



Original article

Stakeholders' perceptions of sustainable mining in Morocco: A case study of the abandoned Kettara mine

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ARTICLE INFO

Article history:

Received 26 May 2015

Received in revised form 12 November 2015

Available online 2 December 2015

Keywords:

Sustainable mining

Mining industry

Stakeholders

Perceptions

ABSTRACT

In order to embrace the sustainable development challenge, the mining industry must balance economic, environmental and social costs and benefits. Collaboration between the industry, governments and local populations requires an understanding of each other's needs and views. This paper examines the case of the Kettara abandoned mine in Morocco, comparing perceptions of sustainable mining among the local population, governmental representatives, and industrial developers. All stakeholder groups agreed that sustainable mining is a shared responsibility. Converging themes were mostly environmental: (1) a clear and effective legal framework is needed to ensure adequate environmental protection; (2) best environmental management practices should be employed; and (3) the post-mine closure has to be planned before the beginning of a mining project. Differences in viewpoints were mostly related to socioeconomic issues, and included (1) the role (direct or indirect) of mining companies in fostering community sustainability; (2) the magnitude of the social impacts of mine closure; (3) the risks to the security of employees; (4) the measures to be taken to minimize health impacts on local populations; (5) the amount of investment to be requested from mining companies to guarantee the long-term viability of local communities; and (6) the understanding of inter-generational equity.

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1. Introduction

The mining industry has a marked influence on the economy of several countries, mostly through job creation and cascading effects on other sectors. However, mining activities often have major environmental impacts that incur long-term costs for governments (e.g., restoration of abandoned mines, and increased health costs due to chronic illnesses). In response to mounting criticism, the mining industry has paid increasing attention to the environmental and social impacts of its activities, notably by embracing the concept of sustainable development (Whitmore, 2006). Governments have followed the trend, implementing laws and rules on “sustainable mining” (Bhattacharya, 2000). However, the capacity of the mining industry to be sustainable is often contested (Bridge, 2004), mostly because non-renewable

resources are exploited (Tilton, 1996). Moreover, while civil society considers sustainable development a necessity, industries such as mining still largely see it as a compromise (Gendron, 2006).

Adopting sustainable development principles can be a major challenge for the mining industry (Azapagic, 2004; Humphreys, 2001). Important efforts have been made to better take into account environmental and social issues across the sector (Bhattacharya, 2000; Hilson, 2001). These issues are increasingly mentioned in the sustainable development reports published by mining companies (Hilson, 2000; Horowitz, 2006; Worrall et al., 2009). However, the efforts of mining companies to ensure that their activities are respectful of the environment and society are often below the expectations of the population (Himley, 2010; Holden, 2011; Prno, 2013).

While the industrial perception of sustainable mining has been well documented (e.g., Hilson and Murck, 2000), the opinion of mining communities on how economic, social and environmental objectives should be balanced has so far received less attention from researchers (Olofade and Annegarn, 2013). Yet, sustainable development is only possible if industries and communities have a

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shared understanding of the concept (Jenkins, 2004). Based on this assertion, this paper aims to compare the perceptions of sustainable mining of the local population, government and industry, drawing on a case study of a Moroccan pyrrhotite mine, operated from 1965 to 1982. Understanding the similarities and differences in perceptions of sustainable mining could yield a shared vision of the concept and prevent future conflicts.

2. Material and methods

2.1. Study area

Kettara is a village of 2000 inhabitants located 30 km northwest of Marrakech (Morocco). The climate in the area is semi-arid: mean annual precipitation is low (250 mm) and irregular, with a rainy season from October to April and a dry season from June to September. Mean relative humidity and mean annual temperature are, respectively, 73% and 12 °C in January, and 33% and 29 °C in July.

