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EVALUATING ENVIRONMENTAL RISKS IN MINING: A PERCEPTUAL STUDY
AT THE VATUKOULA GOLD MINE IN FIJI

A Thesis Presented

by

Mary Ackley

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The Faculty of the Graduate College

of

The University of Vermont

In Partial Fulfillment of the Requirements
for the Degree of Master of Science
Specializing in Natural Resources


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Accepted by the Faculty of the Graduate College, The University of Vermont, in partial fulfillment of the requirements for the degree of Master of Science specializing in Natural Resources.

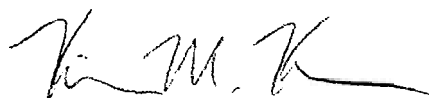
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ABSTRACT

Gold mining is often associated with positive economic benefits; however, it may also have negative impacts on the environment and human health. It is essential that communities understand the risks and benefits associated with mining, particularly in developing countries where there is often a lack of legislation governing the environmental performance of mining corporations. The perceptions of local people regarding the risks and benefits of mining may differ significantly from those of company representatives, policy makers, and the scientific community. Indeed, public concerns have sometimes been ignored or downplayed by those responsible for the implementation of environmental policies and practices. Examination of the complex social, economic, psychological, political, and cultural factors influencing risk perception in mining communities is thus important for successful risk communication and management.

Issues arising from the interplay between socio-economic benefits and risks are particularly acute in small island states which have isolated and highly limited economic development trajectories. The lessons learned in such cases are therefore instructive for crisis planning across the developing world. This study conducted firsthand empirical research into the perception of environmental and health risks in the communities surrounding the Vatukoula gold mine in Fiji. Primary data was obtained through a survey questionnaire designed to quantify and evaluate perceived risks ($n= 340$, representing approximately 24% of the target population). Concurrently, environmental samples were collected to assess the extent of environmental impacts at the study site.

Study results revealed that gender is an important variable in risk perception at Vatukoula. Major findings include: (1) women feel they have less knowledge about the risks of mining compared to men; (2) women feel they have less control to avoid the risks of mining compared to men; and (3) women and men tend to receive risk messages from different sources. The information obtained during this study was made directly available to local stakeholders, to aid in risk management and decision-making.

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TABLE OF CONTENTS

	Page
ACKNOWLEDGEMENTS	ii
LIST OF TABLES	vi
LIST OF FIGURES	vii
CHAPTER 1: VATUKOULA, ROCK OF GOLD	1
1.1 Introduction.....	1
1.2. Location.....	3
1.3. Geology.....	5
1.4. Profile of a Developing Island Economy.....	6
1.5. Historical Context	7
1.5.1. Discovery of Gold	7
1.5.2. Historical Contribution of Vatukoula to the Fiji Economy	9
1.5.3. Development of a Company Town.....	10
1.6. Broader Applicability of the Fiji Case	11
CHAPTER 2: HISTORICAL ENVIRONMENTAL CONCERNS AND CONFLICTS AT VATUKOULA	14
2.1. Historical Environmental Concerns	14
2.2. Historical Conflicts	17
2.2.1. Labor Conflicts	17
2.2.2. Land Conflicts	19
CHAPTER 3: ENVIRONMENTAL IMPLICATIONS OF GOLD MINING	22
3.1. Overview of Mine Processes at Vatukoula.....	22
3.2. Cyanidation.....	22
3.3. Chemical Transportation and Storage	23

3.4. Disposal of Mine Wastes	23
3.5. Environmental and Health Effects of Cyanide	25
3.6. Environmental and Health Effects of Arsenic	27
CHAPTER 4: REGULATORY CONTEXT	29
4.1. Organization	29
4.2. Existing Legislation.....	30
CHAPTER 5: UNDERSTANDING ENVIRONMENTAL RISKS	33
5.1. Risk Perception.....	33
5.2. Risk Communication.....	37
5.2.1. Risk Communication Challenges	37
5.2.2. Best Practices in Risk Communication.....	41
CHAPTER 6: MINING AND SUSTAINABLE DEVELOPMENT.....	44
6.1. Proceed With Caution: The Resource Curse	47
6.2. Stepping Towards Sustainability in the Extractive Industries.....	51
CHAPTER 7: RESEARCH METHODOLOGY	58
7.1. Risk-Perception Survey.....	58
7.1.1. Survey Instrument.....	64
7.1.2. Data Analysis	65
7.1.3. Limitations	66
7.2. Environmental Sampling and Analysis	68
7.3. Hydrogen-Sulfide Testing for Bacterial Contamination.....	70
CHAPTER 8: RESULTS AND DISCUSSION.....	74
8.1. Risk-Perception Survey.....	74
8.1.1. Profile of Respondents.....	74
8.1.2. Knowledge of Risks.....	75
8.1.3. Level of Concern	77
8.1.4. Trust in Authorities	79

8.1.5. Control	80
8.1.6. Ability.....	81
8.1.7. Weighing Risks and Benefits.....	81
8.1.8. Gender and Risk Perception.....	83
8.1.9. Health Data	92
8.1.10. Other Demographic Variables	93
8.1.11. Open-Ended Responses	96
8.2 Environmental Sampling	98
8.3. Hydrogen-Sulfide Testing for Bacterial Contamination.....	102
8.4. Impacts of Mine Closure	103
8.5. Mining in Fiji and the Natural Resource Curse	112
CHAPTER 9: CONCLUSION	118
9.1. Recommendations for Risk Communication and Management	119
9.2. Lessons for Mine Closure and Transition.....	128
COMPREHENSIVE BIBLIOGRAPHY	134
APPENDIX I: SURVEY INSTRUMENT (ENGLISH LANGUAGE).....	143
APPENDIX II: SURVEY INSTRUMENT (FIJIAN LANGUAGE)	154
APPENDIX III: SURVEY RESULTS	165

LIST OF TABLES

Table	Page
Table 1: Organization of Target Population and No# of Respondents	62
Table 2: Sample Key.....	69
Table 3: Summary of Demographic Characteristics	75
Table 4: Respondents Knowledge of Risks: Cross-tabulation According to Gender.....	84
Table 5: Company Reaction to Concern: Cross-Tabulation According to Gender	87
Table 6: Control to Avoid Mining Risks	88
Table 7: Open-Ended Response Coding Categories and Relative Frequency of Occurrence	98
Table 8: Analytical Results.....	99
Table 9: Hydrogen-Sulfide Water Quality Testing Results	102

LIST OF FIGURES

Figure	Page
Figure 1: Regional Map Showing Location of Vatukoula	4
Figure 2: Sample Locations	69
Figure 3: Paper Strip Testing - Color Variation of Black Ferrous Precipitate.....	73
Figure 4: Sources of Risk Information.....	77
Figure 5: Risk Information Source According to Gender.....	85
Figure 6: Decision-making According to Gender.....	90
Figure 7: Considered Moving Away?: Response According to Level of Education.....	95

CHAPTER 1: VATUKOULA, ROCK OF GOLD

1.1 Introduction

Gold mining has often been associated with positive economic benefits; however, it may also result in negative impacts on the environment and human health. It is essential that communities understand the risks and benefits associated with mining, particularly in developing countries where there is often a lack of legislation governing the environmental performance of mining corporations. In addition to the immediate risks associated with a fully operational mine, it is also important to consider the long-term environmental, economic, and social impacts that result from development strategies which exploit non-renewable natural resources. In the case of mining, communities around the world have struggled with the process of closure and remediation after the inevitable cessation of mining activities. Such issues, arising from the interplay between socio-economic benefits and environmental risks, are particularly acute in small island states which have isolated and highly limited economic development trajectories. The lessons learned in such cases are thus instructive for crisis planning across the developing world.

Examination of the complex social, economic, psychological, political, and cultural factors influencing risk perception in mining communities is important for successful risk communication and management. Studies have shown that the perceptions of local people regarding the risks and benefits of mining may differ significantly from those of company representatives, policy makers, and the scientific community (Hadden, 1991). Furthermore, men and women have been shown to

perceive risks differently. While women have traditionally had limited access to the economic benefits of mining, they have consistently been shown to express higher levels of concern about environmental risks compared to men (Davidson & Freudenburg, 1996; Gustafson, 1998). However, less research has been done to identify precisely how and why these gender differences in risk perception occur (Gustafson, 1998). Studies addressing the complex nature of risk perception in developed countries such as the United States (Paul Slovic, Layman, & Flynn, 1991), France, Australia, Germany, and the United Kingdom (Eiser et al., 1990) have made valuable contributions, resulting in improved risk communication and management practices. However, fewer such studies have taken place in the developing world (Bronfman & Cifuentes, 2003). This study attempts to fill these gaps through firsthand empirical research into the perception of environmental and health risks in the communities surrounding the Vatukoula gold mine in Fiji. The information obtained during the study has been made directly available to local stakeholders in the form of a tool-kit, to aid in risk evaluation and communication.

On the morning of December 5, 2006, Emperor Mines Ltd. (EML) announced the sudden closure the Vatukoula gold mine, which had operated continuously for 73 years. Following an internal three-month review, the company indicated that the mine was no longer economically viable (Emperor Mines Limited, 2007). That day, 1,760 mine employees, their families, local businesses, and government officials were shocked to learn that their source of livelihoods for over seven decades had suddenly disappeared. After months of uncertainty and economic hardship, the mine was

purchased by Westech Gold Pty Ltd. (Westech), an Australian-based company that began the process of resuming operations at Vatukoula on a smaller scale in August, 2007. The unanticipated closure of the mine left Fiji's citizens questioning whether the income from this mineral resource was utilized effectively. Although the event caused hardship to many, it may also serve as an important opportunity for reflection on the sustainability of mining as a means of development, and the risks and benefits that accompany such development activities.

1.2. Location

The Fijian archipelago of 330 islands lies approximately midway between the equator and the South Pole¹ along the edge of the Pacific Ring of Fire, a volatile zone of frequent volcanic and seismic activity partially encircling the basin of the Pacific Ocean. The Ring of Fire is known for its rich array of precious metal deposits. The ethnically diverse and culturally rich mining town of Vatukoula, which literally means 'rock of gold,' is situated in the collapsed caldera of an extinct volcano, near the edge of the Nakauvadra mountain range on Viti Levu, the largest Fijian island. Matanagata, which means 'face of the snake,' is the traditional name by which Vatukoula is known (Emberson-Bain, 1994). Vatukoula has a population of approximately 5,700 (Fiji Islands Bureau of Statistics, 2008). The nearby town of Tavua, located approximately eight kilometers north of Vatukoula along the northern coast of Viti Levu, also

¹ Fiji is located between longitudes 174° East and 178° West and latitudes 12° S and 22° South (Fiji Islands Bureau of Statistics, 2008).

developed as a result of the mining industry and has a relatively smaller population of approximately 2,500 (Fiji Islands Bureau of Statistics, 2008).



