST CERTAINLY REQUIRE THAT AN ORE BODY IS NOT MINED-OUT TO THE UNDERLYING LIMESTONE, AS IS CURRENTLY PRACTICED.**
THE KARST WATER CYCLE – IT’S COMPLICATED

**FINDING:** Claims that there have been no short- or long-term impacts to underground water in karst landscapes have not been supported with the required data layers.

Only one field study was found tracing the movement of rainfall through the above-ground limestone hillsides and bauxite-filled doline and cockpit karst depressions in North-central Jamaica. That study was unable to detect dye-traced water after it penetrated the surface of the bauxitic material.

Karst hydrodynamics are complex. Water percolating through soil eventually reaches the underlying limestone, with its myriad fissures, cracks, and conduits. If there is any slope associated with the underlying geology, horizontal movement of water can be exceptionally rapid through the subterranean network of conduits and caves.

Where mining has occurred and the buffering function of thick bauxite deposits has been reduced or eliminated, rainfall will always enter the subterranean limestone conduits more rapidly than to un-mined areas. There will be a flash movement of a “packet” of water through the aquifer rather than a steadier, lower-energy discharge rate that will flow for a longer period after it stops raining. The total volume of water discharged may be identical in an un-mined vs. mined karst landscape; the difference is how long that volume remains available for usage by all communities – natural and human – both locally where the rain fell and at the wider scale of the watershed.

In order to estimate the localized and cumulative impacts of bauxite mining, a model would require GIS data on location, depth, and volume of every bauxite deposit extracted from the landscape, the *in-situ* moisture gradient of every ore body prior to mining, the network of haul roads, the land cover prior to mining, daily rainfall data, and daily surface river discharge rates.

WATER STORAGE AND DUST

**FINDING:** Although the absence of surface water is one of the defining characteristics of karst landscapes, there has been a fundamental failure to appreciate how intercepted rainfall is stored in these areas, and it has not been studied.

While some dust is generated during the excavation and loading of trucks, anywhere from 78 to 97 percent of dust is generated along unpaved haul roads. Depending on many variables, fugitive dust of the size to cause respiratory problems in humans can travel at least 30 metres beyond its source and will remain on a surface until washed-off, blown further afield, or it settles in a water catchment.
In nature, epiphytic tank bromeliads (wild pines) catch, condense, and retain rainfall in the cup-shaped base of the plant providing habitat for organisms with an aquatic stage in their lifecycle, food for larger predators, and a source of drinking water for other animals. Tank bromeliads are a key component of the ecological food web in karst landscapes. We were not able to discover any research on the condition of bromeliad communities in proximity to haul roads.

Humans in karst landscapes also use a variety of rain-interception and water-storage facilities. There are at least 98 hillside water catchments within current Special Mining Leases (SMLs) and an additional 29 within a one-kilometre radius of the leases. Together, these serve 90 major communities and countless smaller villages. As best as can be determined, not a single public water catchment has been monitored for mining-derived fugitive dust. If water quality or storage capacity is compromised, it is the responsibility of Municipal Corporations, not the bauxite companies, to address the problem.

**BEYOND THE MINES: CONTAMINATION OF KARST GROUNDWATER AND SURFACE RIVERS**

**FINDING:** Although improvements have occurred during the life of the industry, the management of the waste generated by alumina processing is not conducted according to international best practices, and causes impacts to ground water and surface rivers in Jamaica.

The Bayer Process used to extract alumina from bauxite ore produces a toxic slurry of bauxite waste residue (red mud), which is highly alkaline, highly saline, has high sodicity\(^3\), and a higher concentration of certain heavy metals.

In the earliest period of bauxite processing in Jamaica, the toxic slurry was discharged directly into mined-out pits near the factories. Up to the mid-2010s, it was estimated that approximately 350 million tonnes of bauxite residue would have been produced in Jamaica, but there was little documentation of “red mud” disposal practices from the 1950s to the 1980s in Jamaica, resulting in contamination of groundwater.

The liquid waste was deposited in man-made settling ponds and lakes which originally had unsealed clay substrates. Eventually, substrates were sealed, but during high rainfall events overtopping as well as breakaways of embankments occurred. If the slurry of bauxite residue was not fully neutralized before being discharged into the “mud lakes” there was contamination of surface water bodies and ground water, either via overtopping or vertical drainage through the underlying limestone.