Here, an underground pyrrhotite mine was in operation between 1965 and 1982. It mostly supplied sulfur dioxide to the Safi chemical complex (Maroc Chimie) for the production of sulfuric acid used to dissolve phosphate ore to produce agricultural fertilizers. The mine opened shortly after Morocco gained independence in 1956. At that time, Morocco was characterized by high unemployment rates and inadequate housing in cities (Sater, 2010). The Kettara mine was owned by the Bureau de Recherches et de Participations Minières (BRPM) and operated in collaboration with Maroc Chimie (former name of the Office Cherifien des phosphates (OCP), which is now the most important state-owned company in Morocco (Croset, 2012)). This exploitation followed the extraction of ochre and copper on an artisanal scale within the gossan part of the orebody (1938–1963). Phosphate mining, over which the OCP has a monopoly, accounts for more than 90% of the mining economy of Morocco (Dolley, 1994; Newman, 2012). The mining sector currently accounts for 35% of Morocco's foreign trade and 6% of its GDP, making it a "mining state" on par with the likes of Chile, Peru and South Africa (Woertz, 2014).

During the period in which the mine was in operation, there was economic and political instability in Morocco and other African countries (Maponga and Maxwell, 2001). The Moroccan political system has remained stable for more than five decades, until this day, due to the inclusion of features such as parliaments, elections, referenda and political parties (Sater, 2010). A new and more democratic constitution was adopted in 2011.

Mining ceased at Kettara when the OCP elected to replace the pyrrhotite from Kettara with imported native sulfur, resulting in substantial reductions in phosphate production costs. Moreover, acid mine drainage had caused severe corrosion of infrastructure and equipment. The closure of the Kettara mine in the early 1980s coincided with a period of economic restructuring (Richards and Waterbury, 2008), causing a prolonged financial crisis (Sater, 2010). Legally, the Kettara mine site and the remaining

infrastructure, including most of the houses in the village, are the property of the Office National des Hydrocarbures et des Mines (ONHYM, the former BRPM).

The exploitation of the Kettara mine produced ca. 3 Mt of sulfur-rich mining waste, covering an area of ca. 16 ha. Acid mine drainage is a source of surface and underground water pollution (Hakkou et al., 2008a,b). Physicochemical analyses have shown that the water from wells in Kettara village located downslope from the mining waste deposit was affected by acid mine drainage, contaminated by sulfates, potassium, magnesium, iron and other heavy metals (Lghoul et al., 2012). When the weather is dry, dominant winds transport yellow dust and sulfur emanations from the waste deposit to inhabited or farm zones, with all of the health and environmental risks that ensue.

The Kettara site is representative of a way of mining that prevailed for several years in Morocco and elsewhere in the Middle East and Northern Africa. Indeed, the mining legislation in Morocco was, until recently, based on the Dahir (royal decree) of April 16 1951 and did not include dispositions to force the owner of a mining permit to take the necessary measures to avoid problems related to health or damage the environment. Several mine sites were abandoned across Morocco without being restored. The government has, however, since undertaken major reforms aimed at promoting the mining sector while ensuring adequate conditions for it to blossom in a highly competitive international market. Among these reforms, Bill 33–13 was adopted in February 2015 (Royaume du Maroc, 2015). It includes provisions for environmental protection and sustainable development for mining, including a requirement to complete environmental impact assessments, as well as drafting plans for mine closure, a requirement before mining actually commences.

2.2. Data collection

Semi-directed interviews were conducted in July–August 2010 with participants from three main stakeholder groups (Table 1): the local population, the industry (former managers of the Kettara mine) and the government (local elected representatives and national state employees). Men and women of different ages and educational backgrounds were interviewed to obtain a variety of viewpoints. The Kettara mine was closed in the early-1980s and was purposefully chosen so that research participants would have the necessary hindsight to objectively analyze their situation. Even then, some participants were reluctant to participate, as they still had mixed feelings about the mining experience in Kettara and did not want to stir up bad memories.

Recruitment of participants in the village was carried out in two stages. First, meetings were conducted with the village council and local citizen associations so that they could suggest names of persons to contact. They in turn suggested other names, following a snowball sampling approach (after Gamborg et al., 2012). Interviews were conducted in the participants' homes (local population) or offices (industry and government). Data collection ceased when information saturation was reached (i.e., when

Table 1
Distribution of participants from the three stakeholder groups (population, government, industry) with regards to gender, age and educational backgrounds.