Figure 1: Regional Map Showing Location of Vatukoula

Vatukoula lies within the 140 square kilometer Nasivi Catchment, which is drained by the Nasivi River (Sinclair Knight Merz Pty Ltd, 1994). The major land uses of the catchment include mining, sugar cane cultivation, pine plantations on upper ridges, and livestock grazing (goats, cattle, and poultry). The Nasivi River flows through the mangroves of the Tavua Delta and discharges into the Pacific Ocean through two primary channels, the *Nasivi* and the *Nasiriti* (Sinclair Knight Merz Pty Ltd, 1994). The river is not generally used for sugar cane irrigation; however, livestock often drink from the river (Sinclair Knight Merz Pty Ltd, 1994). Both the Nasivi River and Tavua Delta are often used for fishing; tilapia (introduced), perch, mussels, oysters, and other shellfish are commonly caught or harvested. Two-thirds of the tropical cyclones that hit Fiji occur in the northwestern region of Viti Levu, where Vatukoula is located (Sinclair Knight Merz Pty Ltd, 1994). On occasion, Vatukoula has been hit by cyclones, which bring high-intensity winds and flooding. These cyclones and other

powerful storms may move large volumes of sediment and produce a rise in water level of between five and ten meters (Sinclair Knight Merz Pty Ltd, 1994).

1.3. Geology

The Pacific Ring of Fire represents the boundary between the Pacific and IndoAustralia Plates, a region known for major epithermal gold deposits and copper-gold porphyry systems, including those in Papua New Guinea, the Solomon Islands, and New Zealand's North Island. Gold deposits were formed at Vatukoula between 3 and 7 million years ago during a period of volcanic activity when hydrothermal forces caused boiling liquid to precipitate gold in thin veins. The rocks of the ancient Tavua Volcano originated as potassium-rich magma of the shoshonite association, which evolved from absarokite (olivine-basalt) parent magma to shoshonite, banakite and monzonite derivatives (Mineral Resources Department: Government of Fiji, 2008a).

Today, the gold at Vatukoula is mostly located within a two square kilometer fractured block, close to the surface (within 600 m). Gold primarily occurs in three types of structural settings:

- steeply dipping northwest- striking shears;
- flat-dipping fractures (flatmakes); and
- shatter blocks between shears (Mineral Resources Department: Government of Fiji, 2008a).

Gold occurs primarily as gold-tellurides and sub-microscopic gold in pyrite. The specific type of gold deposit at Vatukoula is known as a Low-Sulfidation

epithermal gold deposit. There are two main types of epithermal gold deposits, Low-Sulfidation (LS) and High-Sulfidation (HS), each forming from waters of differing chemical composition, and in a distinct volcanic environment. LS epithermal gold deposits are commonly associated with the presence of the following metals: Silver (Ag), Lead (Pb), Copper (Cu), Zinc (Zn), Arsenic (As), Mercury (Hg), Selenium (Se), Cadmium (Cd), and sometimes Antimony (Sb) (University of Otago Department of Geology, 2008).

1.4. Profile of a Developing Island Economy

Fiji's Exclusive Economic Zone covers an area of 1.3 million square kilometers, of which 18,333 square kilometers is land area (Fiji Islands Bureau of Statistics, 2007). There are two main islands, Viti Levu, and Vanua Levu, and approximately one-third of the 330 islands are inhabited. The island nation is a former British colony, which became independent in 1970. According to the recent 2007 census, Fiji's population is 827,900, 51% of whom reside in urban areas. Fiji is ethnically diverse; approximately 57% of the population is indigenous Fijian, and approximately 37% of the population is ethnically Indian. The average life expectancy at birth in Fiji is 68 years, which is slightly below the World Bank reported average for East Asia and the Pacific. The average annual household income for a Fijian family is \$12, 753 FJD, although approximately 31.3% of the population are currently living in poverty according to the most recent survey by the Fiji Islands Bureau of Statistics (Fiji Islands Bureau of Statistics, 2007).

The Fiji Government is party to the United Nations (UN) Millennium Declaration of 2000, has already achieved six of the eight UN Millennium Development Goals (MDGs), and is committed to achieving the remaining MDGs by 2015 (Dumaru, 2006). Infant, child, and maternal mortality rates have been very low since the 1960's, gender disparity in primary and secondary education is low, and adult literacy is high (Dumaru, 2006).

Agriculture and tourism are the primary sources of foreign exchange for Fiji. Sugar exports accounted for over 25% of the total value of Fiji's domestic exports in 2006, and more than 500,000 tourists visited Fiji in 2005 (Fiji Islands Bureau of Statistics, 2008). The country has achieved a modest level of economic diversification and is one of the most developed Pacific Island economies. Garment manufacturing, fisheries, and mineral water exports are also of considerable economic importance. The Gross Domestic Product (GDP) of Fiji has, on average, grown at a rate of 2.04%² between 2000 and 2006.

1.5. Historical Context

1.5.1. Discovery of Gold

The first recorded discovery of gold in Fiji occurred during the British colonial period and has been accredited to Charles Gurney, who found gold in 1868 in the gravel deposits of the Navua River, which is also located on the main island, Viti Levu (Fiji Mineral Resources Department, 1990). A gold rush ensued around the turn of the

² Calculated at constant 1995 prices, at factor cost (Fiji Islands Bureau of Statistics, 2007).

20th century, during which time minute flecks of gold were identified in alluvial deposits in the Nasivi River in the Vatukoula region. In fact, the first recorded discovery of gold at Vatukoula was made by Baron A. B. de Este in 1872. However, the first payable gold deposit at Vatukoula wasn't found until November 5, 1932, in the Lololevu Creek, by the determined prospector from Scotland, William Bothwick (Emberson-Bain, 1994). This discovery ultimately did little to enhance the fortune of Mr. Bothwick; instead there was a general lack of expertise regarding the technical and financial aspects of gold mining in Fiji, which led to an influx of foreign investment and the transfer of control of the majority of mineral wealth to the Australian Emperor group of companies, led by Edward G. Theodore (Emberson-Bain, 1994). By 1936, the gold rush had subsided and only three mining companies held their grip on gold at Vautkoula, including the Emperor Gold Mining Company, Ltd. (Emperor), Loloma Gold Mines, and Dolphin Mines, Ltd, with Emperor assuming full control in 1956 (Fiji Mineral Resources Department, 1990). Emperor was the sole operator, except between 1983 and 1992, when the company entered into a joint venture with Western Mining Corporation (WMC) ("Civil Appeal No. ABU0051 of 2004 " 2006). Emperor once again assumed full control in 1992 and operated the mine continuously until December 5, 2006. In 2003, Durban Roodepoort Deep (DRD) of South Africa acquired 14% of Emperor Mines Ltd. (EML); by 2006 DRD had acquired 100% interest in EML (DRD Gold Limited, 2006). Only one other gold mine was ever developed in Fiji, at the Mt. Kasi orebody on the second-largest island, Vanua Levu. The Mt. Kasi mine was also

operated solely by an Australian company and ceased production in 1946 (Mineral Resources Department: Government of Fiji, 1990).

1.5.2. Historical Contribution of Vatukoula to the Fiji Economy

The overall contribution of the mining sector has declined from its early high in the 1930s and 40's. However, the importance of the mining sector has fluctuated widely at times, due to variability in gold prices. Since 2000, the total value of mining and quarrying sector exports as a percentage of total domestic exports has been approximately 7.7%. However, the mining and quarrying³ sector has only contributed on average approximately 1.5% to GDP during the past 20 years. In addition to gold and silver exports, the mining and quarrying sector has also produced coral sand and limestone for cement manufacturing, and river sand and gravel crude stones for construction during the past five years.

Approximately 7 million ounces have been mined at Vatukoula since 1936 (Department of Lands and Mineral Resources, 2007). Notably, the mine has historically been the recipient of exceptionally generous tax subsidies and concessions by the Fiji government. Indeed, it operated virtually tax-free since the Vatukoula Tax Agreement (VTA) of 1983 (Grynberg, Fulcher, & Dryden, 1997). At the time of closure, the mine had an underground delineated gold reserve of 2.34 million tons, grading 11.4 g/ton, within a total resource of 16.2 million tons, grading 9.1 g/ton. There

³ The overwhelming contributor to the mining and quarrying sector has always been the Vatukoula gold mine, however, prior to WWII, the Mt. Kasi mine (now closed) also contributed to gold production (Mineral Resources Department: Government of Fiji, 2006).

are an additional 250,000 ounces of gold in mine tailings from 5.18 million tons, grading 1.5 g/ton (Department of Lands and Mineral Resources, 2007; River Diamonds PLC, 2007).

1.5.3. Development of a Company Town

Throughout much of Vatukoula's history, labor has consisted primarily of ethnic Fijian males. The mining company was initially able to secure an inexpensive migrant labor supply partially because of a British colonial protectionist policy that erroneously portrayed a comfortable rural Fijian subsistence economy, and thus allowed for the rationalization of low wages and temporary employment (Emberson-Bain, 1994). This policy was rooted in the assumption that the traditional social support system of the rural Fijian village economy would take on the burden of caring for workers during times of sickness, disability, unemployment, and old age (Emberson-Bain, 1994). Indeed, as the Vatukoula mine expanded the recruitment of families eventually became common, and many of these costs were transferred to the wives of mine employees and other women within the village. Women were expected to play an important unpaid domestic role, including preparation of meals, gardening, and maintenance of barracks (Emberson-Bain, 1994).

Housing in Vatukoula was initially built in the 1930's to house single male miners. Later, when families moved in with the miners, little or no extra space was provided. Most of the houses have not had any significant repairs or renovations since they were first built more than seven decades ago. As a result, many houses are now in

severe disrepair and the majority of rainwater tanks are not in safe working condition. Additionally, the land underlying all of the Vatukoula communities is freehold land, which prior to the sale of the mine, was owned by the mining company. Several years ago, EML began selling the houses to employees and their families, without selling the land beneath the houses. Families entered into contracts with EML that required them to take down their houses and move when they no longer worked for the mine (A. Wesson, personal communication, August 15, 2007). These terms have now proven to be unrealistic, with hundreds of former employees currently living in dilapidated houses on company land.

With housing, land ownership, virtually all employment opportunities, many social activities, and even health care historically controlled by the company, Vatukoula can truly be considered a company town. At the time of this study, there was still some residual evidence of this ever-present climate of control, even after the closure of the mine. While many residents were forthcoming about past experiences living in Vatukoula, some remained reluctant to offer opinions for fear of losing future employment opportunities.

1.6. Broader Applicability of the Fiji Case

Directing revenues from mineral extraction into alternate economic sectors has proven to be a daunting challenge for many economies, including the small island nation of Nauru, where phosphate supplies are rapidly nearing exhaustion (Connell, 2006). This research took place shortly after the closure of the Vatukoula mine, at a

critical time of transition for the Fiji economy, the mining company, and the residents of Vatukoula. The closure also facilitated research objectives through improved access to information and employees.

Fiji is a relatively isolated island economy that is highly dependent on the contributions of only a few primary industries, including mining, agriculture, and tourism. It thus provides a very high resolution of variables for causal analysis. As in Nauru, environmental degradation related to mining, including loss of biodiversity and industrial pollution, may potentially impede the development of alternate economic ventures such as tourism or agriculture. Understanding the Fiji case, including the nature and perception of environmental risk in Vatukoula, will thus offer insights into the functioning of competing economies in other developing nations where mining has been an important industry. Such cases are numerous; the list includes, but is not limited to, island nations such as Jamaica, Nauru, Aruba, New Caledonia, and Papua New Guinea; South Africa (Binns & Nel, 2003); former Eastern bloc countries such as the Slovak Republic (Clarke, Denman, Hickman, & Slovak, 2001); and Indonesia (Sondakh & Jones, 2003). Information gathered on best practices and lessons learned in relation to risk management and communication may be widely applicable to these and other developing economies.

