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Can Extractive Industries Promote Sustainable Development? A Net Benefits Framework and a Case Study of the Marlin Mine in Guatemala

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Abstract

This article develops a framework to evaluate net benefits from mining and utilizes it to assess the Marlin mine in Guatemala. The framework integrates "weak" and "strong" sustainability principles. Under weak sustainability, a net gain in human welfare can substitute for the loss of nonrenewable resources. Under strong sustainability, nature's life-support systems are not substitutable. We define "net benefits" as the joint generation of net gains to human welfare, defined as local acceptance and high economic benefits, and low risks to the resilience of environmental life-support systems, especially water, evidenced by best practice management standards. We find little evidence that the Marlin mine meets either weak or strong sustainability criteria: there is strong local resistance to the mine and economic benefits are low, while environmental risk is high, especially in terms of potential long-term contamination of life-supporting ground and surface water.

Keywords

sustainable development, extractive industries, Guatemala, Marlin mine, mining and development

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Introduction

Extractive industries have boomed in the last decade, spurred by a cyclical rise in commodity prices. Developing countries throughout Africa, Asia, and Central and South America have been flooded by a wave of foreign investment in mines deemed marginal when prices were low.

The commodities boom has sparked new waves of political resistance, economic nationalism, global norm-building, and scholarship, all focused in one way or another on the relationship between mining and development. Given high environmental and human rights impacts, the central question is whether and under what circumstances large-scale mining projects can promote development.

This article probes the relationship between extractive industries and sustainable development. Part II develops an analytical framework which defines sustainable development in mining as the generation of "net benefits," a composite of high net human welfare gains and low risk to environmental life-support systems. Parts III to V apply the framework to assess the net benefits of the Marlin gold and silver mine in Guatemala. Part III introduces the Marlin mine and examines the local resistance and social conflict it has engendered. Part IV assesses the economic benefits generated by the mine. Part V evaluates environmental risk. Part VI presents findings and conclusions.

Marlin offers an insightful case study on several counts. Although it has generated intense local resistance and international condemnation on human rights grounds, the owner and operator of the mine, the Canadian multinational Goldcorp, has positioned itself as a "responsible mining" company. Moreover, as a condition of a US$45 million project loan from the International Finance Corporation (IFC), Goldcorp was required to produce and make public Environmental and Social Annual Monitoring Reports (AMRs).[1] These reports, along with a Human Rights Assessment (HRA) commissioned by Goldcorp in response to a request by shareholders, provide rare access to project level data and form the foundation for our analysis of the mine's economic benefits (On Common Ground, 2010). We also conducted a wide-ranging literature review, including IFC, government, scientific, academic, and NGO documents; and we conducted informal interviews with a variety of stakeholders, including Goldcorp, the government of Guatemala, and NGOs and local government officials in cities and towns near the mine, including San Marcos, San Miguel Ixtahuacan, and Sipicapa in July, 2010.

A Net Benefits Framework

Based on nonrenewable resources, extractive industries are inherently unsustainable economic activities. A "strong sustainability" principle, which requires that current human activities do not eliminate future options, would rule out mining as a sustainable development strategy. The "weak sustainability" principle, however, posits that different forms of capital—natural, human, social, productive—are substitutable. Extending neoclassical economic growth theory, the weak sustainability paradigm considers natural resources, both renewable and nonrenewable, as a factor of

production (Dasgupta & Heal, 1974; Solow, 1974). Rational utilization of exhaustible resources entails optimizing the trade-off between current consumption and investment in produced capital for future consumption (Hartwick, 1977). One formulation is the Hotelling's rule, namely, for a given stock of a nonrenewable resource, rents must rise at a rate equal to the interest rate (Blignaut & Hassan, 2001).

Extending the paradigm further, economic activities can be considered "sustainable" if the overall stock of capital is at least not diminished and preferably augmented. Accordingly, mining can be considered to promote sustainable development if "it gives rise to long-term benefits (environmental, social, and/or economic) that equal or exceed the values that existed prior to exploitation" (Amezaga et al., 2011, p. 21).

Many environmental economists, however, argue that natural capital is not substitutable, requiring that a "strong sustainability" principle be employed to manage its use today and in the future. Following Ekins et al. (2003) and Pearce and Turner (1990), Neumayer (2010) differentiates the degree of substitutability according to four functions of natural capital. The most opportunity for substitution derives from the "provisioning" function of natural capital—raw materials, including minerals. On the other side of the spectrum, "life-support functions" on which human (and nonhuman) life depend—such as water, air, global climate regulation—are "almost certainly impossible to substitute" (Neumayer, 2007, p.619). Two other functions of natural capital—waste assimilation and amenity services—may be somewhat substitutable.

Integrating the weak and strong sustainability principles, we conceptualize sustainable development in mining as a linear maximization problem, that is, maximizing human welfare gains subject to a natural capital constraint. We define "net benefits" as the creation of net social and economic gains in human welfare while maintaining the resilience of essential natural life-support systems. Moreover, given that environmental risks and social costs are borne by local communities, we define "net benefits" as the provision of welfare gains to local communities.

The concept of "human welfare gains" can be assessed largely using a cost–benefit analysis (CBA), though it encompasses a wide variety of potential social, economic, and cultural benefits (or costs). Many studies have drawn on cost–benefit methodology to define and measure a complete set of social, economic, and environmental "sustainability indicators," including those specific to the mining and minerals industry (Azapagic, 2004; Kumah, 2006; Laurance, 2011; Withmore, 2006; Worrall, Neil, Brereton, & Mulligan, 2009).

We focus our analysis on four indicators that are central to assessing whether a mining project is likely to deliver net economic benefits to local communities over the operating and postclosure life of a mine.

First and foremost, is evidence of "free, prior, and informed consent," that is, that local communities have been informed of benefits, costs, and risks and have demonstrated acceptance of the mine. A "willingness to accept" suggests that local communities have evaluated complex economic, social, and cultural trade-offs and have themselves determined that the mine will bring net welfare gains. The demonstration of a "willingness to accept" is especially important when there is potential harm to a nonsubstitutable cultural value, such as the maintenance of an indigenous lifestyle and

identity.[2] Moreover, the rights of indigenous people to prior consultation and consent in enshrined in international law in ILO 169 and the UN Declaration of the Rights of Indigenous Peoples.[3]

The overarching aim of mining is to generate economic benefits. Sustainability requires that economic benefits are substantial enough to outweigh social, cultural, financial, and environmental costs and are productively invested to support livelihoods after the mine is closed.