	Gender		Age			Educational background			
	Male	Female	<30 years	30–45 years	>45 years	None	Primary school	High school	University
Population	14	6	4	9	7	5	2	2	11
Government	8	4	1	7	4	–	–	–	12
Industry	5	1	–	–	6	–	–	2	4

additional interviews did not provide new information). An ethics certificate was previously obtained from the Ethics Review Board of Université du Québec en Abitibi-Témiscamingue.

2.3. Data analysis

Thematic analysis of interview transcripts allowed for a comparison of the viewpoints of the three stakeholder groups (Marshall and Rossman, 1999). This method is used to identify and link the main ideas conveyed by participants. NVIVO software (QSR International) was used to classify the information contained in the interview transcripts. This information was categorized as follows: (1) history of the Kettara mine; (2) mine closure; (3) impacts of mining; and (4) perceptions of sustainable development by the three stakeholder groups. The thematic analysis yielded significant information, a thorough account of which is provided in Babi (2012). The following sections present the main results according to the four themes.

3. Results

3.1. History of the Kettara mine

Kettara village was established following the discovery of a major pyrrhotite deposit and the opening of the mine to exploit it. People came from all corners of Morocco to work at the mine and start a new life in a new region that they would later come to consider home. Infrastructure had to be built to lodge, feed, and offer services to the workers: water, electricity, telephone, schools and health clinics. All of this was planned and paid for by the company, which built a new village in this rural setting, with the specific goal of exploiting the pyrrhotite deposit. The company also established stores where the local population could buy just about anything, from bread to clothing, and even luxury products. A public transportation system was also available for people to attend fairs in nearby regions. A close link thus existed between the mine and village that bloomed and declined together. As one Kettara resident explained in an interview, “we benefited from a lot of advantages during the exploitation of the mine, but unfortunately we lost everything after closure”.¹ While the mine was in operation, Kettara villagers benefited from above-average living conditions compared to the rest of Morocco. Following mine closure, living conditions decreased below the national average.

3.2. Mine closure

Most participants (35/38) mentioned that mine closure was unexpected at Kettara. Many even referred to this period as a “crisis”. Several retired miners used the term “disaster zone”, feeling despondent about the collapse of economic activity in Kettara. Some participants (10/38) nevertheless thought that the company had no choice but to shut down the mine and leave Kettara: “They tried to find solutions for people, but it was complicated” (Kettara resident). Mine closure also meant cessation of free services provided by the company: “They left us without even drinking water. We had to manage by ourselves” (Kettara resident).

Most participants (30/38) were of the view that, following the crisis, it was impossible to stay in what, as one respondent described, was a “death-stricken town”. Leaving Kettara became the most viable solution for many ex-miners, but also the most difficult as they were forced to leave their families behind to try and find work elsewhere. An entire community based on the value of work

was torn apart. As Kettara ceased to be a mining town, its inhabitants lost the values that constituted their group identity. Still today, unemployment is endemic, as no other major employer replaced the mine.

Many chose to stay in Kettara in order to keep their houses, and several of those who ended up finding jobs in other cities kept their houses in Kettara to maintain a link with the community. To them, leaving was temporary, and many came back to Kettara when they retired. In fact, most Kettara villagers were more concerned with economic issues (losing the house leased by the company), than with environmental or social issues:

“They [the company] tried to force us to leave the houses they gave us during exploitation, but it wasn’t easy as some of us refused to leave, considering that the houses were ours after all these years working for the mine, and that we had a right to keep them. [. . .] Miners insisted on keeping the houses, and succeeded to this day, but the company remains the sole owner of the houses and land, and there is nothing we can do about it.” [Kettara resident]

3.3. Impacts of mining

The Kettara mine was abandoned without the site being restored. For most respondents (35/38), it was a source of water, air, and soil pollution and a threat to human health. As one resident recalled in an interview:

“In summer, we see fire coming out of the waste, the smell is unbearable and it impacts vegetation. As you can see, there is no vegetation here. Health is also affected, mostly for ex-workers that caught silicosis. [. . .] In addition, some people suffer from allergies because of all the dust.”