\(^3\) Presence of sodium attached to clay in soil.
Since the mid-1980s, dry stacking by the Robinsky disposal system has been used at Ewarton in Jamaica. This involves evaporating the bauxite residue slurry to a density of at least 48 percent solids (compared to 18 to 20 percent solids with lake storage), depositing it on a land surface, and then allowing it to further evaporate/consolidate before a successive layer is deposited. A slope eventually forms, allowing rainwater to run off – but to where? – and minimizing liquid stored in the disposal area.

**BEYOND THE MINES: RESIDUE DISPOSAL AREAS – DUST AND REMEDIATION**

**FINDING:** Some remediation has been attempted but there are still considerable dust impacts from mud lakes and dry stacks which require management oversight from the companies. It does not appear that the desired end state of remediation has been defined.

The surface of “mud lakes” and “dry stacks” must be kept moist either by rainfall or sprinklers, otherwise surfaces dry out and Jamaica’s fine bauxite dust becomes airborne. The 2008 global recession resulted in reduced management and oversight by bauxite companies in Jamaica, and these residue disposal areas became dust bowls, impacting nearby communities.
The long-term solution is establishing permanent vegetation cover on all bauxite residue disposal areas (BRDAs) and vegetation remediation efforts have been underway since the mid-1990s on a small subset of the old residue storage ponds near Kirkvine in Manchester and more recently, at the Mount Rosser “mud lake” near Ewarton. This “lake” was created through the damming of a valley in 1959 and has been undergoing drainage and remediation under a closure process guided by Natural Resources Conservation Authority (NRCA) (Wastewater and Sludge) Regulations, 2013. These regulations, which identify red mud as “industrial sludge,” govern the removal of infrastructure and contamination but do not define any end state criteria.

Defining an end state is critical. A 2005 vegetation assessment for the Kirkvine Pond #6 which was planted with five species, has been described as comparable to a dry limestone forest in Jamaica. Even while species diversity was poor, the centre of the pond had open patches of ground, and most species occurred at the edges of the pond where soil types were different, suggesting that re-vegetation was creeping in from the peripheral forest found naturally on the adjacent hillside. Maximum root depth of trees halted at 1.4 metres below the surface, which reveals the importance of reconstructing soils post-mining to a depth greater than 15 centimetres if trees are to be the desired end-state, while also indicating that the functional hydrology of the Kirkvine rehabilitation effort remained compromised.

The potential for bioaccumulation of toxic elements, especially heavy metals, should also be given attention for ensuring the long-term safety of environmental and public health.

**INFORMATION ON COMMUNITY WATER SUPPLIES, LEVEL AND QUALITY**

**FINDING:** The only easily accessible online data on water quality is 20 years out of date. Real time data on aquifer water quality have never been easily available to the public. Data on ground water levels are easily accessible up to the end of 2019.

In 1994, the JBI was delegated responsibility by the NRCA to monitor water quality in collaboration with the Underground Water Authority, the precursor to the current Water Resources Authority (WRA). Although the JBI’s website confirms that it is engaged in water quality monitoring, no monitoring data, quarterly summary statistics, or annual quantitative reports on water quality parameters could be located on the JBI’s website. Submitting ATI requests to the JBI for monitoring data was beyond the scope of the study.

WRA’s online Ground Water Information System (GWIS) includes a comprehensive database of the >1000 wells drilled in Jamaica, and the WRA has claimed to provide online data on quality and quantity of surface and underground water for the public. According to the
GWIS, of the 150 wells owned by bauxite companies, only 19 have been monitored for water quality for at least one year, and all 19 are associated with the Nain plant in St Elizabeth. Water quality data for 18 of these 19 wells end on 31 December 1999. Similarly, of the more than 70 wells owned by the GOJ which are within 15 kilometres of the “down aquifer” flow of the alumina factories, only six had water quality reports available on the GWIS database. Five of the six are associated with Nain, while the sixth well would have been affected by the now-derelict Revere facility. The Nain wells are part of the set of Pepper wells which provide water for Mandeville, the capital of Manchester Parish.

Ground water levels, in contrast, are much more consistently reported. The GWIS online database has data through 2019 for ground water levels of 43 company-owned wells.

A LEGACY OF DAMAGE AND SUSTAINED ABUSE OF THE LAND

FINDING: Jamaica’s Charter of Fundamental Rights and Freedoms guarantees all its citizens “...the right to enjoy a healthy and productive environment free from the threat of injury or damage from environmental abuse and degradation of the ecological heritage.” Since bauxite mining began in Jamaica long before there were regulatory requirements for descriptions of environmental conditions prior to mining leases being issued, the true and complete extent to which Jamaica’s ecological heritage has been damaged can never be fully known. The absence of data, of course, does not mean that irreversible damage has not occurred, and mining industry stakeholders acknowledge there is a legacy of damage and sustained abuse, from the nearly one-quarter mined-out ore bodies which have yet to be reclaimed, to inadequate storage of bauxite residue.