Mines generate a wide range of social, health, and cultural impacts. We argue that three metrics should be considered in estimating economic benefits:

1) The share of total mine revenues and earnings captured by host governments and local communities as royalties and taxes, as well as voluntary social investment by the mining company;
2) The total cash injections into local communities during the operating life of the mine, including via direct and indirect wages and local procurement;
3) Investment in future productive capacities, including spillovers to other industries and public (and private) investment in physical or social infrastructure.

The natural capital constraint requires that the resilience of life-support systems be maintained over the operating and postclosure phases of a mine. In the mining context, the most vulnerable life-support system is surface and ground water (and air, if blasting is involved). Given uncertainty and lack of scientific knowledge, the appropriate measure is risk, which is a function of the quality of care reflected in management and oversight, and the adoption of a precautionary approach. We assess risk as a function of the robustness of company and government environmental management and oversight, especially of the water resources surrounding a mine. Robust management is evidenced by the adoption of best practice environmental and health standards in the design, construction, operation, and closure of the mine, as well as in transparency, stakeholder engagement, and third-party monitoring.

In the "net benefits" framework, four outcomes are possible from a mining project: net human welfare gains could be high or low, each coupled with high or low risk of damage to essential natural life-support systems (see Figure 1). For mining to generate net benefits and thus to promote sustainable development, net human welfare gains must be high while risk is low.

The Marlin Mine

The Marlin mine is located in the western indigenous highlands of Guatemala and straddles two Mayan municipalities: San Miguel Ixtahuacan (SMI), (37,000 inhabitants), and Sipacapa, (14,000 inhabitants, 2003 census).[4] The people in the small agricultural communities bordering the mine live literally on or near its edge—a primary school overlooks the mine's tailings pond.

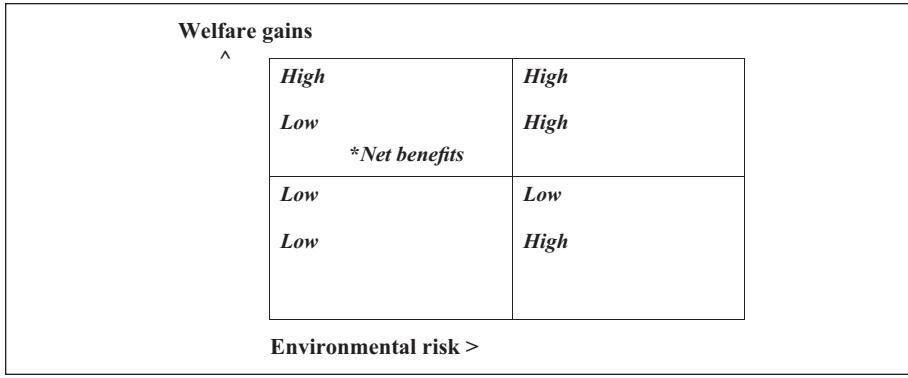

Figure 1. Net benefits framework.

Marlin is Guatemala's first major mining investment in 20 years and has been in operation since 2005.[5] The primary ore is gold, with silver produced as a by-product. The mine spans 5 sq km and includes two open pits, one underground tunnel mine, an ore processing facility using cyanide VAT-leaching techniques, a smelter, a tailings storage dam and pond, and a waste rock facility.

Guatemala's economy, workforce, and exports have traditionally been centered on agriculture and more recently, services. Mining contributes less than 1% to GDP and only about 4% of exports (CIEN, 2009). Agriculture contributes only about 14% of GDP but absorbs about half the labor force and accounts for three quarters of export earnings. However, the returns to agriculture dropped precipitously in the last decade, with value-added as a percentage of GDP falling from around 23% in 1998 to 12% in 2009 (Trading Economics).

Mining is attractive as an alternative to agriculture for several reasons. Over half of Guatemala's population lives in poverty and wages in mining are about three times higher than in agriculture. Most importantly, it provides a source of direct fiscal revenue to the state. At 13% of GDP, Guatemala's tax revenues are among the lowest in the world and fall significantly below the Latin American average of 17.4% (Organisation for Economic Co-operation and Development [OECD], 2009).[6]

Local Response to the Marlin Mine

The first condition for a net benefits assessment is credible evidence of local acceptance and support for the project. In the Marlin case, there is ample evidence of widespread local opposition to the mine.

The people in SMI and Sipicapa are poor: 97.5% live in poverty and 80% in absolute poverty (Van de Sandt, 2009). The major industry is subsistence farming, but peasants supplement earnings by seasonal labor in coastal sugar cane and coffee plantations. However, the major source of income is remittances from family members who have migrated to the United States (Van de Sandt, 2009).

As a condition of its loan, the IFC required Glamis and its wholly owned affiliate Montana Exploradora to hold consultations with local communities in SMI and Sipacapa. Some 3,000 people participated in a series of informational workshops, which the company interpreted as signaling a high level of popular endorsement. Many residents, however, had deep objections to the mine and perceived the workshops as informational rather than consultative. Tensions erupted in January 2005 when a group of mine protestors confronted trucks carrying equipment to the mine (Stevenson, 2005).

In March 2005, communities in Sipacapa filed a complaint with the IFC's Compliance Advisor Ombudsman (CAO) raising concerns that the Marlin mine would reduce access to and contaminate local water supplies. The complaint also alleged that the project was being developed without adequate consultation and that it exacerbated social tensions (CAO, 2005).

In June, 2005, Sipacapa held a *consulta*—a traditional plebescite—on the Marlin mine. In the presence of 75 national and international observers, 11 communities rejected mining, almost unanimously, while one supported it and one abstained. In total, 98.5% of some 2,400 people participating in the referendum voted no to mining activities in their territory (BIC, 2005).

The roots of local resistance are complex. The region experienced the most intense fighting during the civil war of the 1990s and indigenous peoples continue to be generally excluded not only from development planning but from government services. Like in other mining conflicts in Latin America, the Marlin megaproject is considered to undermine indigenous concepts of development—which, in the Mayan highlands, are based largely on agriculture—and to threaten indigenous territory and identity (Stetson, 2012). The greatest long-term risk, however, is the potential loss of access to water—the Marlin mine consumes about 2.2 billion L annually—and contamination of water needed for irrigation and animal husbandry (Goodland, 2012). Without water, Mayan communities cannot live in the highlands and retain their Mayan identity.