Participants from the three stakeholder groups believed that Kettara village should have never been constructed because the disposal of mine waste near homes presented a serious health concern. As one resident made clear in an interview, “They shouldn’t have built a village here. [. . .] It should have remained a mine and nothing else”. A local elected representative did not understand “how people can still live here, as they saw so many die of silicosis”. And, a former company manager still insists that “waste is dangerous, but unfortunately there are some people that don’t even know”.

Despite all of these negative impacts, most participants (34/38) were of the view that the mine had a positive impact on people’s lives. One resident in particular detailed how in an interview:

“Still, it was beautiful here. We had everything and were even better off than in Marrakesh. [. . .] There was an atmosphere of good relations between people. We were like family. Problems started after the crisis. But fortunately, the younger ones studied, most of them up to the university level. Frankly, this was thanks to the mine.”

3.4. Perceptions of sustainable development

3.4.1. Population of Kettara

Some participants from the local population had never heard of sustainable development before (5/20), whereas many claimed to be familiar with the concept (15/20). Participants talked about all three aspects of sustainable development, frequently discussing economic aspects first, followed by environmental and social issues. The following passage was fairly representative of the breadth of coverage provided by interviewees:

“Generally speaking, a human being lacking resources will not think about the environment or other things. However, when one has a steady job, one can start thinking about other things, such as having a proper environment, good relations with others, etc. I tell

¹ Interviews were translated from Arabic to English.

you, in my opinion, economic issues really affect all other sides of our lives.” [Kettara resident]

It is, however, important to point out that environmental issues were identified first by the younger participants interviewed, and that social issues were the most important for the women and participants older than 45 years. But overall, the three dimensions of sustainable development were given more or less equal attention by most participants. In their collective opinion, mining companies must necessarily dedicate a portion of their profits for community development.

Some participants stressed the importance of government intervention to ensure application of sustainable development principles. According to these individuals, political will ensures that the necessary resources are put aside to help fulfill these objectives. As for the role that local populations themselves should play in ensuring sustainable development, some participants claimed that communities were powerless and that it is the responsibility of the companies to ensure that problems do not arise, up to after mine closure.

On the other hand, some participants emphasized that local populations can play an important role in facilitating sustainable development, sharing the responsibility with companies. However, others accused the company of not informing people of the various short- and long-term impacts of mining. For some interviewees, companies and communities should not only think of short-term benefits, but also identify, jointly, the long-term impacts of mining. Most emphasized the importance of post-closure planning.

“The real problem is that people [from Kettara] only thought about mining time, taking for granted that it would last forever. If the company had thought about long-term impacts, and consequently assumed its responsibilities, and if the population had also seen things in the long-term and prepared for mine closure, there would have been much less impacts towards the end.” [Kettara resident]

A minority of participants (2/20) claimed that they did not see how sustainable development applied to mining, as non-renewable resources are being exploited. However, several participants preferred to see sustainable development as a challenge embraced by the mining industry, and that the approach taken should ensure that activities are extended for as long as possible and by developing parallel projects that could supply jobs following closure.

3.5. Industry

Participants from the industry were of the view that today, the mining industry views sustainable development as a global concept that does not solely emphasize environmental protection. They emphasized the economic importance of the mining sector, while agreeing that a balance must be reached between the three

dimensions of sustainable development. In the word of a former mine manager: *“We must exploit our resources. We just need to find the best way to do so while minimizing negative impacts”*.

Half of the participants (3/6) were in favor of generating profits sooner rather than later.

“I am against the idea of linking sustainability with keeping part of the resources for future generations. I think [. . .] we must exploit our resources to the maximum. It’s not that I don’t think about the next generations, but we have to be realistic: prices change every day. [. . .] To leave there a deposit that might lose its value in the future would be wasting it. But by exploiting it today, we could fund other projects that could last.” [Former mine manager]

Participants were generally optimistic and believed that errors from the past would not be repeated. In their opinion, the impacts of the Kettara mine were important because of the lack of appropriate techniques and because of improper management at the time.