The economic opportunities created by growth in the mineral sector frequently stimulate the development of new urban centers in previously undeveloped areas, attracting an interregional labor force. Research resulting in improved risk communication practices will encourage individuals and families to make informed

decisions regarding migration to urbanized mining centers from rural or agricultural areas. The development of the Fijian mining labor supply and the subsequent urbanization of the area surrounding Vatukoula depict a notable parallel with migration and urbanization patterns in mining communities across the developing world. A system of migrant mine labor akin to that in the early Fijian mining industry has operated in South African gold mines for over a century (Moodie, 1994). Similarly, mine workers in Brazilian Amazonia view gold mining as a viable alternative to agriculture, and thus migration to urbanized mining centers is becoming increasingly common (Godfrey, 1992). When employees and their families decide to migrate, either temporarily or permanently, to a mining community, it is critical that they have the information required to make an informed decision regarding the potential risks and benefits of living and working near a mine.

The Vatukoula case is also of immense value because it involves a medium scale gold mine that has been financed by a “non-major” foreign company. The South African company DRD Gold Limited held 100% interest in Emperor Mines Limited (EML) in Fiji at the time of closure (DRD Gold Limited, 2006). Several of the projects studied previously have involved “major” mining conglomerates such as Rio Tinto or BHP_Billiton. However, the growing dominance of medium scale companies, particularly those arising in China and the Asia-Pacific region have not been studied in much detail. The corporate social responsibility ethos in such companies deserves further study as it is likely to be most consequential in coming years.

CHAPTER 2: HISTORICAL ENVIRONMENTAL CONCERNS AND CONFLICTS AT VATUKOULA

2.1. Historical Environmental Concerns

There has been little independent study of the environmental impacts at the Vatukoula mine to date. However, residents have repeatedly expressed concern over contamination of surface waters, drinking water, and sulfur dioxide emissions (Macdonald, 2004). The Nasivi River has historically been severely impacted by sewage and mine wastes (Mineral Resources Department: Government of Fiji, 2004-2007). Many of the residents in Vatukoula have been forced to drink untreated water from the nearby Nasivi River for decades. According to the Vatukoula Primary School head teacher, the major cause of illness at the school is the consumption of contaminated water, as there is limited treated water available to students (Anjali, Jikowale, & Lata, 2007). In 1981, a United Nations Environmental and Social Commission for Asia and the Pacific (ESCAP) report recommended that until Emperor could develop a “satisfactory program for monitoring their environmental impact”, their lease should not be renewed (Macdonald, 2004). In 2003, Emperor claimed that it could not afford to supply treated drinking water supply without government funding (Macdonald, 2004). However, according to a representative from the Ministry of Health, the Ministry had tried on several occasions to put in a public treated water supply, however, the company (Emperor) would not permit them to do so on their privately owned land (Timothy Young, personal communication, August 9, 2007).

Following a formal request from the Fiji Mine Workers Union (FMWU) and the Citizens Constitutional Forum (CCF) in May 2003, the Oxfam Australian Community Aid Abroad Mining Ombudsman conducted an investigation into the mining activities at the Vatukoula Gold Mine in November 2003 (Macdonald, 2004). The case report, published in July 2004, recommended that, “an independent audit of the occupational health and safety practices at the Vatukoula mine site be undertaken (Macdonald, 2004).” In addition, the report recommended that independent environmental and social impact assessments be undertaken and be released publicly, “in a transparent and accountable manner (Macdonald, 2004).” Emperor did not respond to the requests for comment on the 2004 report, or the recommendations the report set forth (Case Updates, 2005). The Mining Ombudsman returned to the site in 2005 to conduct a follow-up investigation and Gender Impact Assessment (GIA). Mine workers reported that newer mine management had taken some steps to improve safety, specifically by installing a new ventilation shaft. However, workers maintained that underground conditions were “very poor, with an intensely hot and wet environment, lack of proper respiratory equipment and consequent health concerns (Oxfam Australia, 2006).”

The head teacher at Vatukoula Primary School, which is located within sight of the mine’s roaster stack, explained that during mining operations children were affected by sulfur dioxide emissions. Teachers were often forced to close all the school windows from 8am until the early afternoon to avoid exposure to emissions, and several teachers requested transfers to different locations because of their environmental concerns (Head Teacher, personal communication, July 30, 2007).

Limited air quality testing was commissioned by Emperor in December, 2003, after the investigation by Oxfam (Simtars, 2004). Ore is roasted as part of the gold extraction process at Vatukoula, and a portion of the gases resulting from this process are removed through cooling in a gravity-fed water tower (Wrigley, 2004). However, residual gases, including traces of heavy metals are subsequently released to the environment (Wrigley, 2004). In December, 2003 Emperor commissioned SIMTARS of Australia to conduct monitoring of ambient air quality in Vatukoula. Activities included monitoring of sulfur dioxide (SO₂), total suspended particles (TSP), and suspended metals (Simtars, 2004). TSP and suspended metals were monitored over a one-month period at single locations, while sulfur dioxide was monitored over a five-week period at three separate locations (Simtars, 2004). Fiji does not currently have federal air quality standards. Thus, various international air quality guidelines, including the United States Environmental Protection Agency (USEPA) guidelines for sulfur dioxide and World Health Organization (WHO) guidelines for trace metal concentrations, were used to draw conclusions regarding the implications of the analytical results (Wrigley, 2004). The final report produced by Australasian Pacific Environmental Consultants concluded that further sampling of lead and arsenic concentrations over an annual time period is required to determine if a potential lifetime risk exposure exists. Further sampling of sulfur dioxide concentrations over an extended annual period was also recommended. Concentrations of cadmium, chromium, copper, nickel and zinc in ambient air were all reported as below the

analytical Limit of Reporting (LOR) and appeared to have no community health implications (Wrigley, 2004).

Furthermore, six tailings dams are located in the Vatukoula region. These dams are designed to store industrial wastes, or tailings, which result from mineral processing. Some residents live only meters away from the dam walls. According to Emperor's 2006 Annual Report, there was a major environmental incident involving a pipeline failure along a section of the Toko tailings pipeline. This incident resulted in the coverage of a 30 meter by 30 meter residential compound with industrial waste (Emperor Mines Ltd., 2006).

2.2. Historical Conflicts

2.2.1. Labor Conflicts

On February 27, 1991, 436 mine workers, who were members of the Fiji Mine Workers Union (FMWU), went on strike in protest of alleged low wages, unsafe working conditions, health concerns, poor housing, and poor environmental standards (Macdonald, 2004). However, the officially recorded reason for the strike, and the only reason that EML recognized, was the "refusal of Emperor to recognize the FMWU for the purpose of collective bargaining under the Trade Union (Recognition) Act (Cap 96A) ("Civil Appeal No. ABU0051 of 2004 " 2006)." In 1991 there were changes in Fiji's industrial legislation which required that employers only recognize those unions which represented over 50% of the total workforce, and following this legislation EML claimed that it was the responsibility of the FMWU to prove that they represented over

half of the labor force (Macdonald, 2004). This was despite the fact that EML and the government had worked with the FMWU for decades prior to the 1991 strike. Indeed, the International Labour Organization's Expert Committee on the Application of Conventions and Recommendations criticized EML in 1996 for "...refusing to recognize independent trade unions, resorting to legal procedures to delay recognition of trade unions...(Macdonald, 2004)" During the 2003 Mining Ombudsman investigation, representatives of the FMWU also claimed that EML used court cases as a delay tactic to avoid confronting the real issues behind the strike (Macdonald, 2004).

On March 4, 1991 the Fiji police enforced an eviction notice on strikers, which resulted in violence, and the death of a court sheriff (Macdonald, 2004). Because of their failure to return to work, EML dismissed the strikers between April and July, 1991 ("Civil Appeal No. ABU0051 of 2004 " 2006). On February 20, 1995, a Commission of Inquiry commenced, with Ganeshwar Prasad (GP) Lala appointed Commissioner. The Commission of Inquiry submitted its Report and recommendations in July, 1995, however the findings were never debated in Parliament because EML applied for and was granted leave for judicial review on March 28, 1996 ("Civil Appeal No. ABU0051 of 2004 " 2006). The GP Lala Report made many recommendations, including increasing environmental control/enforcement by the government, improvements in underground working conditions by EML, inspection of tailings dams and monitoring of sulfur dioxide emissions by EML, and the establishment of a treated drinking water supply. It also recommended that EML make a "humanitarian lump sum payment" consisting of four years' salary and the cost of living for striking workers, and the

establishment of a social justice fund, to consist of annual contributions from EML, the government, mine workers, and all Fiji employers, to improve housing conditions in Vatukoula. Following a lengthy legal battle, the dispute was ultimately resolved in the courts in favor of EML, however, this decision was based solely on a technicality. In 2004, the GP Lala Commission of Inquiry Report was declared null and void because it continued to receive submissions and evidence after the allotted time period in its original terms of reference ("Civil Appeal No. ABU0051 of 2004 " 2006). However, a 2006 High Court of Appeal judgment in response to an appeal of the decision to make the GP Lala report null and void stated that "the recommendations of the Commission had no binding effect and had the Government wished to implement any of them, it would have been free to do so irrespective of the High Court Decision ("Civil Appeal No. ABU0051 of 2004 " 2006)." In the eyes of the strikers, the dispute remains unresolved after more than 16 years, and workers continue to sit in protest outside the mine on a daily basis, even now that the mine has closed.

2.2.2. Land Conflicts

There are several on-going disputes over land ownership in the Vatukoula area. Indigenous Fijian culture is characterized by a strong social and cultural attachment to the land. Indigenous landowners believe that their ownership extends to the sky above and the minerals below their land. In Fiji, 84% of the total land area is owned by indigenous landowners (Mineral Resources Department: Government of Fiji, 2008b). This land, called *Native Land*, is owned by traditional landowning units called *mataqali*, rather than by individuals, and cannot be sold (McLeod, 2000).

Landownership rights are collective and temporary, being passed on through generations (McLeod, 2000). The remaining land area is either freehold land or state land.

According to Fiji law, unextracted minerals belong to the state, but royalty payments for the right to extract minerals, and compensation payments for landowner loss of tenure and/or damage to land must be paid to the government and subsequently distributed to landowners (Mineral Resources Department: Government of Fiji, 2008b). The Native Land Trust Board (NLTB) is the governing body in charge of leasing Native Land and distributing benefits arising from commercial activities on Native Land (McLeod, 2000). In 1999, a comprehensive compensation policy was developed by a interdisciplinary team, led the Mineral Resources Department, titled, “Compensation Policy for Fiji’s Mineral Sector,” however this policy has not yet been fully implemented (McLeod, 2000; Mineral Resources Department: Government of Fiji, 2008b). Historically disputes have arisen related to the unfair distribution of compensation. For example, payments may be made directly to the *mataqali* leader, when customary law actually demands that such payments be made to the provincial chief. Equity issues also arise related to distribution of compensation between individuals within the *matagali* unit. Additional problems have arisen when the NLTB has withheld payments and instead distributed only interest to landowners (McLeod, 2000).

Landowners from the Nasomo region claim that over 1,000 acres of their land was unlawfully given to EML during their joint venture with WMC in 1983, when 70%

of the land under dispute was granted to EML under Special Mining Lease (SML) 55 (Macdonald, 2004). In 2002, the Nasomo people were granted \$1 Million FJD by the courts, as compensation for this land. However, the Nasomo people sought significantly more, including that SML 55 be declared “null and void” and that the companies reimburse landowners for all of the revenues they had derived from resources on the disputed land. At the time of the mine closure, EML was undertaking exploration activities on the disputed land. Nasomo landowners remain very concerned that their current water source will be contaminated by mining activities (Nasomo landowner, name withheld, personal communication, July 21, 2007).