A Guatemalan court judged the Sipacapa referendum to be legal but not binding. Guatemala is a signatory to ILO 169 which binds governments to seek "free, prior, and informed consent" of indigenous peoples ahead of any development projects which affect them. However, Guatemala has not enacted domestic laws or adjudicative processes to implement the obligation.

The *consulta* fuelled local opposition and ignited international attention.[7] The Catholic Church in nearby San Marcos launched an information campaign and began monitoring waters near the mine. Indigenous groups allied with NGOs in Guatemala City, Canada, and the United States and reached out to international organizations. Pressed by shareholders, Goldcorp commissioned an independent HRA which identified seven areas of concern: social conflict, consultation, environment, land acquisition, economic and social investment, security, and access to remedy (On Common Ground, 2010).[8]

In its assessment of the Sipacapa complaint, the CAO found significant gaps in the IFC's own Environmental and Social Impact Assessment (ESIA) of the Marlin project. The most telling was the failure of the IFC to undertake "a thorough consideration of

the governance and country context and *the balance of risks and benefits* accruing as a result of this investment" (On Common Ground, 2010, p. 39, emphasis added).

Economic Benefits of the Marlin Mine

The capture of economic benefits is the overarching rationale for a mining project. This section first examines the total flow of mine revenues and earnings, that is, mine productivity and then assesses: (a) the share of total mine revenues and earnings flowing to Guatemala and to local communities as direct benefits—royalties and taxes, as well as company social investment; (b) the total cash injections from the mine as wages, local procurement, indirect jobs, and induced income; and (c) investment in sustainable, postmine productive capacities including spillovers to other industries.

Mine Revenues and Earnings

Gold mining became a highly lucrative business in the last half decade. Between 2006 and 2011, the market price of gold rose by more than 150%, hitting a high of about US$1900 in November, 2011 (GoldPrice). Silver prices have also risen from US$10 per ounce in mid-2006 to a high of over US$48 per ounce in early 2011. The high price has produced a bonanza for gold companies, including Goldcorp, and their shareholders. Between 2000 and 2010, the value of Goldcorp stock increased by over 1,400%, more than doubling the performance of other senior gold producers and tripling the increase in the price of gold and silver (Goldcorp Annual Report, 2010). By January, 2010, Goldcorp was the world's second biggest gold producer by market capitalization (Goldval, n.d.).

Goldcorp's business strategy is based on positioning itself in North America and owes its strong financial performance to its low costs of production, some 40% below the industry average (Stanley, 2011). The Marlin mine has the lowest production costs of all Goldcorp operations sites. At US$192 per ounce in 2009, cash costs of production at the Marlin mine were 35% below Goldcorp's average of US$295 per ounce. In 2010, due to the escalating market price of silver as a residual product, production costs at Marlin were a negative US$19 per ounce (Goldcorp Annual Report 2010).

Buoyed by low costs of production and a high gold price, Marlin has had a strong financial performance. Between 2006 and 2010, earnings grew rapidly and totaled over US$594 million on revenues of US$1.3 billion (Table 1). Contributing 14.2% of Goldcorp's total earnings, the Marlin operation is the company's third highest earner.

Guatemala's Share of Marlin Revenues and Earnings. A host country's share in a mining project is derived from direct benefits, that is, royalties and taxes paid by the company to the national treasury, as well as company social investment in development projects; and indirect benefits derived from company spending on wages and procurement and their multiplier effects.

Table 1. Marlin Revenues and Earnings, 2006-2010 (US$ millions).

	Revenues	Earnings
2006	32.3	16.0
2007	203.7	72.8
2008	258.1	100.0
2009	331.8	136.9
2010	500.6	268.6
Total	1,326.5	594.3

Source: Goldcorp Annual Reports, multiple years.

Royalties and Taxes

Royalties are payments made to governments to compensate for the loss of a nonrenewable resource. They also compensate for the legacy of contamination left by mining activity that must be managed indefinitely (Kuyek, 2008). Most countries, including Guatemala, assess royalties as a percentage of the total gross sale value of processed ore. As commodity prices continued to rise, many mineral-rich countries raised royalty and tax rates through legislation or contract renegotiation.[9] Guatemala, however, has remained an outlier in the trend toward "resource nationalism" (Financial Times, 2011), and royalties still fixed at 1%—with municipalities receiving half of that amount. Together, royalties and taxes paid to the Guatemalan treasury from the Marlin mine between 2006 and 2009 amounted to US$51.9 million—accounting for 6.3% of mine revenues and 15.9% of total mine earnings. Local communities received just under US$4.5 million, one half of 1% of mine revenues and 1.3% of mine earnings (Table 2).

In addition to royalties, mining companies pay host governments a wide array of taxes, including corporate, remittance, and specific mining taxes. Goldcorp's initial tax rate on earnings was 9.3% in 2006 but increased to an average of 12.8% between 2007 and 2009. The company paid a total of US$42.9 million in corporate income tax between 2006 and 2009, making Marlin the largest single taxpayer in Guatemala[10] (Table 2; On Common Ground, 2010).

Social Investment

Social investments are philanthropic company contributions to community welfare and development. As a condition of IFC project finance, Glamis prepared an Indigenous Peoples Development Plan (IPDP) which outlined plans to share the economic benefits of the mine though local hiring; local capacity building, and infrastructure improvements; projects to promote local sustainable development; and reforestation and sustainable forestry (IFC, 2004).

Goldcorp implements the IPDP by channeling funds to a local NGO that it created, as well as directly financing primary school teacher salaries and other projects.

Table 2. Royalties and Taxes From the Marlin Mine, 2006-2009.

	2006	2007	2008	2009	Total	Local share
Royalties (US$ millions)	1.3	1.9	2.5	3.3	9.0	4.5
Corporate income taxes (US$ millions)	3.4	9.5	12.5	17.5	42.9	
Total royalties and taxes (US$ millions)	4.7	11.4	15.0	20.8	51.9	4.5
Total royalties and taxes as % of mine revenues	14.6%	5.6%	5.8%	6.3%	6.3%	0.5%
Total royalties and taxes as % of mine earnings	29.3%	15.7%	15.0%	16.4%	15.9%	1.4%

Source: Goldcorp Annual Reports, multiple years: Goldcorp Annual Monitoring Reports. Multiple years.