“It’s true that things were not done correctly back then, but honestly, the notions of sustainability and thinking of the after-mine and all that didn’t exist in the past. Today it’s different. Studies are being done that can help us adopt such concepts and operate mines with minimum impacts.” [Former mine manager]

Participants mentioned that sustainable development could only be achieved through the full participation of all stakeholders, including communities and governments. Former mine managers claimed that *“the local population should not accept just about anything, it must know that the mine will close and prepare for closing”* and that *“the government is also concerned and should see that sustainable development policies are respected”*.

3.6. Government

Participants from local and national governments were conscious of the importance of integrating sustainable development principles into mining practices to avoid negative social impacts, reduce the environmental footprint of operations and contribute to economic development in communities. In Morocco, where mining operations are conducted by the State as well as by private companies, it can be difficult to determine where the responsibilities of each stakeholder start and end. However, most participants (9/12) considered that the responsibility for sustainable development should be shared by governments and companies, insisting that the impacts of the mining industry were more serious in the past due to the absence of an appropriate national legal framework. However, participants from government did not go as far as to suggest that abandoned mines should be restored:

“We are conscious that perception of mining is very negative in the country. There were indeed many errors in the past, due to several reasons, one being in my view the absence of a legal framework that would have forced mining companies to respect the

Table 2

Perceptions of the three stakeholder groups (population, government, industry) of the environmental dimension of sustainable mining.

	Population	Government	Industry
Legal framework	Current environmental problems are due to poor management in the past	The mine was exploited at a time when mining regulation did not force companies to respect the environment	Current environmental impacts are mostly due to the absence, in the past, of laws clearly defining each stakeholder’s responsibilities
Environmental management	The mining industry must sustainably exploit resources, taking environmental issues into account	Mining companies must now comply with a series of commitments toward the environment and communities	Mining companies must adopt best environmental management practices
Post-mine closure	Mine closure must be planned before exploitation even begins	A plan for mine closure must be prepared beforehand	Mining companies must favor adaptive management and plan the post-mine closure

environment and local populations. What counts now is that we work together to change this perception.” [National state employee]

4. Discussion

Members of the three main stakeholder groups shared their views on what constitutes—or should entail—sustainable mining. While some similarities were identified, there were also some differences that could be sources of conflict. In the following sections, each of the three dimensions of sustainable development will be presented in turn, followed by a discussion on the roles each stakeholder group must play to make sustainable mining a reality.

4.1. Environmental dimension

The three stakeholder groups interviewed in this study (population, government, industry) had similar perceptions of the environmental dimension of sustainable mining (Table 2). The Kettara mine was closed without restoration. Mining waste was scattered over a vast area instead of being more adequately confined to a localized waste pile. Moreover, the sulfur-rich waste threatens public health by producing acidic water containing heavy metals (El Khalil et al., 2008). Participants in this study mentioned that these environmental problems are the products of past deficiencies in regulation. They mentioned that mining companies are now expected to adopt best practices in the area of environmental protection, recommendations which resonate with the conclusions of previous studies (Hamann, 2004; Jenkins and Yakovleva, 2006; Esteves, 2008). They insisted on the need for participatory, adaptive management planning at all stages of the mining process, including during the post-closure period. Indeed, preserving environmental quality is not only a challenge while a mine is open, but also after closure. Mining companies now recognize the importance of elaborating closure plans in collaboration with local communities (Azapagic, 2004). Furthermore, the new Moroccan mining law (Royaume du Maroc, 2015) recognizes the importance of site restoration, and includes stronger regulations on water, air and soil quality. It remains unclear, however, whether the numerous abandoned mines inherited from the past will be adequately restored. Solutions have even been devised specifically for the Kettara mine over the last few years by researchers from the Cadi Ayyad University (Morocco) and Université du Québec en Abitibi-Témiscamingue (Canada), as part of the activities of the IDRC Research Chair in Management and Stabilization of Mining and Industrial Waste (Hakkou et al., 2009; Bossé et al., 2013, 2015; Ouakibi et al., 2013). These solutions include emphasizing the use of phosphate limestone waste to

neutralize acid mine drainage. Proceeding with restoring this site would set a precedent, in the process, likely exposing the reluctance of participants from the government to evoke this possibility.