At least two other traditional landowning groups, the Natolevu Landowning Unit, and the Nakoroboya Landowners also have unresolved land claims in the Vatukoula region. The Nakoroboya group claims they hold documents dating back to 1895, including a map detailing their land ownership claims to the area where the mine is located (Macdonald, 2004). This group told the Mining Ombudsman in 2003 that these unresolved claims were causing tensions in the community (Macdonald, 2004). When asked by the Mining Ombudsman about the land claims of these three groups in 2003, EML stated that they owned the land outright and were not aware of any claims (Macdonald, 2004).

CHAPTER 3: ENVIRONMENTAL IMPLICATIONS OF GOLD MINING

3.1. Overview of Mine Processes at Vatukoula

Vatukoula is a multi-shaft underground mine, with average gold grading of 7-11g/ton. The gold recovery process begins with the crushing and grinding of ore and the removal of the resulting primary slime through screening and rake classification. Next, the bulk gold-telluride/pyrite concentrate and primary slime are sent through separate flotation circuits and then re-combined after achieving a specified level of concentration (Sinclair Knight Merz Pty Ltd, 1994). The combined flotation concentrates then undergo roasting and a process known as *cyanidation*. Because gold occurs in extremely small concentrations, cyanidation is the only economical way to extract gold particles from the ore. This process involves the application of a cyanide solution to dissolve the gold into an aqueous medium through several leaching circuits, followed by the adsorption of the resulting gold-cyanide complex onto activated carbon. Silver is also recovered at a later stage using sodium chloride (Sinclair Knight Merz Pty Ltd, 1994). Residual cyanide is destroyed through the gassing of pulp from the carbon adsorption circuit with SO₂. Tailings are subsequently pumped off for disposal into a tailings dam.

3.2. Cyanidation

Worldwide, 90 % of gold is recovered using cyanidation (Akcil, 2006). As is the case with any industrial chemical, cyanide can pose unacceptable risks if it is not managed properly. Cyanide is known to react with a wide variety of elements in

solution, resulting in the formation of many cyanide-related complexes. Because they process such large quantities of ore, gold mining facilities also produce large quantities of effluent from the cyanidation process, which can contain free cyanide and a variety of metal-cyanide complexes including zinc, nickel, cadmium, copper, arsenic, and iron, depending on the composition of the water that is used in the solution. Effluent is also likely to contain the oxidized products of these compounds, including ammonia, cyanate and thiocyanate (Muezzinoglu, 2003).

3.3. Chemical Transportation and Storage

The chemicals used in the mine processes at Vatukoula are imported, transported to the mine, and subsequently stored on-site. The chemicals present at Vatukoula at the time of this study included sodium cyanide (NaCn; solid tablets and liquid solution), sulfuric acid, lead nitrate, zinc powder, nitric acid (HNO₃), various flotation reagents, and approximately 100 tons of elemental sulfur (Metallurgy mill worker, name withheld, personal communication, July 27, 2007). Chemical storage units are contained within concrete secondary containment, however, the concrete is reportedly old, with potential for seepage (Metallurgy mill worker, name withheld, personal communication, July 27, 2007).

3.4. Disposal of Mine Wastes

Effluent is eventually stored in large tailing dams, where some of the cyanide solution is recycled. The dams are left open to the atmosphere to allow the evaporation

of hydrogen cyanide (HCN) gas into the air, which is accelerated by direct solar radiation (photolytic dissociation of cyanide) (Muezzinoglu, 2003). Many ores contain pyrites and sulfur-containing inorganic compounds that can make controlling pH extremely difficult. Variations in pH in tailings dams or effluent streams may increase the solubility of metal cyanide complexes and thus create the potential for heavy metal contamination of the ground water, surface water, and soil (Muezzinoglu, 2003).

Releases and failures of tailings dams have been documented across the globe. The majority of major mining-related environmental incidents worldwide have been the result of dam overtopping, breaching, geotechnical failure, or earthquake (Akciil, 2006). In 2000, the Aural gold mine in Romania experienced a dam failure that caused leaching of mine wastes into the Danube river system (Stenson, 2006). In 1988, the Kumtor mine in Kyrgyzstan recorded a spill of 100 tons of cyanide (Stenson, 2006). Unfortunately, it was only after the Kumtor spill that many of the issues associated with cyanide management were addressed. While many developed countries maintain strict regulations on the storage and disposal of wastes from gold mines, mining corporations in the developing world often operate under much less scrutiny. It is thus extremely important for residents in mining areas to be informed about the potential environmental and health risks posed by the storage, transportation, and handling of mining wastes.

There are six tailings dams located in the Vatukoula region, none of which were active at the time of this study. Tailings dams No.1-5 are located relatively close to the Vatukoula settlements, while the 6th dam, Toko Dam, is located approximately 5

kilometers northwest of the mine and is currently filled to capacity. Dams No. 1-4 are significantly older and are all variously re-vegetated. Dam No. 1 has been substantially removed, while the walls of Dams No. 2-4 were all re-vegetated and stabilized with cane grass (*Miscanthus sp.*). A 1992 environmental audit by Sinclair, Knight, & Mertz indicated that levels of certain heavy metals in food crops grown on the older tailings dams were safe for human consumption; however, the same report warned that the harvesting of crops grown on dam walls could encourage large scale erosion of walls over time (Sinclair Knight Merz Pty Ltd, 1994). A trial wetland was constructed at Toko Dam in the early 1990's. This trial wetland was designed to treat 20% of the dam outflow, while 80% was directly discharged to the local waterway. During full operation, the mine was discharging on average 80-90 tons of waste per hour into local waterways, approximately 32% of which would settle (Metallurgy mill worker, name withheld, personal communication, July 27, 2007). The wetland reportedly functioned well for two years, and then gradually deteriorated. EML was in the middle of negotiations with the Nadelei landowners to purchase land for a new tailings dam at the time of the mine closure (Metallurgy mill worker, name withheld, personal communication, July 27, 2007).

3.5. Environmental and Health Effects of Cyanide

Cyanide is produced naturally in over 1,000 plant species and the human body (International Cyanide Management Institute, 2006). Cyanogenic plants such as cassava, young bamboo shoots, coffee beans, lima beans, soy, and chickpeas naturally

contain low concentrations of cyanide, which occurs as part of sugars or other compounds. Certain bacteria, fungi, and algae also produce cyanide (Agency for Toxic Substances and Disease Registry, 2006). Cyanide is acutely toxic to humans and wildlife; fish and invertebrates are particularly susceptible to cyanide poisoning (International Cyanide Management Institute, 2006). Cyanide does not bioaccumulate, so chronic exposure to very low concentrations will not eventually result in acute toxicity. However, incidences of chronic cyanide poisoning have been documented in people who consistently eat a diet containing large quantities of cyanogenic plants such as cassava (International Cyanide Management Institute, 2006). In Fiji and other tropical climates across the globe, cassava is a staple source of carbohydrates. However, the inner portion of the tuber contains the lowest concentrations of cyanide and traditional preparation methods can reduce cyanide concentrations even further (Agency for Toxic Substances and Disease Registry, 2006; Keeler & Tu, 1983).

Hydrogen cyanide gas (HCN) is colorless and has a faint, bitter, almond-like odor. Sodium cyanide and potassium cyanide are white solids which also have a bitter almond-like odor in damp air (Agency for Toxic Substances and Disease Registry, 2006).

Humans may be exposed to cyanide by breathing in HCN gas, breathing tobacco smoke or smoke from burning buildings or plastics, through contaminated drinking water, eating foods containing cyanides, or by touching soil contaminated with cyanide. In surface waters, the majority of cyanide will evaporate as HCN gas under most natural conditions. Exposure to large concentrations of cyanide over a short

period of time may result in acute cyanide poisoning. The first indications that a person may be experiencing cyanide poisoning include shortness of breath, deep and rapid breathing, seizures, or loss of consciousness (Agency for Toxic Substances and Disease Registry, 2006). Similar health effects of acute toxicity are exhibited by both adults and children.

3.6. Environmental and Health Effects of Arsenic

Arsenic is naturally found in all soils in varying quantities. The geological origins of a soil and its past uses determine the amount of arsenic present, and areas with volcanic activity are known to contain particularly high levels of arsenic (Aalbersberg, 2007; Agency for Toxic Substances and Disease Registry, 2007). Use of arsenic containing pesticides, coal-fired power plants, and incinerators are also environmental sources of arsenic, which may enter the water, soil, or air. Many common arsenic compounds can dissolve in water, so they may enter lakes, rivers, and streams. Unlike mercury and lead, which are most toxic in their organic forms, *inorganic* arsenic is the most toxic form of arsenic to humans (Agency for Toxic Substances and Disease Registry, 2007). A person may be exposed to arsenic through drinking water or air, but food consumption is the largest source of arsenic. Children may also be exposed to arsenic if they consume soil during play (Agency for Toxic Substances and Disease Registry, 2007).

Inorganic arsenic is toxic to humans and may cause death in large doses (above 60,000 ppb in water). Inorganic arsenic is recognized as a human carcinogen (cancer-causing chemical) by the following agencies: the Department of Health and Human

Services (DHHS), the International Agency for Research on Cancer (IARC) and the Environmental Protection Agency (Agency for Toxic Substances and Disease Registry, 2007). Symptoms of acute exposure to inorganic arsenic include nausea, vomiting, fatigue, impaired nerve function. Long-term exposure to lower doses causes patches of darkened skin and the appearance of small "corns" or "warts" on the palms, soles, and torso, associated with changes in the blood vessels (Agency for Toxic Substances and Disease Registry, 2007). Breathing in low doses of inorganic arsenic may cause a sore throat and lung irritation. Skin, liver, bladder, and lung cancer are also associated with exposure to inorganic arsenic (Agency for Toxic Substances and Disease Registry, 2007). Organic arsenic is much less toxic, and is usually excreted in urine within several days of exposure.

CHAPTER 4: REGULATORY CONTEXT

4.1. Organization

Since the most recent military coup, which occurred in December, 2006, the Fiji government has undergone significant reorganization of its ministries and departments. Currently, the Ministry of Lands, Mineral Resources, & Environment is the principal government agency responsible for development and implementation of mineral resources policy in Fiji. The Mineral Resources Department (MRD), under the supervision of the Ministry of Lands, Mineral Resources, & Environment provides technical and geoscientific information to assist investors in the mining sector, develops mineral policies, promotes the mineral industry in Fiji internationally, and facilitates exploration and development of mineral, petroleum, and other non-living resources (Mineral Resources Department: Government of Fiji, 2008b). Additionally, the MRD is responsible for environmental monitoring and inspection of operational mines. The MRD has a functional analytical laboratory, and drilling and engineering geology units. The Public Service Commission appoints the Director of Mines, who is responsible for management and oversight of the MRD (Mineral Resources Department: Government of Fiji, 2008b). The Department of Environment, also under the supervision of the Ministry of Lands, Mineral Resources, & Environment is responsible for the enforcement of the recent 2005 Environmental Management Act and thus may also be involved with mining operations. At the time of this study, the ministry responsible for the Department of Environment was the Ministry of Labour, Industrial Relations, Tourism & Environment. The Ministry of Health, Women, & Social Welfare may also

be directly involved with mining operations because it is responsible for environmental and public health inspections under certain circumstances, such as after an environmental incident (e.g. cyanide spill or fish kill) (Timothy Young, personal communication, August 9, 2007). Vatukoula was excluded from the Health and Safety a Work Act of 1996, and occupational health and safety at the mine remains under the jurisdiction of the Mining Act. As a result, the Occupational Health & Safety (OHS) department is not involved at Vatukoula; instead the MRD is responsible for occupational safety & health under the Mining Act (Timothy Young, personal communication, August 9, 2007).