According to the AMRs, Goldcorp contributed about US$1 million per year to social investment projects between 2006 and 2009 focused on health, education, women's business, and microlending. The company has also built a health clinic in the town of San Miguel Ixtuahacan. However, according to a HRA commissioned by Goldcorp, the company does not rigorously account for the level or scope of its projects, precluding an evaluation of their development impacts (On Common Ground, 2010).[11]

Wages and Procurement. An important source of income generated by mining operations, especially for local communities, is employment. The Marlin mine generates about 1900 jobs, about 60% of which were held by local community members in 2009. Some proportion—about 30% in 2009—are part-time "rotational" workers. The total payroll in 2009 came to US$22.4 million, of which US$10.4 million was spent locally.

Neither the government nor the company publishes information about job descriptions, wage scales, or job ladders. In our field research, interviewees said that workers hired as gardeners on a 15-day contract basis are paid at a rate of 1,500 quetzales (US$192) per month; permanent gardeners at 2,200 quetzales (US$282) per month; and mine workers involved in tunneling and processing, who tend to not live in SMI or Sipacapa, at 3,500 quetzales (US$449) per month.[12]

National and local procurement by mining companies of materials, equipment and supplies can be a potent way to inject income into local businesses and households, in effect sharing the revenues from mining operations. Procurement also generates indirect jobs, that is, jobs created by local suppliers, which generate further income through "demand linkages" or wage multiplier effects. Most important, local procurement builds linkages to and strengthens local economic sectors, promoting sustainable development. Without local supply linkages, foreign direct investment, including in extractive industries, creates enclave economies (Gallagher & Zarsky, 2007).

According to the AMRs, Goldcorp purchases about 70% of its requisite materials, equipment and supplies for the Marlin mine within Guatemala. However, the company provides no detailed information and reports only aggregate figures (US$86 million in

2009 and US$150 million in 2011 (AMR, 2009; Goldcorp, 2011).[13] While national procurement spending is apparently substantial, local procurement for the Marlin mine was only US$6.5 million in 2009 (5% of total) (AMR, 2009). Data is missing but the most likely purchases are for food-related goods and services.

Indirect Jobs and Induced Benefits

Procurement spending on goods and services produced in-country stimulates business demand, creating indirect jobs in the businesses that supply the mine. Spending of wages by workers, both direct and indirect, inducing further job creation and income through "demand linkages."

Estimating the indirect jobs and induced benefits of the Marlin mine is hampered by lack of data. Without specifying its methodology, one study estimates that the Guatemalan mining sector generates six indirect jobs for every (presumably full-time) direct job. Under this assumption, the Marlin mine would have generated 11,430 indirect jobs in 2009. Assuming a monthly average manufacturing wage of 2737 quetzales (US$361), each indirect job would have generated an annual income of US$4328 and a total wage injection into the Guatemalan economy of some US$49.5 million—more than double direct wages.

No studies have estimated an induced income multiplier for either the highlands or the urban areas of Guatemala. Studies in other mining regions such as Region II in Chile (the country's largest copper-mining area) and Western Australia have found great variability in income multipliers. In Western Australia, reflecting a highly diversified local industrial structure, one study found an income multiplier of 3.0 in 1995 (Clements & Ye, 1995). In Chile's Region II, the country's largest copper mining area, Aroca (2000) estimated "open" and "closed" system output multipliers of 1.28 and 1.80 respectively in 1999. The "open" system multiplier does not include induced household spending, effectively assuming that wage income is spent outside the region, while the "closed" system multiplier does include it and assumes that all income is spent on goods and services produced within the region.

As a crude estimate, we took the average of the two Chilean Region II output multipliers (1.54) and applied it to direct and indirect wage income from the Marlin mine. In 2009, total wage income totaled US$71.9 million. An induced wage income multiplier of 1.54 would mean that Marlin mine direct and indirect wages induced additional economic activity in Guatemala worth about US$141.7 million.

These estimates suggest that the indirect benefits of the Marlin mine, in the form of indirect jobs and induced wage spending, might significantly outweigh the direct benefits. However, a few caveats are in order.

First, the employment multiplier of 6:1 needs to be verified and checked against the details of Goldcorp's procurement spending. Imported goods and services purchased from local retail agents will not generate as many indirect jobs in Guatemala. Second, the induced spending output multiplier in Chile is likely much higher than in Guatemala due to Chile's more developed domestic industry structure, proactive industry policies, and more accountable government. Third, the long-term impact of greater output

and spending induced by mining depends on how income is spent. If there is no investment in building the skills, infrastructure, and technological capacities needed for sustainable, competitive industries, the "income bubble" will burst when the mine closes and the economy will shrink.

Given lack of data about Goldcorp's procurement spending in Guatemala, there is very weak evidence that the mine generates a substantial number of indirect jobs.

Spillovers and Productive Investment. The potential benefits of mining for sustainable development stem from knowledge and technology spillovers to other enterprises and industries from mining operations; and the investment of mine-generated revenues in building long-term productive capacities.

There is little evidence of potential local or national spillovers created by the Marlin mine. There is no public information about job descriptions or requisite skills at the mine, though skills are evident in operating heavy machinery that may be applicable to other industries. Goldcorp's worker training targets skills specific to mining and even more narrowly to gold mining. Information about how mine wage income is spent is also lacking. Wages can pump demand for locally produced goods and services, stimulating enterprise growth. At the national level, further study is needed to determine whether spillovers have been captured through procurement of mine supplies.

There is little evidence that national and local governments have allocated royalties and taxes to productive investment. Accountability and transparency are lacking more generally: national and municipal governments either do not keep or do not make public accounts of total mine-related royalties and taxes received or how the revenues are spent.[14] In 2010, Guatemala ranked in the bottom third of 178 countries on Transparency International's Corruption Perception Index (Transparency International, 2010).

Guatemala has a poor record of investment in social and economic development.[15] Our field research found that an unknown portion of the royalties received by the municipality of SMI had been spent on paving mountain roads. While welcomed as an improvement over muddy roads, especially in wet weather, local community members pointed out that the roads primarily serve the trucks coming and going from the Marlin mine. Moreover, they suspect that some of the royalties are used to support housing construction and other consumption by local officials, or perhaps are channeled into election campaigns.