The water contamination risk due to pyrrhotite exploitation was mentioned several times during interviews. This concern appears legitimate, as surface and underground water can be contaminated with sediments, cyanide, oil and acid (Younger, 2001; Kitula, 2006; Hakkou et al., 2008a,b; Lghoul et al., 2012). Acid mine drainage occurs when sulphide minerals are exposed to oxygen and humidity, thus producing sulfuric acid (Lee et al., 2002; Akcil and Koldas, 2006). Acidic conditions can adversely impact biodiversity (Rios et al., 2008).

The people interviewed from Kettara for this study mentioned that the toxic waste produced by the mine had considerable negative impact on soil fertility in the area, a phenomenon already documented in the scientific literature (Smith et al., 1991). Mining has been shown to damage soils, notably through salinization, acidification, pollution and loss of structure (Boularbah et al., 2006; Wang et al., 2007). Soil contamination in turn impacted vegetation (Razo et al., 2004; El Khalil et al., 2008), as evidenced by the barren grounds in the vicinity of Kettara. Furthermore, the village is located downwind from the waste deposits, and dust contaminated with sulfur and heavy metals causes health problems. For example, several residents have contracted silicosis, an illness common among mine workers (Devinck and Rosental, 2009).

4.2. Social dimension

The perceptions of the social dimension of sustainable mining differed among the three stakeholder groups, in particular with regard to the impacts of mine closure, community sustainability, employee security and local population health (Table 3). Mine projects produce socioeconomic benefits for workers and local communities (Azapagic, 2004), but most of these benefits disappear after mine closure (Andrews-Speed et al., 2005). From the interviews with people from Kettara, it is obvious that the mine has impacted their lives. Coming from different regions in Morocco, they created a community that blossomed during the mine development phase. Working at the mine was the cement that held the community together. Following mine closure, ex-miners lost their identities (Lapalme, 2003) and those who accepted to be relocated to other mines were forced to leave their families. The social fabric of the Kettara community was thus severely eroded. Similar phenomenon have been reported in other mining countries, notably Australia (Solomon et al., 2008). Industry representatives interviewed in this study were of the view that, as most residents of Kettara came from other regions of

Table 3

Perceptions of the three stakeholder groups (population, government, industry) of the social dimension of sustainable mining.

	Population	Government	Industry
Community	sustainability	Create sustainable communities	Contribute to sustainable community development
Produce socioeconomic benefits			
Impacts of mine closure	Negative impacts from closure exceed benefits from mining	Mining is temporary and people should be prepared for mine closing	People should leave after mine closure, and relocated somewhere else
Workers security	Mining exposes employees to major risks, some life-threatening	Workers' security is a challenge for the mining industry	Workers' security is of the utmost importance and technological improvements make for better working conditions
Local population health	Mining should be prohibited if it might cause illnesses	Precautions have to be taken not to affect human health	New technologies must be used to protect people from toxic products

Morocco, their sense of belonging in the mining town should have been low and they should have left the village after mine closure. This might be true of short-term exploitation but the Kettara mine was open for almost 18 years, giving people time to develop strong family and friendship links.

While most of the houses in Kettara are still legally owned by the company (formerly BRPM, now ONHYM), the residents refuse to leave, claiming they are entitled to own the houses in return for their commitment and hard work at the mine. However, if the company were to restore the site—either for land reclamation or in preparation for a new phase of pyrrhotite extraction—it would need to destroy all the houses, which would leave the people with nowhere to stay. Some participants suggested that mining towns should not be built anymore in order to avoid the impacts of mine closure. Companies are indeed increasingly relying on “fly-in/fly-out” instead of developing mining towns (Cheshire, 2010). But this also adversely impacts workers and neighboring populations (Storey, 2001). Participants from the government suggested that local populations should know that mining is temporary, and prepare for closure.