4.2. Existing Legislation

The Mining Act of 1978 is the primary piece of legislation governing mining activities in Fiji. The Act prohibits the pollution of waterways, and also requires the filling of any hole, shaft, or pit other excavation created during mining activities (Fiji Parliament, 1978). However, the fines imposed for violations of the Act are extremely small, especially when levied against a large foreign corporation, such as EML. For example, the Act calls for a fine not to exceed \$100 FJD for anyone who “causes or permits the deposit or discharge of any rubbish, dirt, filth or debris or any waste water from any sink, sewer or drain or other dirty water or any chemical or other substance deleterious to animal or vegetable life, or any other noxious mater or thing, into any watercourse (Fiji Parliament, 1978).” The Act allows the Director to issue permits for discharge of wastes and mine tailings as he deems fit and also gives the Director the

power to require the discharging party to supply an alternative water supply to residents if he deems that their water supply has been compromised. The maximum fine imposed for any violation of the Act is \$200 FJD (Fiji Parliament, 1978). Under the Mining Act, the MRD is responsible for inspections and environmental monitoring at Vatukoula, however, according to the Director of Environment, Eveli Nasome, these monitoring requirements are weak, and Emperor, on occasion, blocked MRD inspectors from completing inspections (Eveli Nasome, personal communication, August 9, 2007).

In 2005 a new Environment Management Act was passed, which requires Environmental Impact Assessments (EIAs) for all new development projects, environment bonds for mitigation purposes, and imposes strict fines (up to \$1 Million FJD) for violations (Parliament of the Fiji Islands, 2005) . However, at the time of this study, the specific regulations that must accompany the Act were still being finalized, making it impossible to enforce the Act (Timothy Young, personal communication, August 9, 2007; Eveli Nasome, personal communication, August 9, 2007). The new regulations will provide the mandate for the Department of Environment to undertake the EIA process through direct legislative requirements once they receive final approval.

“Currently, the Department of Environment undertakes the whole process of approving EIA Reports through the powers of the Director of Town and Country Planning or through the own initiative of developers who recognize the environmental

impacts on their developments and the need for the process to be done (Fiji Government, 2007).”

Prior to the enactment of the Environment Management Act, the Ministry of Health also had the power to enforce environmental and health standards under the Public Health Act. The Public Health Act requires EML to supply residents with a water supply on their land, however, the Act does not require that the supply be treated or fit for human consumption (Timothy Young, personal communication, August 9, 2007).

CHAPTER 5: UNDERSTANDING ENVIRONMENTAL RISKS

It is important that individuals accurately understand the risks and benefits associated with mining, so that they may make informed decisions about living and working in a mining community. However, community perceptions of risk can differ significantly from those of company representatives, policy makers, and the scientific community (Hadden, 1991). Indeed, public concerns have sometimes been ignored or downplayed by those responsible for the implementation of environmental policies and practices (Williams, Brown, Greenberg, & Kahn, 1999). Thus, examination of the unique and complex social, economic, political, psychological and cultural factors influencing public risk perception is essential for successful risk management. Studies addressing the complex nature of risk perception in developed countries such as the United States (Paul Slovic et al., 1991), France, Australia, Germany, and the United Kingdom (Eiser et al., 1990) have made valuable contributions to the understanding of effective risk management, often resulting in improved risk communication practices. However, fewer such studies have taken place in the developing world (Bronfman & Cifuentes, 2003).

5.1. Risk Perception

The constructivist view of risk perception holds that risks are not purely a product of the existing environmental reality, but rather, they are formed on both an individual and societal level in a complex setting of contextual factors (Jasanoff, 1999; Kasperson & Kasperson, 1996), not necessarily including science (Davis, 2005;

Hadden, 1991). Slovic, Fischhoff, and Lichtenstein conducted some of the earliest studies quantifying risk perception beginning in the late 1970s (P. Slovic, Fischhoff, & Lichtenstein, 1980). They developed a methodology which they later termed the psychometric paradigm, using a survey instrument to quantify a wide variety of social, cultural, and psychological factors which they found to influence what an individual subjectively understands as risk. The psychological paradigm has since been widely replicated, albeit to a lesser extent in the developing world (Bronfman & Cifuentes, 2003), and has contributed to our improved knowledge of how people understand risks and how they use this understanding in the decision-making process. However, more recent contributors to risk literature have argued that although the paradigm has been replicated with much success, it may not be totally sufficient to understand the complex nature of the risk perceiver (Marris, Langford, & O'Riordan, 1998; Sjoberg, 1999). Sjoberg demonstrated that variables such as the seriousness of consequences and the perceivers interest in the risk were also important predictors of the resulting level of demand for mitigation of a particular risk (Sjoberg, 1999). The present study, while borrowing from the model of the psychometric paradigm to examine the social and cultural context of risk perception at Vatukoula, also endeavors to take a more exploratory approach using complimentary qualitative methods, given the lack of prior research on risk in Fiji.

Sokolowska and Tyszka (1995) found that public acceptance of risk may be influenced by the perceived economic benefits associated with the activity (Sokolowska & Tyszka, 1995). Issues arising from the interplay between socio-economic benefits

and environmental risks are particularly acute in small island states which have isolated and highly limited economic development trajectories. Williams, Brown, Greenberg, and Kahn (1999) expanded upon the earlier research of Sokolowska and Tyszka regarding perceived economic benefits and risk perception, by examining the relationship between “actual economic dependence,” on a hazardous waste facility in the United States, and perception of environmental risks. The present study extends this line of research, by examining the relationship between economic dependence and perception of risk in the differing context of a mining facility in a developing country.

The role of women in risk-analysis and decision making processes has been another important area of inquiry in many risk perception studies. Women have traditionally had limited access to the employment and business opportunities related to mining, while assuming much of the social and environmental burden. These issues are further complicated by the alienation of families from land that has been widely associated with mining development, especially in Pacific Island cultures where access to land is linked to the status of women. At the Lihir mine in Papua New Guinea, women who previously played a vital and self-directed role in household activities began to feel dependent on their husbands for housekeeping money when mining development occurred. “Depriving women of land and failing to provide them with viable alternative ways of affirming their importance in society, unlike men who can earn good money working in the mining development, effectively deprives them of the opportunity to feel that they are contributing to society and are valued, productive members of their family and clan (Scheyvens & Lagisa, 1998).” Women have also

been documented as being the first residents to become dissatisfied with the mining process, often leading to domestic conflicts and even civil unrest (Scheyvens & Lagisa, 1998).

Finally, women have been shown to express consistently higher levels of concern about environmental risks than their male counterparts (Davidson & Freudenburg, 1996). While this finding has been replicated widely throughout the existing literature, there has been less research into the reasons why this is the case. Interestingly, one study found that women were less likely to view environmental risk as counterbalanced by economic benefits, but rather as exacerbating economic costs including “negative impacts on business development, tourism, and the acceptability of agricultural products (MacGregor et al., 1994).” Another study found that women were also more likely to take voluntary action to mitigate environmental risks (O'Connor, Bord, & Fisher, 1999). Furthermore, this disparity in perception of risk has primarily been found between Caucasian men and women in the United States. Further investigation into the role of gender in risk perception across other cultural contexts is thus warranted (Davidson & Freudenburg, 1996). Davidson and Freudenberg (1996) have also suggested that while numerous studies have focused on nuclear energy and nuclear waste, additional research into technologies that have thus far been categorized broadly as “other” may benefit our understand of risk perception and gender.

5.2. Risk Communication

Risk communication is a dynamic process of interaction between individuals, communities, groups, and institutions. The process involves not only information about risks, but also the concerns, opinions and reactions that people have to risk information (Committee on Risk Perception and Communication & National Research Council, 1989). Whether or not risks are communicated effectively depends upon several factors, including, but not limited to the accuracy of risk assessment and information delivery, the level of trust placed in those who communicate risk messages, existing perceptions and knowledge of risks, inter- and intra-community interactions, and the effects of unintended and unofficial risk messages (Fessenden-Radon, Fitchen, & Heath, 1987; Lofstedt, 2003; Lundgren & McMakin, 2004). Although the nature of risk communication is complex, there are strategies that may be employed to more effectively communicate risks. However, the multifaceted nature of risk communication requires that the strategies used in any particular case must be adapted so that they are appropriate for the unique community and industry stakeholders involved.

5.2.1. Risk Communication Challenges

Messages about risk, by their very nature, simplify and condense technical information, creating the potential for confusion and/or distrust. Risk messages also invariably contain some level of uncertainty, further complicating their delivery

(Fessenden-Radon et al., 1987). It is therefore important to set realistic goals for any risk communication plan, recognizing that improved risk communication will not necessarily lead to the resolution of existing controversial issues (Committee on Risk Perception and Communication & National Research Council, 1989). This is because people have differing interests and values; when people have more accurate information about risks, they will not necessarily reach the same conclusion about a particular risk.

Many of the challenges that arise in the risk communication process can be broadly categorized into two general types, including problems arising between risk communicators, recipients, and intermediaries; and problems arising from the political or institutional systems related to risk management (Committee on Risk Perception and Communication & National Research Council, 1989; Fessenden-Radon et al., 1987; Lofstedt, 2003). The former type can usually be addressed more directly than the latter, making problems between message recipients, intermediaries, and deliverers a particularly appropriate area of focus for improvement. However, understanding the unique political and institutional challenges in a particular case can also aid in the risk communication process.

One important challenge that confronts risk managers is that existing political and institutional systems, including legal and statutory considerations can limit the options available for dealing with a particular risk (Committee on Risk Perception and Communication & National Research Council, 1989). For example, in the United States, the Federal Clean Water Act requires that the best available technology be

employed in dealing with certain risks, regardless of the financial costs of that technology. A lack of consideration of these influences may lead to difficulty on the part of some recipients in understanding risk messages. Indeed, industries are expected to comply with all statutes and regulations at a minimum, to meet the expectations of regulators and the community (Sadar & Shull, 2000). Another political challenge often arises because individuals, communities, and citizen groups do not have access to the same resources to obtain information and conduct research about risks as government and industry. As a result, the public may not accept messages about risk if they do not feel that the information and research used in creating the messages addresses their concerns (Committee on Risk Perception and Communication & National Research Council, 1989). Finally, when multiple authorities are involved in the risk communication process, for example industry representatives and local and regional government authorities, there is a potential for conflicting and fragmented communication. Often such conflicting information casts doubt on the validity of risk messages, especially if the multiple information sources are all viewed as experts (Fessenden-Radon et al., 1987).