The lack of accountability for mine revenues, coupled with available macroeconomic data and field observations, suggests that national or municipal governments have applied little if any of the economic benefits of the Marlin mine toward productive investment in building sustainable industries that could generate income after mine closure. Goldcorp's social investment projects, including the schools and health clinic, will either shut down with the mine or be government-supported.

Environmental Risk of the Marlin Mine

The central question in assessing the environmental risk of a particular mine is whether company management and governmental oversight are sufficiently rigorous

and robust to minimize risk to mine workers and local communities in both the operating and postclosure phases of the mine. According to the "net benefits" framework, some environmental damage could be traded off for economic and social benefits, but the resilience of basic life-support systems—surface and ground water capable of sustaining life and the agricultural lifestyle essential to a Mayan identity—must be maintained.

The greatest risks to water at the Marlin mine stem from exposure to cyanide and acid mine drainage from heavy metals. Since it is relatively short-lived, cyanide poses environmental and health risks primarily in the operating phase of the mine. However, cyanide liberates heavy metals from gold-bearing rocks. Acid mine drainage can persist and even worsen in the postclosure phase, especially in the context of projected climate change. Heavy metals found in Marlin mine ore include arsenic, mercury, and lead (Intrinsik, 2010).

Rich veins of ore in which gold can be extracted in solid chunks have been exhausted. Today, gold is found primarily in low concentrations of less than 10 g per ton. To get the gold requires clearing vegetation and topsoil from large swaths of land; blasting large open-pit mines and underground tunnels and hauling the waste rock into large nearby mounds or valleys; excavating large amounts of ore and pulverizing it into a fine powder; treating the ore with a mix of water, lime, and sodium cyanide; leaching the pregnant solution to separate the gold and sending it to a refining smelter, on- or off-site; and channeling the leftover tailings slurry to storage in a pond or "impoundment."

Cyanide is acutely toxic to humans and wildlife. Unlike heavy metals, cyanide is not bioaccumulative: small concentrations occur naturally in the human body and are removed by the liver. In the environment, cyanide degrades easily into nontoxic substances and is quickly dispersed. Mine workers are the most vulnerable to cyanide inhalation and skin contact during the heap leaching or tank extraction process. Risks to surrounding communities stem from the transport of cyanide to the mine, and the potential for leaching of sodium cyanide-rich pond tailings into ground and surface waters, either incrementally or in a catastrophic spill.[16]The process of toxic releases from acid mine drainage is extremely long-lived, perhaps irreversible from a practical point of view (Earthworks & Oxfam, 2004).

Contamination of surface and ground water with heavy metals is especially risky in poor areas where water-supply infrastructure is lacking. In the area surrounding the Marlin mine, about 47% of households near the mine have no access to piped water and depend on ground and river water for drinking, as well as crop irrigation and watering livestock.

Climate change will exacerbate existing risks and create new risks to mining operations. Among the projected impacts of climate change are greater intensity and/or frequency of storms, with associated flooding; and changes in water hydrology. The greatest risk posed by climate change to local communities is heavy metals (and cyanide) contamination stemming from the overtopping of tailings ponds and/or changes in interaction of ground and surface water with waste rock (Locke et al., 2011).

Government Oversight of Marlin

The Marlin mine is a large-scale operation. When the IFC approved it, the mine was estimated to produce 2.5 million ounces of gold and 36 million ounces of silver over a lifetime of 10 years. It was also estimated to generate some 38 million tons of waste rock and 23 to 27 million tons of tailings over 10 to 13 years (CAO, 2005; Moran, 2004). The processing mill is designed to treat a minimum of 1.82 million metric tons of ore per year (Howell & Christophersen, 2009).

The government of Guatemala holds primary responsibility for the regulation and oversight of the Marlin mine. In practice, environmental assessment, standards, and monitoring have been inadequate or nonexistent. Labor standards generally suffer from lack of enforcement in Guatemala, leaving mine workers virtually unprotected from occupational hazards, including cyanide.

At the outset, the Marlin mine project was approved by both the Guatemalan government and the IFC despite the lack of adequate environmental oversight. In its 2005 response to the complaint by residents of Sipacapa, the IFC's CAO found that improvement was needed in "the capacity of Guatemalan government agencies to effectively regulate the Marlin project and other projects in the mining sector." Of greatest concern was the failure of the government to establish "a clear and comprehensive system for regulating the Marlin site that includes water quality standards and government monitoring of adherence to regulations and standards" (CAO, 2005, p. 39).

In 2010, the U.S.-based consulting firm E-Tech International produced a comprehensive evaluation of predicted and actual water quality around the mine. The report found that the ESIA "provided limited information on the baseline environmental setting in and around the Marlin Mine" and should have included more information about "water quality, water quantity and levels, and the abundance and health of aquatic biota" (E-Tech International, 2010, p. 5). The review also found that the ESIA provided no evidence to support its claim that the "acid generation and contaminant leaching potential of the rocks are low" and suggested that "more extensive geochemical testing should have been conducted before mining began" (E-Tech International, 2010, p. 6).

In addition to failing to adequately assess environmental impact at the outset, the government failed to provide adequate avenues for meaningful public disclosure and consultation. The highly technical ESIA was produced in Spanish only, even though local communities speak Mayan languages, and was available for comment for only one week. "Public disclosures," concluded the CAO, "did not at the time have sufficient information to allow for an informed view of the likely adverse impacts of the project" (CAO, 2005, p. ii).

Guatemala's environmental oversight has improved since the Marlin mine was approved, most importantly because the Ministry of Environment and Natural Resources (MARN) has set standards for water quality. However, enforcement is still lagging due to MARN's failure to regularly undertake independent water quality monitoring. In response to the IACHR order to suspend mine operations, the government conducted an administrative review and submitted an assessment—based on

information provided by Goldcorp—that found no negative impacts on water quality or health risks.

In its assessment, the government ignored four independent studies that found evidence that cyanide and/or heavy metals may be seeping into the ground and surface waters surrounding the Marlin mine. One study found arsenic concentrations in surface water 2.7 times in excess of U.S. drinking water standards (COPAE, 2009). Another found that the mine is drawing arsenic-rich groundwater to the surface (Van de Wauw et al., 2010).[17]

In December, 2011, in the face of pressure from the Guatemalan government, the IACHR lifted the suspension order finding no imminent cause of harm. However, it ordered the government to "implement effective measures to prevent environmental pollution" and ensure that local people have access to water fit for human consumption and agriculture (Kosich, 2011).