The residents consulted in Kettara are of the view that mining companies generate profits by exploiting the resources of a given territory, and that consequently they should pay back local communities by ensuring their sustainability. The government officials interviewed seemed to view the mining industry as a catalyst for community development, but not the sole one. Both of these viewpoints were deemed illogical by those interviewed from the industry, who claimed that their contribution to community development was indirect, through job creation and stimulation of the local economy, the diversification of which would increase community resilience after mine closure. This is in line with the proposal of Davis and Tilton (2005), who contest that the mining industry favors socioeconomic development, but that following closure, such concerns become the responsibility of government. The residents of Kettara interviewed also identified this, stressing the role the government should play in this context in the event of premature mine closure.

A paradox emerged from the interviews with the local population. On the one hand, people from Kettara believed that the negative impacts of mining exceeded the benefits. But on the other hand, many were holding out for a reopening of the mine. This paradox is only apparent and can be explained by the fact that, while people were nostalgic of the standard of living they had while working at the mine (Vanclay, 2002), they would not accept a return to a situation in which the old mining ways prevailed: there would need to be some assurance that negative impacts were going to be minimized as much as possible (Kapelus, 2002). Those interviewed from Kettara insisted on being part of the decision-making process, and stressed the importance of evaluating the social impacts of mining projects before commencing operation. Indeed, mining is more acceptable to local populations when its impacts are manageable (Gibson, 2000). The expected duration of a mine should, therefore, be divulged from the start, and

measures should be taken to ensure continuation of services following closure (Manteaw, 2007).

Workers' security is a major challenge in the mining industry (Robson et al., 2007). Interviews revealed that several workers had died at the Kettara mine due to accidents, silicosis or other work-related illnesses. Participants consulted from the industry mentioned that mining companies now place more emphasis on ensuring workers' security, notably through deploying new technologies that have improved working conditions. Participants from the government also acknowledged the challenge of ensuring high-quality workers' security. Effective regulation is needed to pressure companies to adopt new approaches which reduce risks for workers (Poplin et al., 2008).

For development to be truly sustainable, it is essential to ensure good health conditions, not only for workers but also for local populations (Ogola et al., 2002; Van Dam et al., 2002; Gunningham, 2008). This was seen as a challenge by participants from the industry and the government. Those interviewed mentioned that precautions have to be taken to reduce risks, and that new technologies can help in this regard. Participants from the local population stressed that any risk to a population's health should be avoided, and that if it is judged impossible, exploitation should not be authorized.

4.3. Economic dimension

A mine is an economic activity of limited duration. Mono-industrial communities, such as Kettara, often find themselves with no viable economic activity following mine closure (Kitula, 2006). The impacts of mine closure are even more pronounced in developing countries, as it is often hard to find work elsewhere, and as governments generally do not have the economic backbone to finance replacement projects. The mine was the only source of employment in Kettara, and closure had major impacts on community livelihoods, to the point where people now talk about the current period as a “crisis” that transformed Kettara into a “death-stricken town”, a situation analogous to the “cursed communities” reported by Littlewood (2014) in Namibia. There is a sense of abandonment among the people interviewed from Kettara, as they were not informed of what was coming. Improper community consultation can indeed aggravate the impacts of mine closure (Laurence, 2006). Some people do not (or cannot) save money in anticipation of mine closure. The situation was even more tragic for widows who could not leave to find work elsewhere and who were all of a sudden alone, without an income, and often with several children to take care of.

Based on the Kettara mine experience, the perceptions of the three stakeholder groups were somewhat different when it came to explaining the role the industry should play in sustaining the economic viability of communities, and with respect to intergenerational equity (Table 4). Those interviewed from the local population judged it essential that part of the profits generated by mining be reinvested within the community to guarantee its long-

Table 4
Perceptions of the three stakeholder groups (population, government, industry) of the economic dimension of sustainable mining.