Many additional challenges arise related to the complex interaction between the messenger, message, and receiver in the risk communication process. The role of the risk information receiver is indeed extremely important, however, this role has often been ignored (Fessenden-Radon et al., 1987). Perhaps most importantly, recipients of risk messages must trust the authorities which communicate risks to them (Jardine, 2003; Kasperson, 1986; Lofstedt, 2003; Siegrist, 2000). Research has revealed a direct

relationship between high public trust in authorities and low perceived risk, and low public trust in authorities and high perceived risk (Lofstedt, 2003). Although individuals ultimately decide how to interpret risk information, research has also indicated that collective interpretations of risk can develop in communities, and these may also affect how risk messages are received. For example, people may use vicarious experience (those experiences which are only known to a person indirectly) to interpret the level of risk and messages about risk (Fessenden-Radon et al., 1987). Community leaders can further exacerbate collective interpretation of risk. If they hear about a risk situation in another community, they may interpret this to mean that the same risk exists in their own community (Fessenden-Radon et al., 1987).

To further complicate matters, official, intentional messages about risk are not the only messages that recipients receive. Some risk messages are sent unintentionally, and may take verbal, written, or non-verbal form (Committee on Risk Perception and Communication & National Research Council, 1989; Fessenden-Radon et al., 1987). Additionally, a lack of basic knowledge, or the concepts needed to interpret messages on the part of the recipient may cause confusion or doubt about risks (Fessenden-Radon et al., 1987).

Finally, the aggregate nature of risk messages provides another obstacle to communication about risks. Information about risks is often provided in terms of the risk to a typical population; however, if people cannot answer the question 'how will this affect me?' and relate risk information to their personal experience, then messages about risk may simply be ignored (Fessenden-Radon et al., 1987).

5.2.2. Best Practices in Risk Communication

Contributions to risk communication have come from many different disciplines; this discussion of best practices will draw on a wide variety of approaches to risk communication, which can all offer insight depending on the unique audience and situation at hand. The best practices are compiled into two categories: 1) recommendations relating to the *process* of risk communication 2) recommendations related to the *content and presentation* of risk messages. In general, risk managers have traditionally focused on improving the accuracy of message content, however, it has been demonstrated that both risk communication procedures and message content must be improved (Leiss, 1996).

Best Practices: The Risk Communication Process

- It is important to begin by setting realistic expectations for the risk communication process. Improved risk communication will not necessarily resolve existing tensions between stakeholders. Practical goals should be established so that all stakeholders have realistic expectations and progress towards goals can be assessed.
- Identify any limitations, which may include regulatory or audience requirements, for example, limits to the audience's ability to read or process information.
- Pre-test risk messages and conduct additional testing between communication rounds so that improvements in messages can be continually made. Tests with

small sections of the intended audience can potentially be used to identify whether a risk message is addressing the intended concerns and is appropriately presented.

- Assess audience perceptions and concerns prior to and throughout the communication process. Some concerns may appear to be based on inaccurate scientific reasoning, or to be irrelevant; however, these concerns must be listened to and addressed if risk communication efforts are to be successful.

Best Practices: Message Content and Presentation

- Knowing the audience to whom risks will be communicated is perhaps the most important principle of effective communication. A thorough knowledge of a particular audience may include unique cultural considerations, audience preferences for timing of messages, background knowledge and the existing level of confidence and trust in risk management authorities. Messages should then be conveyed in relationship to the audience's perspectives.
- The language and presentation of risk messages should be simplified, but the *content* should not.
- Messages about risk should not minimize the level of uncertainty. In some situations uncertainty should be fully discussed, including the methods that were used to gather data, how data was analyzed and how the results were interpreted. For example, if the audience has been involved throughout the process of risk assessment, a discussion of uncertainty may not be required because the audience

may already understand the sources and level of uncertainty. In crisis situations, risks may be obvious and can also be left out unless requested.

- Comparisons about risks should be presented with caution. Analogies can be useful, but care should be taken so that they do not trivialize the level of risk. Ranges can be used to express the level of risk (this is particularly useful for hostile audiences, allowing people to determine their own personal risk level). Finally, comparisons should be used to relate risks to certain segments of the population (risks to seniors versus young children).

CHAPTER 6: MINING AND SUSTAINABLE DEVELOPMENT

The concept of sustainable development was first popularized following the 1987 United Nations (UN) Brundtland Commission report, *Our Common Future*, which adopted it as an official UN goal. They loosely defined the term as development that “meets the needs of the present without sacrificing the ability of the future to meet their own needs (World Commission on Environment and Development (WCED), 1987).” Since 1987, many attempts have been made to more clearly define sustainable development, resulting in a growing debate over how to operationalize the concept.

In general, economists have approached sustainable development by recognizing that sustainability is closely linked to the economic concept of income. Particular attention has been paid to this approach because it offers practical insight into how measure progress towards the goal. The approach is based on the economic definition of income, outlined by Hicks in 1946 as the maximum amount an individual can consume during a period and remain as well off at the end of the period as at the beginning (Hicks, 1946). In other words, Hicksian income is the amount that can be consumed (spent) without depleting the associated existing capital base (from which the income is generated). It follows that maintenance of capital is the key to sustainability. The concepts of income and capital have thus become the basis from which a more detailed definition of sustainability has arisen. According to this definition, sustainable development is development that ensures non-declining per capita national wealth by replacing or conserving the sources of that wealth; that is, stocks of produced, human, social and natural capital (United Nations, European

Commission, International Monetary Fund, Organization for Economic Co-operation and Development, & World Bank, 2003)

In 1931, Harold Hotelling recognized that the management of non-renewable natural resources posed a special problem; unlike renewable natural resources, which can be managed so that they produce a sustainable income, non-renewables, such as mineral stocks, inevitably decline as they are extracted (Hotelling, 1931). It follows that their ability to produce the same level of income also declines with extraction. From a purely accounting standpoint, this means that the net receipts from the extraction of non-renewable resources must actually be separated into two components: *user cost* and true income (El Serafy & Lutz, 1989). User cost being the capital component earned at the expense of degrading the value of the resource. True income is the component earned that is value added (not earned at the expense of asset depletion) (El Serafy, 1989). The important point is that the capital component of the net receipts originating from exhaustible resources must be set aside for investment in new types of capital (and thus subtracted from GDP in the case of national accounting) (El Serafy, 1989).

Until very recently, countries have employed mostly aggregate measures of national income accounting. However, traditional methods of income accounting using GDP, such as the widely used 1968 version of the UN System of National Accounting (SNA), while useful in describing short term changes in economic activity, are not as valuable for assessing long-term sustainable growth. This is partially because they ignore the depletion of natural resources and expenditures to protect or restore the

environment (El Serafy & Lutz, 1989). In the case of natural resource exploiting countries, traditional accounting methods have grossly overestimated real income, and natural capital stocks have been largely consumed rather than reinvested in other forms of capital. Fortunately, research on natural resource accounting has offered ideas on how to update national accounting procedures to account for natural resource depletion and environmental pollution. Adopting the ideal of sustainable development, the UN has worked with the World Bank, Organization for Economic Co-operation and Development (OECD) and the International Monetary Fund (IMF) to develop an updated version of the SNA. The updated 2003 Handbook for Integrated Environmental and Economic Accounting (SEEA), offers practical methods for measuring natural capital (United Nations et al., 2003). In this way, countries can begin to take stock of their natural assets and manage their development activities accordingly. It is important to note however, that natural resource accounting is still a work in progress. The SEEA focuses primarily on the environmental and economic aspects of sustainability, and offers less advice on social sustainability. Practically speaking, there are also many challenges associated with the valuation of environmental resources, especially in developing countries. Some of these challenges include a lack of environmental and financial data, a lack of transparency, the need for a determination of the stage at which the resources should be valued, and the limitations of reducing environmental resources to monetary value (Peskin, 1989). Nevertheless, these methods represent a significant improvement over traditional

national accounting, and provide practical guidance on one way to assess sustainability in resource-rich countries.

6.1. Proceed With Caution: The Resource Curse

Research has demonstrated that some countries with significant endowments of natural resources have fallen victim to a phenomenon referred to as the *resource curse* (Humphreys, Sachs, & Stiglitz, 2007a). Many naturally wealthy countries have experienced slower economic growth, higher rates of political turmoil and corruption, and a host of other economic and political challenges compared with countries with fewer resources (Humphreys et al., 2007a). The tendency for states to consume revenues (capital) originating from the sale of non-renewable resources, rather than investing the revenue into assets, is just one of the many pitfalls of natural resource wealth. Other side-effects of natural resource wealth include *Dutch Disease*, a decline in other domestic economic sectors; boom-bust cycles, which result from volatility in income derived from natural resources; increased corruption; weakened democratic political systems; militarization and meddling of foreign powers in local politics; and an uneven distribution of knowledge and power, where extracting corporations have the upper hand in negotiations with governments (Humphreys et al., 2007a). Furthermore, mineral rich economies in particular, have been prone to government failure (Auty, 1998).

The negotiation process often marks the beginning of the potential hurdles that a country wishing to extract natural resource wealth may encounter. Natural resource

contracts are usually dependent on several time-sensitive factors, including the changing price of the resource, and the current economic and political conditions in the country (Radon, 2007). Informational advantages on the part of companies, and a lack of technical and negotiation expertise on the part of governments often combine to result in contracts with large concessions, inhibiting the government's ability to invest resource rents far into the future. Such contracts tend to impose very low royalty rates which are often charged only on profits. In theory, since oil, gas, and minerals are fixed and non-mobile assets, high taxes could be charged without encouraging their movement out of the country; in reality though, this has not always been achieved (Humphreys, Sachs, & Stiglitz, 2007b). However, governments can begin to negotiate better contracts, starting with a simple step: they can hire one or more expert negotiators, which would represent a relatively small up-front cost and increase their chances for retaining resource rents for years to come (Radon, 2007). Also, ensuring that government employees with the necessary technical expertise are part of the negotiation team, and the strengthening of tax legislation prior to the negotiation of contracts can also encourage more optimal outcomes.

After a contract is negotiated, the potential for "Dutch Disease," consumption of capital, and boom-bust cycles face resource wealthy countries. In the uncertain political climate of many developing countries, politicians often have an incentive to spend revenues sooner rather than leaving investment opportunities for future opponents (Humphreys et al., 2007a). Compounding the problem, volatility in earnings from natural resource extraction, originating from variability in extraction rates, natural

resource prices, and the timing of payments made by corporations, result in further difficulty in managing expenditures (Humphreys et al., 2007a). Additionally, while states tend to overspend, they also tend to under-invest. For example, studies have revealed a particular tendency to short-change investments in education (Glyfason, 2001).

Political challenges also confront resource-wealthy nations. Profit-motivated companies sometimes find it easier to bribe political officials to obtain resources at low prices, than to search for more efficient means of extraction (Humphreys et al., 2007a). Additionally, because a high level of wealth is available in the short-run, theft of these assets may provide an easy means of maintaining power (Humphreys et al., 2007b).

While many resource-rich developing nations have failed to benefit significantly from their natural wealth (Sachs & Warner, 2001), others have managed to achieve socio-economics benefits. Out of 18 resource-abundant developing countries studied between 1970-90, only two, Malaysia and Mauritius were able to sustain over 2 % growth per year (Sachs & Warner, 1997). However, more recent studies have indicated a higher level of success, and perhaps more importantly, a high degree of variation between the performance of resource-rich countries. For example, between 1990 and 2003, poverty fell by 60 % in Chile's mining Antofagasta region (International Council on Mining and Metals, 2006b) Botswana, Peru, Tanzania, and Ghana have also accrued benefits from investments in mining (Humphreys et al., 2007a; International Council on Mining and Metals, 2006b). This variation in performance between different resource-rich countries highlights the fact that not all

countries have experienced the resource curse. Until very recently, the literature on the resource curse did not focus much attention on *why* these variations existed and why some countries have in fact not been completely “cursed.” Fortunately, more recent efforts on the part of researchers, industry, and civil society have shed some light on the strategies that can be adopted to avoid the potential traps of resource wealth (Humphreys et al., 2007b; International Council on Mining and Metals, 2006b).