The Marlin mine was approved on the basis of predictions in the ESIA that the mine would have no moderately negative impacts on water resources or aquatic life. Six years later, E-Tech International's detailed technical report concluded that "adverse effects to the environment may have already begun as a result of mining operations at the Marlin Mine" (E-Tech, 2010, p. 6).

The risk of heavy metals contamination from acid mine drainage (AMD) is likely to increase in the future. E-Tech found that "nearly half of the waste rock is potentially acid generating, and an additional 25% to 35% has uncertain acid-generation potential. Wastes with higher acid-generation potential will release higher concentrations of metals and pose a greater risk to water resources" (E-Tech, 2010, p. 7). The routes by which heavy metals may leach, leek or seep from the waste rock have not been thoroughly studied. Furthermore, as noted above, these routes are subject to change with hydrological impacts of projected global climate change.

Company Environmental Management

Goldcorp has positioned itself as a socially responsible mining company. It is a member of the International Council of Metals and Mining, a CEO-led organization that seeks to catalyze better social and environmental performance, and a supporter of the Extractive Industries Transparency Initiative.

Goldcorp enjoys a reputation for having environmental management systems and technologies that are "above average for its peer group" (Sustainanalytics, 2008). Goldcorp's record of environmental compliance, monitoring, and disclosure, however, has been found to be below par. In 2008, an advisor to the Jantzi Social Index recommended that Goldcorp be ineligible for "socially responsible investment" portfolios.[18]

The company's social responsibility strengths and weaknesses are evident in its environmental management of the Marlin mine. According to the environmental review undertaken for the HRA,"the Marlin mine operates to a good standard of practice within the mining industry worldwide with a few exceptions" (KP Consulting, 2010, p. 1). Marlin is certified to the International Cyanide Code and Goldcorp has undertaken a number of measures to reduce the risk of cyanide and heavy metals

contamination of surrounding waters and land (Goldcorp, 2009). The tailings and water coming out of the mill "are treated with an SO2 air cyanide removal technology prior to discharge to the mine's tailings impoundment" (Howell & Christophersen, 2009). Waste rock is stored so that water leakages can be diverted into the tailings pond (KP Consulting, 2010).

Nonetheless, there is cause for concern that there is seepage from the tailings pond, which is lined with compacted clay rather than a synthetic liner. In a comprehensive study, E-Tech International concluded that "Although water in the pond is continually pumped back to the tailings impoundment, it is unlikely that the pond captures all the seepage from the impoundment" (E-Tech International, 2010, p. 59).

A major concern that has not been addressed by Goldcorp is the capacity and stability of the tailings dam and pond. A November 2009 technical review found that "the Marlin tailings dam is approaching the end of its design life" and that "maximum capacity for [the mine's] crest height will be achieved by about mid 2011" (Robertson, 2009, p. 8). Pond waters that breach the dam will spill into surrounding waters. Robertson listed three options as being "under consideration": (a) raising the dam to add storage; (b) developing a second tailings impoundment east of the current dam; and (c) dewatering the existing tailings pond (Robertson, 2009).

In the short term, the company has apparently taken the option of dewatering by discharging water from the pond through the surrounding environment. In September 2010, the Minister of Environment accused Goldcorp of a secret nighttime discharge from the pond swollen due to heavy rains (IKN, 2010). Goldcorp claimed that it had notified MARN of the discharge. Goldcorp has since announced other discharges.

Another risk is that the tailings dam will be breached due to geologic instability, that is, earthquakes. According to a company geo-consultant, "Postclosure the Marlin tailings dam will continue to contain tailings that would liquefy under seismic loadings or a dam breach. It will therefore remain classified as a high hazard dam" (Robertson, 2009, p. 10).

In addition, it is not clear whether and how Goldcorp is managing the potential for overtopping the tailings impoundment due to extreme weather events such as floods and cyclones, especially in the context of climate change. The water treatment plant is designed to contain and control water in a "one in hundred year" rainfall event over 24 hr (KP Consulting, 2010). Guatemala is one of 10 countries most vulnerable to the effects of climate change and will become both drier and more vulnerable to extreme weather events such as "one hundred year storms" (ECLAC, 2010). The number of extreme weather events in Guatemala increased dramatically between 1970 and 1989 and 1990 and 2008: there were twice as many floods and the number of tropical storms and hurricanes rose from zero to seven (Figure 2).

In addition to concerns about the stability and adequacy of the tailings impoundment, Goldcorp's environmental management has been criticized in two other areas: water quality and quantity monitoring, and mine closure and postclosure planning and monitoring.

In 2005, Goldcorp established the Community Environmental Monitoring Association (AMAC) to undertake and audit water monitoring. Praised as an example