FINDING: Until bauxite mining in Jamaica is evaluated within a holistic framework of karst characteristics and processes – the distributions and functions of soils, the surface and subsurface movements of water, the adaptations of plants and animals to karst geology and hydrology – the distributions and functions of soils, the surface and subsurface movements of water, and the ecosystem services of karst landscapes, such as Cockpit Country, will never be effectively protected from mining impacts.
Chapter 6: The Social Costs of Bauxite-Alumina Production in Jamaica

ERNIE NIEMI

OVERVIEW

The bauxite-alumina industry generates important economic benefits for Jamaica: industrial products exported to the global economy, jobs for workers, sales and income for local vendors, and revenue for the government. The industry’s contribution to Gross Domestic Product (GDP), a common measure of the cumulative benefits, is about USD1 billion per annum. The industry also potentially imposes many social costs (or externalities) on Jamaicans. Chapter 6 provides an overview of these costs, but there was insufficient data to quantify them except for two types – increases in human illnesses and premature deaths from specific air pollutants, and intensification of the climate crisis from emissions of carbon dioxide. These two costs alone total USD4.7 billion–USD19 billion per annum.

WHAT ARE SOCIAL COSTS AND HOW ARE THEY MEASURED?

Social costs are also called externalities. These are costs which are not borne by the industry’s owners but instead by the society at large, as well as future generations.

Examples of social costs are loss of life or illness due to pollution, reduction in quality of community life caused by displacement of families or entire communities, and degradation of natural or cultural resources. There are also increased risks posed by accidents, spills, or failure of dams/mud lakes.

Economists assess social costs in one of two ways: (a) measuring Willingness to Pay (WTP), which investigates how much a person would pay to eliminate harm from an industry, or (b) measuring Willingness to Accept (WTA), which looks at how much compensation individuals want from an industry if the harm is to continue.

THE BAUXITE-ALUMINA INDUSTRY GENERATES IMPORTANT ECONOMIC BENEFITS FOR JAMAICA: INDUSTRIAL PRODUCTS EXPORTED TO THE GLOBAL ECONOMY, JOBS FOR WORKERS, SALES AND INCOME FOR LOCAL VENDORS, AND REVENUE FOR THE GOVERNMENT.
SOCIAL COSTS IMPOSED BY THE BAXITE-ALUMINA INDUSTRY ON JAMAICANS

**FINDING:** The considerable social costs imposed by the industry have not been fully described or quantified.

Chapter 6 presents a partial list of the many ways in which the bauxite-alumina industry imposes social costs on Jamaicans because of its activities. These include:

- Displacement of families and communities, which causes breakdown of community life, loss of livelihoods, reduction in subsistence food, and loss of asset value (home, land).
- Noise and light pollution, which reduces quality of life through loss of sleep.
- Transportation along haul roads causing dust, resulting in public health impacts, and damage to water catchments, crops, and property.

See Table 10 on pages 202–210 of the main document for the full list.

QUANTIFYING THE SOCIAL COSTS

**FINDING:** Jamaica has not developed a comprehensive estimate of the social costs of the bauxite-alumina industry, but some global information is available.

Some social costs are more easily measured than others. For example, increased health care costs due to illness caused by an industry can be counted. Many social costs, however, are more difficult to measure, because they are not traded in markets and have no price. These include the pain and suffering that people endure when they are made ill by air pollution, as well as reductions in well-being that result from degradation to the environment.

ILLUSTRATION OF THE SOCIAL COSTS OF COAL MINING IN CESAR, COLOMBIA

**FINDING:** The costs of mining and producing coal in Colombia in 2012 exceeded the benefits.

Researchers recently developed sufficient data to estimate many (but not all) of the social costs imposed on the local community and the nation by coal mining in Cesar, Colombia in 2012 (See Table 11 for details). Overall, the estimates of social costs on Colombians are USD110.10–161.01 per tonne of coal mined and exported. The market price per tonne of coal
in 2012 fluctuated between USD90.3 and USD100.57 per tonne, so the costs of producing coal exceeded the benefits.