Norway and Malaysia provide two examples of countries that were able to escape the resource curse, in part by developing efficient state-owned companies to extract their oil resources (Stiglitz, 2007). The strategy of nationalization allowed Norway and Malaysia to avoid many of the problems associated with the privatization of a natural resource. Although proponents of privatization cite efficiency as an important reason to privatize, faster than efficient levels of resource extraction are often encouraged when long-term property rights are not viewed as legitimate in corrupt privatizations (Stiglitz, 2007). Private companies are thus also encouraged to move as much of the resource wealth to a safer locale, namely out of the country, as quickly as possible (Stiglitz, 2007). Furthermore, agency problems are often increased when privatization occurs, leading to increased opportunities for diversion of resource wealth (Stiglitz, 2007).

New investments in mining, however, are currently shifting towards the developing world (Humphreys et al., 2007b). This means that the need to understand and avoid resource curse type outcomes in the specific context of developing countries will continue to increase. If resource extraction continues to lead to lasting and

negative economic, social, and political consequences, it cannot be considered sustainable. The following section examines some of the efforts being made to improve performance in the extractive industries with regards to sustainable development.

6.2. Stepping Towards Sustainability in the Extractive Industries

Efforts have been increasing to document the mechanisms by which certain countries have been more successful in achieving socio-economic development through the exploitation of non-renewable resources. The proponents of these efforts argue that if managed prudently, mining can be a viable and rewarding strategy, particularly as an economic jumpstart during the early stages of development.

Beginning in the 1980's and 1990's the World Bank first attempted to demonstrate this by pointing to poverty alleviation, job creation, and infrastructural development, using resource-rich developed countries as examples of successes in mining (Kumah, 2006). They maintained that the "quality and competency" of a country's institutional structures could determine whether mining revenues would promote or impede development in that country (Pegg, 2006). However, throughout this period, the World Bank continued to support mining projects in developing countries that did not demonstrate good governance, resulting in an increase in foreign investment without poverty alleviation (Pegg, 2006).

Many criticized the World Bank's initial approach, looking at the impacts of mining on communities and on the environment, especially in the developing world

(Power, 2002). In response to this criticism, the World Bank released the Extractive Industries Review (EIR) report in 2004. This report represented a major step towards sustainability in the mining sector; the World Bank explicitly stated that certain preconditions must be in place before it will become involved in mining or oil and gas projects. Additionally, the report stated that social, environmental, and poverty alleviation must be explicitly stated goals, equal to the goal of economic growth (Pegg, 2006).

Meanwhile, pressure groups and the internet have been increasingly drawing attention to environmental incidents related to mining (Horowitz, 2006). Particular attention has been paid to the string of environmental catastrophes that have occurred in the developing world as a result of cyanide use in gold mining (Kumah, 2006). Partially as a result of this pressure, businesses are realizing there are benefits to improved social and environmental performance. This was evidenced by the creation of International Council on Mining and Metals (ICMM) in 2001 to promote industry leadership towards sustainable development. Currently 16 major mining companies are members of the ICMM (International Council on Mining and Metals, 2006a). In 2003, all of the corporate members of the ICMM adopted the organization's Sustainable Development Framework, which commits them to transparency, and to continually make improvements in health, safety, environment, human rights, and community development (Mitchell, 2006). Furthermore, the same year the ICMM formed a partnership with the World Conservation Union (ICUM) to protect biodiversity by pledging not to mine or explore in World Heritage Sites (Mitchell, 2006). In May of

2004, the ICMM partnered with the World Bank and the United Nations Conference on Trade and Development (UNCTAD) in undertaking its Resource Endowment Initiative, which aimed to better understand how mining can contribute to socio-economic development in host countries.

Corporations, however, aren't the only ones who can contribute to progress towards sustainability; civil society has also taken a stand, launching the "Publish What You Pay" campaign in June, 2002. This campaign now includes more than 300 non-governmental organizations, led by Global Witness, calling for increased transparency in the form of mandatory disclosure of payments made by companies in the extractive industries (Global Witness, 2007; Publish What You Pay, 2007). Governments also have a responsibility and the potential power to make changes that can ensure that more natural capital revenues are invested into other forms of capital. Indeed, industry cannot be expected to take on the challenge alone, without regulatory, fiscal, and incentive-based measures from governments at all levels (local, regional, national, and through international cooperation). As the Publish What You Pay campaign highlights, transparency of revenues must be improved so that governments can be held accountable. To this end, the Extractive Industries Transparency Initiative (EITI) was established in 2002 by the UK Prime Minister Tony Blair at the World Summit for Sustainable Development in Johannesburg. The EITI aims to promote good governance and accountability through the full publication and verification of company payments and government revenues from mining, oil, and gas activities (Extractive Industries Transparency Initiative, 2007). The EITI, by setting a global standard for

transparency, can potentially address several of the key negative aspects of the natural resource curse, thereby increasing the potential for sustainability in the industry. For example, when transparency is required, it can assist companies in demonstrating the contribution of their investment in a country, and level the playing field for companies wishing to voluntarily disclose their information. Furthermore, increased transparency has the potential to decrease political instability and create a more stable investment climate.

Some critics argue, however, that many of these efforts involve large western NGOs partnering with industry, which fails to engage local communities in dialogue that can help them improve conditions in their communities (Whitmore, 2006). But, there is evidence that progress is being made at the local level too; the Revenue Watch Institute (RWI) is also working to increase transparency, while providing assistance to governments and citizens in combating resource curse effects (Revenue Watch Institute, 2007). The RWI works to publicly monitor both financing and expenditure relating to natural resource development. As RWI partners continue to collaborate and share skills, an indigenous-led network of NGOs is developing to combat corruption in the developing world (Revenue Watch Institute, 2007). The RWI has provided resources for workshops and conferences aimed at increasing public involvement in the accounting and monitoring process, and provided grants to create local public finance monitoring centers which conduct their own research and discussions. RWI has worked to build civil society coalitions in Azerbaijan, Kazakhstan, Kyrgyzstan, and Nigeria (Revenue Watch Institute, 2007).

Investors are also realizing they can reduce risks by requiring some level of Corporate Social Responsibility (CSR) (Horowitz, 2006). Companies are increasingly reporting information on their corporate governance practices. In 2003, the top ten mining companies all published Annual Reports and seven of these companies also published a separate social and environmental report (Jenkins & Yakovleva, 2006). Such reports are also becoming more sophisticated, however, there currently aren't any standards for external verification of the reporting company's data (Jenkins & Yakovleva, 2006).

Academic institutions also hold the potential to foster improvements in the extractive industries. Research, training for future industry professionals, and partnerships with stakeholders such as the Sustainability Working Group at the University of British Columbia's Department of Mining Engineering can help to bring about positive change (Costa & Scoble, 2006). Cooperative efforts between researchers and stakeholders such as the Britannia Beach Sustainable Development Project in British Columbia, which aims to convert a former mine site into a sustainable community, have demonstrated the potential for creative partnerships to bring about positive change in the industry (Meech et al., 2006).

Despite the efforts that have just been outlined, the debate surrounding sustainability in the extractive industries continues. Many maintain that the apparent increase in concern over sustainability by corporations isn't enough and the impact on communities is simply too great (Power, 2002; Whitmore, 2006). Another study concluded that much more progress must be made before gold mining, in particular,

can be deemed sustainable, "...as long as mining continues to displace people, disrupt social organization, cause sudden loss of livelihoods, and loss of access to public services it cannot be considered sustainable (Kumah, 2006)."

Still, it is clear that some progress has been made, and the potential for continued improved management of non-renewable resources exists, regardless of the setbacks of the past. However, there are still environmental, economic, and social challenges associated with the exploitation of natural resource wealth which require continued attention. One specific area that could benefit from more research and action is the level of support provided to mining communities for economic diversification and planning for mine closure (International Council on Mining and Metals, 2006b). Additional improvements in transparency, governance, legislation, and economic policy could also hold keys to unlocking resource wealth which can truly foster genuine and sustainable development. Strengthened taxation regimes, strict fines for environmental damage, increasing requirements for reporting of social and environmental performance can all potentially increase the benefits of natural resource wealth. Although governance and institutional structures in developing countries are often weak when mining, oil, or gas initiatives are undertaken, long-term success can be achieved if income is successfully reinvested into areas such as technical capacity (a form of human capital), alternative domestic industries (especially investment in alternate renewable forms of natural capital where possible), and social capital. Innovative partnerships between companies, governments, and civil society organizations can help build the capacity of local and regional public agencies to

responsibly deal with revenues, while national and international level partnerships can potentially bolster commitments to transparency, environmental performance, and human rights.

CHAPTER 7: RESEARCH METHODOLOGY

A combination of quantitative and qualitative methods was used for this study. This approach of methodological pluralism allowed the research design to be comprehensive yet flexible, while working within a large community where reliable demographic information was difficult to obtain prior to travel to the study site (Sechrest & Sidani, 1995). A quantitative risk-perception survey, including the collection of health data, and environmental sampling were accompanied by qualitative semi-structured interviews. Interviews were particularly useful in gaining additional in-depth insights from community members and exploring the perception of risk and mine closure process from the varying perspectives of different demographic groups, company representatives, government officials, and other stakeholders. A total of 32 semi-structured interviews were conducted, twelve of which were conducted with women (Oishi, 2003). A snowball sampling technique was used to identify women who had been employed at the mine for interviews, because they were a minority in the population. In particular, the relationship between risk perception and gender was examined using a combination of quantitative and qualitative methods, an approach which few studies have thus far attempted (Gustafson, 1998).

7.1. Risk-Perception Survey

A survey questionnaire was designed to quantify and evaluate environmental and health risks as they are perceived by Vatukoula residents, and build upon prior environmental risk assessments. The survey aimed to assess how people understand and

utilize information about environmental and health risks (Trumbo, 2002), including but not limited to, potential for contamination of water, soil, and air, potential for acute environmental disasters (Stenson, 2006), land use conflicts (McLeod, 2000), and risk to future generations. The survey also included questions about health symptoms experienced by mine workers and their families (Elliott, Cole, Krueger, Voorberg, & Wakefield, 1999), focusing on symptoms that are known to occur with exposure to the chemicals used in the gold mining operations and their by-products (Muezzinoglu, 2003).

The target population for this study consisted of all people living within the larger community surrounding the Vatukoula mine, including current and former mine employees and their families. For organizational purposes, the target population was divided in accordance with 19 existing geographically distinct villages and mining settlements. Many of these settlements are located in very close proximity or are adjacent to each other. However, some of the settlements are located a few kilometers from the central mining area, including the Nasomo and Nasivi settlements. Reliable, up-to-date census data was not available for the target population. The most recent government census data was collected in 1996 and significant changes may have occurred in the population since that time, especially following the closure of the mine. The most reliable estimate of the target population was determined to come from a list of the number of households in each geographic region, provided by the EML company. Household data for the Nasivi and Nasomo settlements was not available from EML, so this data was obtained from the nurse at the Tavua District Health

Office. Based on the information collected from EML and the health office, it was estimated that approximately 750 households were located within the study region. Population was subsequently estimated from the number of households, based on information from EML that the average household consists of 2 adults and 3 children. Only adults over the age of 18 were selected for this study, resulting in a total estimated target population size of 1,500 people. Based on the estimated target population size of approximately 1,500 people, a predicted maximum response variance of .50/.50, a confidence level of 95%, and a desired confidence interval of +/- 5%, it was determined that approximately 304 responses would be required (Fink, 2003). Because of the uncertainty inherent in the estimated population data, the actual number of occupied houses was field verified during the survey and the resulting estimate of the target population was adjusted to 1,446 people.