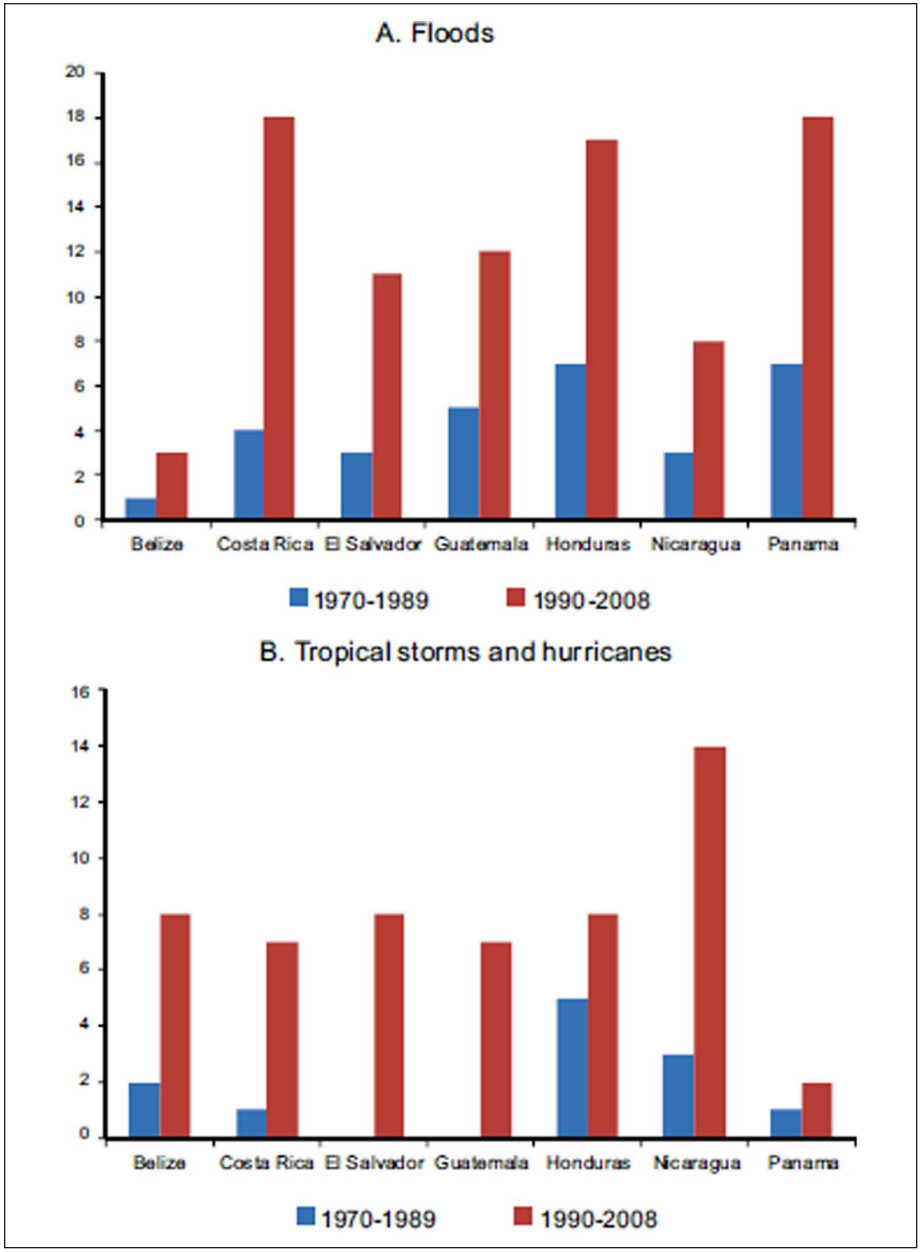

Figure 2. Central America: Main extreme weather events, 1970-2008 *(number of events recorded)*.
Source: Economic Commission for Latin America and the Caribbean (ECLAC), on the basis of Regional Disaster Information Center (CRID), 2010, Emergency Events Database (EM-DATA) [online] http://www.emdat.be/Database/terms.html.

of "industry good practice," the credibility of AMAC suffers from its dependence on Goldcorp for funding. The 2010 HRA found that "external auditing of the water monitoring program has not been implemented in accordance with international standards" (On Common Ground, 2010, p. 15). In its April 2011 response to the HRA, Goldcorp asserted a commitment to "aggressively support AMAC to become an independent and widely accepted independent community-based monitoring committee." However, Goldcorp remains the funder (Goldcorp, 2011b).

The HRA found plans for mine closure to be "the weakest aspect" of Goldcorp's management of the Marlin mine and "has the potential to leave the community vulnerable to long-term impacts on human rights" (On Common Ground, 2010, p. 82). The major defects of Goldcorp's closure plan are (KP Consulting, 2010):

- *Short closure period*: The closure period is 18 months, when a period of 2 to 3 years is standard practice.
- *No long-term monitoring and maintenance*: The time period for postclosure monitoring and management is very short when there should be "a provision for continued care and maintenance of the facilities for a very long time, often defined as 100+ years" (p. 13). Such activities include annual dam inspections, monitoring and treatment of impacted waters until they meet discharge criteria, monitoring and maintenance of tailings pond and waste rock piles, and so forth.
- *Low cost estimate*: The full estimated closure cost of US$13.6 million is very low. Besides the absence of long-term monitoring and maintenance costs, the costs of revegetation are low compared to norms.
- *No financial assurance*: The only resources available to close the mine in the event of failure for any reason is a US$1 million fund voluntarily established by Goldcorp.

Climate change will likely make the postclosure phase of the mine riskier than the operating phase for the local communities surrounding Marlin. The combination of increasing aridity and extreme weather events is likely to change local water hydrology in unanticipated ways, increasing the potential for more severe and widespread contamination from AMD. The western highlands of Guatemala are already at the highest level of risk in terms of three hazards: cyclone mortality, flood mortality, and economic loss from drought (Climate Change Team, 2011).

Climate risk is exacerbated by Guatemala's poor capacities for risk reduction and disaster management. In recent years, Guatemala has reduced the number of weather monitoring stations due to fiscal constraints and as of early 2011, only five remained (Climate Change Team, 2011). To date, there are no studies of the projected impacts of climate change on the environmental risk posed by the Marlin mine.

Conclusion

This article has explored the proposition that mining can be considered to promote sustainable development if it generates net benefits to host governments and local

communities over both the operating and postclosure phases of the mine. We developed a framework to conceptualize and assess net benefits based on the integration of weak and strong sustainability principles which suggests that social and economic benefits are maximized subject to the constraint that life-support systems be maintained. We applied the framework to the Marlin gold and silver mine in the highlands of Guatemala to assess whether the mine can be considered to generate net benefits.

We have two primary case study findings. First, on three counts, the available evidence suggests that the mine does not meet the weak sustainability criterion, that is, the social and economic benefits of the mine are low and unlikely to outweigh social and environmental costs. The first count is that a substantial portion—likely the majority—of local community members are strongly opposed to the Marlin mine, suggesting that local people have done their own "cost-benefit" assessment and concluded that the mine does not offer net gains despite jobs and company development projects. Indeed, the company's willingness to proceed with the mine despite the lack of free, prior and informed consent, and the government's failure to clarify and adjudicate the exercise of indigenous rights, cloud not only benefit assessment but the very legitimacy of the Marlin mine.

Our second source of evidence is that benefits are low: Guatemala is capturing a relatively small share of total mine revenues and earnings of the highly lucrative mine. Third, economic benefits will drop off sharply when the mine closes because jobs and procurement will end and there has been little investment in building sustained productive capacities.

Our second case study finding is that the Marlin mine is not likely to meet the strong sustainability criterion. The risk to the region's life-support water systems is not only high but likely to rise over the remaining operational and postclosure phases of the mine due to poor planning, the lack of transparent third-party water monitoring, and the absence of an adequate mine closure plan with sufficient financial resources to monitor and mitigate water contamination. Moreover, projected climate change will exacerbate the risk the mine poses to the region's water resources and to the Mayan communities who depend on them for livelihood and cultural sustenance.