HUMAN HEALTH COSTS OF AIR POLLUTION IN JAMAICA

**FINDING:** Estimated health costs for Jamaica are USD2.9 billion–USD13 billion (three pollutants only).

Data from Jamaica and the USA provide initial estimates of the human-health-related social costs resulting from the bauxite-alumina industry’s air emissions. The Jamaican industry emits about 4,500 tons of PM$_{2.5}$ (Table 12), which was determined by adjusting data for the emissions of PM$_{10}$ (particulates, with diameter of less than 10 micrometres) and assuming that PM$_{2.5}$ constitutes two-thirds of PM$_{10}$ emissions. Data from the US show the social costs resulting from each ton of each pollutant emitted into the atmosphere, and these figures are used to estimate the social costs for emissions in Jamaica. The social cost for PM$_{2.5}$ emissions is USD120,000–USD750,000. The health-related social cost per ton yields the social cost per annum for each pollutant: USD540 million–USD3.4 billion for PM$_{2.5}$. New research has shown that these estimates for PM$_{2.5}$ are understated. Overall, the estimated social costs (mortality and morbidity) of the Jamaican bauxite-alumina industry’s emissions of three pollutants (PM$_{2.5}$, SO$_2$ and NO$_x$) are between USD2.9 billion and USD13 billion annually, not including PM$_{2.5}$ from dust on the haul roads.

VALUE OF ECOSYSTEM SERVICES

**FINDING:** Jamaica’s forests provide value of approximately USD52 million per annum.

Chapter 6 describes a range of ecosystem services, including provision of fresh water for crops, industry and domestic use; regulation of flooding; habitat for animals used as food for humans (such as fish); opportunities for recreation; carbon capture and storage; and many others.

Research conducted for the World Bank estimated the WTP value of four types of ecosystem services provided by Jamaica’s forests: recreation, habitat and species protection, non-wood forest products, and water. The estimates indicate that each year, these four ecosystem services have a value of about USD15.420 per hectare (2013 dollars), and this value, applied across all the country’s forests, totals about USD52 million (Table 14). These estimates indicate that the present value of these services would total about USD2,340 per hectare.
CLIMATE-RELATED SOCIAL COSTS

**Finding:** The social cost of carbon for the bauxite-alumina industry in Jamaica is between USD0.8 billion–USD6.5 billion.

In 2012, the bauxite-alumina industry emitted 1,791,827.91 tonnes of CO\(_2\) as it produced 9,372,801 tonnes of bauxite, or about one tonne of CO\(_2\) for every five tonnes of bauxite. In 2018, the industry produced 10,272,268 tonnes of bauxite, indicating that the industry’s CO\(_2\) emissions had risen to 1,963,780 tonnes.

Each tonne of CO\(_2\) emitted will intensify the damage from the climate crisis (global warming, ocean acidification, etc.) for decades. The social cost of carbon dioxide (SCCO\(_2\)), is expected to total USD 417 per tonne CO\(_2\) (tCO\(_2\)). Other estimates are up to eight times higher.

Combined, these numbers show that the social costs resulting from the CO\(_2\) emissions of the bauxite-alumina industry are at least USD0.8 billion–USD6.5 billion per annum from direct emissions from the burning of fossil fuels.

SOCIAL COSTS FROM DEGRADATION OF BIODIVERSITY

**Finding:** Greater benefits would be earned from protection or restoration of biodiversity than any activity which degrades it.

The Government of the United Kingdom (UK) recently assessed the economic costs resulting from actions that degrade biodiversity. The assessment concluded that actions that conserve or improve biodiversity have an average rate of return on investment of about 19 percent, whereas actions that degrade biodiversity or prevent its conservation have an average rate of return of about five percent.

CONCLUSION

**Finding:** The social costs of the bauxite-alumina industry far exceed its economic benefits to Jamaica. Using only two categories of social costs, the industry’s social costs exceed the economic benefits by at least USD2.7 billion–18 billion per annum.

The bauxite-alumina industry imposes social costs on Jamaicans in many ways. Currently available data support quantification of just two categories of social costs – human health costs and the social cost of carbon. The health cost represents those costs associated with
increases in human illness and premature death resulting from the industry’s emissions of harmful airborne pollutants: PM$_{2.5}$, SO$_2$, and NO$_x$. The human health costs resulting from the industry’s emissions of these three air pollutants are about USD2.9 billion–USD13 billion per annum.

The social costs resulting from the industry’s annual emissions of carbon dioxide are about USD0.8 billion–USD6.5 billion.

Combined, these two categories of social costs total about USD4.7 billion–USD19 billion per annum. The actual total social costs from the industry’s operations are much larger, insofar as currently available data are not sufficient to support quantification of several categories of costs.

The contribution of the bauxite-alumina industry to Jamaica’s GDP is about USD1 billion per annum, estimated at 5 percent of GDP of USD27 billion in 2018.