	Population	Government	Industry
Economic viability	Economic sustainability must be guaranteed after mine closure	Mining companies should contribute to funds for economic diversification	Mining operations should be extended for as long as possible
Intergenerational equity	Equity should be ensured both within and between generations	Part of the profits from resource exploitation should be invested in short-and long-term community development projects	Resources should be exploited to fill today's needs, while counting on the resulting economic growth to fill the needs of future generations

term viability. They mentioned that governments have a major role to play in this regard, and must pass laws to make it happen. By contributing to community development, the mining industry can help to facilitate economic diversification (Humphreys, 2000). A strong and diversified economy can then persist following mine closure (Bebbington et al., 2008). Participants from the government echoed similar sentiments, although they were in agreement that mining companies should contribute to economic development funds as opposed to financing projects directly. Participants from the industry believed that the companies' responsibility toward the community was restricted to the operations period itself and that all they could do, as regulators, is work toward extending this period to the maximum amount of time possible without major impact on profits. They believed it was up to the communities to properly manage the benefits they obtained during exploitation to ensure their long-term viability, with the help of governments, if needed.

With regards to intergenerational equity, the views of the government and industry representatives interviewed in this study were comparable, favoring intensive exploitation of natural resources to produce richness and goods that will benefit future generations. The perception of the local population was different, as they insisted that part of the resources be left aside for future generations. They also insisted that mineral resources are public goods and that companies should consequently not be allowed to make profits out of their exploitation without sharing with local populations.

4.4. Stakeholders' responsibilities

Mining companies, governments and local communities must work together to facilitate the adoption of sustainable development principles in the mining industry (Hilson, 2001). The responsibility of local communities in sustainable mining is mostly indirect. They constitute a lobby group that can bring companies to better respect the environment and society (Luning, 2012). According to the three stakeholder groups interviewed in this study, communities should define their priorities in terms of sustainable development and seek to actively participate in improving local quality of life. Companies that show strong commitment to the environment and society often benefit from a competitive advantage (Vogel, 2005). Having a legal right to mine a site is increasingly insufficient and community support is necessary (Hopkins, 2004; Goddard, 2005; Sayer, 2005; Whitmore, 2006). The national government plays a central role in guiding mining companies toward sustainable development through proper legislation for environmental and community protection. The new mining law adopted in Morocco in February 2015 is a step in the right direction, as it emphasizes impact assessment and mandates improved planning of mining activities. The adoption of laws is, however, insufficient on its own; monitoring is mandatory. Local authorities also have an important role to play as they often are responsible for ensuring that laws are applied.

5. Conclusion

Since the closure of the Kettara mine in the early-1980s the mining context has changed considerably in the Middle East and North Africa, a situation paralleling that of other developing countries with abundant natural resource wealth (Richards and Waterbury, 2008). Some of these social, economic and political changes were captured in this study, as the participants offered reflections on the Kettara mine period while taking into account the current situation – post mine closure – as well. Despite some similarities, mostly in the area of environmental protection, the perceptions of the three main stakeholder groups involved in

mining in Morocco differed markedly, mostly on the social and economic fronts. These divergent viewpoints could be sources of conflict and will need to be reconciled, especially in the context of the implementation of the new Moroccan mining legislation.

The results presented here mirror findings from previous studies conducted in other contexts, pointing to general patterns in terms of perceptions of sustainable mining by the three stakeholder groups considered (local population, industry and government). There might be differences between state- and privately-owned companies about how sustainable development is perceived and practiced (Croset, 2012; Woertz, 2014), but these need to be investigated further, as the literature is still inconsistent in this regard (e.g., Chun, 2009). More investigation is also needed to decipher the respective effects of mine type (e.g., open-pit vs underground, type of mineral mined, etc.) and countries' political system, level of development, population density and resource endowment on sustainable mining indicators.

Acknowledgements

Funding for this study was provided by the IDRC Research Chair in Management and Stabilization of Mining and Industrial Waste. We would like to thank the men and women of Kettara for having welcomed us so kindly and generously. We are grateful to the Société de l'exploitation de pyrrhotine de Kettara (SEPYK), the ministère de l'Énergie, des Mines, de l'Eau et de l'Environnement, and local authorities from Kettara for their collaboration and support. Rachid Hakkou and Patrice LeBlanc provided thoughtful comments on an earlier draft of this manuscript.

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