The Marlin case demonstrates the strengths and weaknesses of cost–benefit analysis (CBA) and the "weak sustainability" principle as the sole or primary assessment and planning tool for mining policy, especially in areas impacting indigenous people. On the one hand, CBA is useful in assessing economic benefits, both in the operating and postclosure mine phases. If projected economic benefits are low, there is little point in going forward with the mine. If economic benefits are high, then social and environmental costs can be assessed and institutions developed to design acceptable trade-offs, including to local communities.

But CBA tools cannot be used to assess long-term risk to the resilience of life-support systems, that is, whether or not a mine meets the "strong sustainability" criterion. Needed are ecosystem resilience indices, especially for water, and risk assessment tools and risk reduction management strategies. Moreover, CBA tools cannot assess the "costs" of damage to indigenous (or other) culture. Needed is a subjective evaluation by impacted communities themselves.

The net benefits framework suggests that, to promote sustainable development, mining projects should have three characteristics: (a) acceptability to local communities; (b) substantial social and economic benefits; and (c) low risk to ecosystem resilience. As it is currently designed and managed, the evidence suggests that the Marlin mine fails on all three counts.

Authors' Note

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Notes

1. Until 2009, Goldcorp continued to produce the Annual Monitoring Reports (AMRs) even after it repaid the loan to the International Finance Corporation (IFC).
2. The "willingness to accept" can be measured by survey techniques that ask potential victims what level of compensation they would accept to endure negative impacts. It has been utilized to evaluate risk such as loss of recreational values or increased risk of death (Markyanda, 2001).
3. Arguably, the right to free, prior and informed consultation and consent for all local communities is also encapsulated in the UN "Protect, Respect, and Remedy" Framework for human rights.
4. The western highlands experienced some of the worst violence of Guatemala's 36-year civil war.
5. Many more mining sites are being explored: as of March 2009, the government had granted 395 mining licenses and 383 more were pending.
6. The Organisation for Economic Co-operation and Development (OECD) average is 35.6%.
7. Concerns about human rights and environmental risk culminated in June, 2010, when the Inter-American Commission on Human Rights of the Organization of American States (IACHR) issued precautionary measures, ordering the Guatemalan government to suspend mine operations based on evidence of health risks to local indigenous people (Mining Watch, 2010).
8. In March 2010, the International Labour Organisation (ILO) requested that the government of Guatemala suspend operations due to the lack of adequate consultation; and in June the UN Special Rapporteur on the Human Rights of Indigenous Peoples called on the Guatemalan government to adopt a law defining and assuring indigenous rights to consultation over mining and other resource development projects (TodaNoticia, 2010).

9. A number of African countries, including Zambia, Tanzania, South Africa, and the Democratic Republic of Congo initiated a process of contract renegotiation with mining companies based on amended mineral legislation that raised royalties and/or taxes, an effort that has garnered the support of the International Monetary Fund (IMF; China Mining, 2010; BIC, 2007). The Organisation for Economic Co-operation and Development (OECD) has called for radical tax reform in Africa, including taxing extractive industries more fairly and transparently (OECD et al., 2011). In October 2010, Chile's Congress approved a government proposal to raise royalties paid by mining companies from the current rate of 4% to 5% to as much as 14% (Economist, 2010b). In 2010, Panama increased its royalties from 2% to 4%, along with introducing changes in the Mining Resource Code (www.CentralAmericaDATA.com, July 7, 2010).
10. Guatemala also collects a value-added tax at 12% of gross company income. However, companies receive a refund based on the proportion of production that is exported. Since 100% of the gold (and silver) produced at the Marlin mine is exported, there is no net VAT payment.
11. In December 2011, Goldcorp released information stating that its social investment at the Marlin mine to date amounted to US$22.7 million, including US$15 million in over 150 development projects, US$5 million in reforestation, and US$2.7 million in a health clinic in SMI (Goldcorp, 2011a). The company did not release an itemized accounting. If accurate, social investment would dwarf the flow of royalties to local communities. Nonetheless, the local share would remain small at 2.4% of total mine revenues and 5.4% of total mine earnings.
12. By comparison, the nationally legislated minimum wage in agriculture in 2010 was 57 quetzales per day plus a 250 quetzales bonus per month. Assuming that employers comply with the legislation and a 5-day work week, a monthly wage in agriculture would total about 1874 quetzales (US$240) per month. Wages for gardeners at the Marlin mine are about 16% higher; wages for heavy machinery workers (tunnelers and processers) are about 87% higher (Wageindicator).
13. In Chile, in-country procurement accounts for about 80% and in Peru, about 65% of total procurement (United Nations Conference for Trade and Development [UNCTAD] and World Bank, 2007). Furthermore, a detailed case study in Chile found that "a portion of the domestic procurement is likely to consist of imported goods bought from local agents" (UNCTAD, 2007, p. 33).
14. In April 2011, Guatemala was accepted as a candidate to the Extractive Industries Transparency Initiative (EITI). To be accepted, Guatemala submitted a plan to work with companies and civil society to create and publish consensus reports of financial flows for the mining and oil industries (Portillo, 2011).
15. Guatemala's social spending as a percentage of GDP is the second lowest in Latin America after Ecuador (ICEFI and CESR, 2009). Whereas spending on research and development remained fixed at 0.05% of GDP.
16. Due to its high risks, the production, use, transport and disposal of cyanide is regulated in most countries. In addition, the UN Environment Program and the International Council on Metals and Mining, an industry-based body, have developed a voluntary code of good practice. The International Cyanide Management Code for the Manufacture, Transport and Use of Cyanide in the Production of Gold (Cyanide Code) provides third-party certification that a company has adopted nine standards, including disclosure of risks to workers and training of workers in handling accidents. As of April 2011, 29 companies, including Goldcorp, had signed the Code.
17. Another study by a team from the University of Michigan found evidence of local exposure to arsenic and other toxic metals. Published by Physicians for Human Rights, the

study found that people living closer to the mine had higher blood levels of arsenic, copper, and zinc and urinary mercury compared to people living farther away (Basu & Howard, 2010).

18. The analyst cited three concerns: (a) growing opposition by indigenous peoples to the Marlin mine based inter alia on the mine's environmental impacts; (b) the company's failure to adequately address health concerns associated with its Honduras operations; and (c) the fact that Goldcorp had the highest level of environmental fines among mining companies listed on the Toronto Stock Exchange (Jantzi Research, 2008).

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