A simple random sampling method was employed for this study (Fink, 2003). While gender and age were subgroups of interest, for the purposes of this study, our random sampling method selected adequate proportions of each of these groups to obtain the desired confidence interval. Based on the desired number of responses (304), the estimate that two adults reside in each household, and the estimated total number of households (750), a simple random sampling technique using an interval of every other household (1 out of 2) was implemented. To minimize coverage error, a systematic method was used to select the households that participated in the survey. This method was based on a geographic sample frame because a reliable list of the members of the survey population was not available (Dillman, 2007). To ensure

randomization, a number between 1 and 2 was randomly selected when sampling in the first region was undertaken, to indicate whether the first or second household encountered would be the first household systematically selected (Dillman, 2007). When arriving at each selected household, the individual who was over the age of 18 with the most recent birthday was selected as the survey participant to further ensure random selection (Dillman, 2007). Surveys were self-administered and the survey team returned to each home at a later time to collect each questionnaire. To minimize non-response error, the survey distribution and collection times were selected based on the time of day residents were likely to be home (early morning and late evening). If the selected household member was not home at the time of the first visit, the survey questionnaire was dropped off to be completed by the selected participant when they became available. The survey team subsequently returned at a later date to collect the questionnaire. If the questionnaire was not filled out when the survey team returned, multiple future contacts (consisting of home visits by the survey team) were made to ensure that a response was achieved whenever possible.

A token incentive, consisting of a University of Vermont ink pen, was included with each survey questionnaire. Participants received the incentive in advance, regardless of whether or not they responded. This technique has been shown to help establish trust and increase response rates (Dillman, 2007). In fact, we found that many people didn't have a pen or pencil on hand to fill out the questionnaire, so the inclusion of a pen was also convenient, which likely increased response rates even further. A high response rate was achieved (92%; n= 240). Demographic data is not

available to conduct an analysis of the differences between the population who responded and those who didn't, however, the response rate is high enough to expect that no significant differences would exist (Dillman, 2007).

Table 1: Organization of Target Population and No# of Respondents

<i>Settlement Name</i>	<i>Estimated No# Households</i>	<i>Field Verified No# Households</i>	<i>Total No# Individual Respondents</i>
Matanagata	29	26	16
Upper Matanagata	88	82	38
New Town	24	24	12
Low Cost	47	60	30
Veiquwawa	15	20	11
Slime Dam (Nademo)	28	20	9
Loloma/Upper Loloma	69	67	31
Maingate	8	8	8
Rotuma	13	11	8
Narau Barracks	21	21	11
Smith St./Cody Place	18	6	6
Nasivi	100	100	50
Nasomo	160	160	38
Korowere	50	42	25
Lomalagi	17	17	7
Lololevu #1	19	19	12
Lololevu #2	18	18	9
Church Road	15	12	11
Vatukoula Primary School Compound	11	10	9
<i>Totals:</i>	<i>750</i>	<i>723</i>	<i>340</i>

The survey was conducted from July 10-30, 2007 in Fiji. The survey instrument underwent expert review and field pilot testing prior to implementation to maximize content validity and reduce measurement error (Bourque & Fielder, 1995; Dillman, 2007). Pilot testing was conducted on July 5-6, 2007, with five participants selected from the target population. A snowball sampling technique was employed to select test

subjects who represented a range of ages, education levels, both men and women, and former mine employees and non-employees. Participants were asked to complete the survey questionnaires and return them using the same procedures planned for the actual survey. A response rate of 100 % was achieved during the pilot test. Interviews were conducted with each pilot test participant, asking questions regarding the clarity of instructions, readability and clarity of questions, and understanding of study objectives. The results of these interviews and results of the pilot test surveys indicated the need for minor revisions of three survey questions to facilitate easier readability and comprehension. For example, several of the test subjects indicated that the word “Indigenous” was unnecessary as a descriptor of Fijian ethnicity in a question asking respondents to indicate their ethnicity. As a result “Indigenous Fijian” was changed to “Fijian” to make the answer choices as clear as possible for our specific target population. After revision, the survey instrument was translated into Fijian language.

A local representative was chosen to assist in the translation, distribution, and subsequent collection of survey questionnaires. This representative attended a training session, which outlined the required procedures to ensure random sampling and effective implementation of the survey plan. The survey team included researcher Mary Ackley and Pita Vatucawaqa (local representative). The survey team worked in tandem for the first day of the survey implementation and then split up tasks to increase efficiency. A total of 369 people were selected to fill out the survey, and completed questionnaires were collected from 340 people, resulting in a 92% response rate. Each of the 19 different villages and settlements and approximately 24% of the adult

population in the region were represented. Each respondent was given the choice to complete the survey in English or Fijian language.

While demographic data was collected, names were not recorded at any stage, and every effort was made to maintain subject anonymity. Surveys were screened for any information provided that could potentially identify a subject, and this information was subsequently concealed permanently using a black pen. Surveys were kept in a locked location until the data was entered electronically, after which time the original questionnaires were destroyed.

7.1.1. Survey Instrument

The final survey instrument consisted of 46 questions, including 1-7 point Likert-type scale questions, multiple choice questions, and open-ended questions (Dillman, 2007). Questions aimed to evaluate risk perception variables such as ability, sufficiency, level of concern, and knowledge of risks. Questions also aimed to quantify the degree to which participants utilize systematic vs. heuristic processing in evaluating risks (Trumbo, 2002). The full survey instrument in English language is included as Appendix I, the full survey instrument in Fijian language is included as Appendix II.

The survey instrument was accompanied by a cover letter which explained the purpose of the survey and outlined instructions for completion of the survey. In addition, each participant was also asked to sign and return a copy of an “Informed Consent to Participate” form indicating their understanding of the purpose and objectives of the study and their consent to participate. The cover letter and consent

forms are included in Appendices I and II as they were in the original survey instrument.

7.1.2. Data Analysis

SPSS 15.0, a statistical analysis software package was used to conduct univariate and bivariate analysis of closed-ended survey questions. Chi-Square and Mann-Whitney tests were conducted to assess variation in responses according to gender; Kruskal-Wallis tests were conducted to assess variations between ordinal variables such as *knowledge of risks* and nominal demographic variables such as *ethnicity*; Spearman correlation coefficients were calculated to assess correlation between multiple ordinal variables and scale vs. ordinal variables. One-way ANOVA and Bonferroni tests were conducted to assess variation between scale demographic variables such as age, and nominal variables. For ordinal variables, “don’t know” responses were treated as missing values during bivariate and multivariate tests to ensure accuracy of results. Finally, PLUM ordinal regression analysis was conducted to assess the relative influence of two independent variables, *gender* and *employment at the mine* on the dependent variable *knowledge of risks*.

The final survey question was open-ended, asking respondents to rank the three environmental or health issues that concerned them most. Responses to this question were translated, coded, and compared to quantitative results obtained with SPSS 15.0. A hierarchical coding procedure, using categories and subcategories, similar to that used in the 1991 risk-perception study by Fischer et al was used to classify risks

(Fischer, Morgan, Fischhoff, Nair, & Lave, 1991). When a response could potentially be placed in multiple categories, the most specific category possible was chosen.

7.1.3. Limitations

All households and survey participants were approached in person. This process was time intensive; however, it ultimately achieved a high response rate. In the settlement of Nasomo, houses were located far apart, sometimes requiring a 20-30 minute walk between houses. Additionally, reliable maps of the region were not available so the survey team had great difficulty in locating some of the households. Local community members assisted the team in locating the houses, but even these individuals were unable to confirm if all of the households were ultimately identified. As a result, the sample collected for this particular region was not truly a probability sample, but rather a convenience sample. Additionally, the final field verified number of households remains simply a best estimate.

Pilot testing was only conducted for the English language version of the study. This occurred due to time constraints for the study and the need to confirm translations with local experts. We wished to get started with pilot testing as soon as practical after arriving at the study site, however, translation of the survey instrument needed to be verified concurrently after arriving in Fiji. However, all translations were verified by local translators prior to use.

We were interested in ethnicity as an independent variable that might affect risk-perception. However, reliable data on the ethnicity of the target population was

not available so it was not possible to stratify the sample accordingly. Census data from 1996 indicated that the population was predominantly ethnically Fijian, with minority populations of ethnic Indians, Rotumans, Chinese, and Caucasians. We thus attempted to over-sample minority populations by selecting additional persons to participate at households with more than one person of a minority ethnicity. However, this only occurred in a very small number of cases and thus did not significantly affect survey results. A snowball sampling technique was employed to identify people of minority ethnic backgrounds to participate in interviews, which provided additional insights into the views of these sub-populations.

The final open-ended survey question was translated incorrectly and the mistake was not identified until after the survey was initiated. The English language question asked respondents to list the “three environmental or health issues that concern you the MOST in decreasing order.” The Fijian language version translated to “Please list the three issues that concern you MOST in decreasing order.” The question could not be changed after the survey began, but it resulted in an interesting twist on the final question. Respondents who took the Fijian language version simply listed the three most important concerns they were facing, regardless of whether they were related to the environment or health. These responses offered insight into the relative importance of environmental and health risks compared to other concerns. Open-ended results are discussed in Chapter 8.

Finally, respondents were asked to report symptoms that they had experienced within the past month. The period of time during which respondents were asked to

report symptoms was important because if people are asked to recall information from far in the past they may not be able to accurately remember this information (Dillman, 2007). However, in this particular case the mine had been closed for several months prior to the survey, so interview subjects reported that some of their symptoms had faded or stopped completely since the mine closure. Specifically, difficulty breathing and severe cough were mentioned, but it is possible that many people experienced several symptoms more often, or more severely, during mining operations.

7.2. Environmental Sampling and Analysis

A total of six samples of surface water and drinking water were collected and analyzed. Water quality was chosen as the primary focus because water represents a significant pathway through which people may be exposed to contaminants from mine wastes. Many of the households in Vatukoula are supplied with untreated water, pumped directly from the nearby Nasivi River and families routinely use river water for washing clothes, washing dishes, fishing, and swimming.

The six sample locations were chosen because they are places where Vatukoula residents may commonly come into contact with potentially contaminated surface waters or drinking water. Detailed information about each sample is described in detail in Table 2, and sample locations are presented in Figure 2.

Table 2: Sample Key

Sample No.	001	002	003
Sample ID	UVM -080607-TW-001	UVM -080607-SW-002	UVM -080607-SW-003
Sample Location	Galvanized Iron Tank - Matanagata (Behind House EM3)	Nasivi River - Upstream of bridge at pumping station	Upstream of bridge at Lololevu Creek
Sample Matrix	Tank (Drinking) Water	Surface Water	Surface Water
Date Sampled	8/6/2007	8/6/2007	8/6/2007
Time Sampled	07:31	07:45	08:00
Weather Conditions	Sunny, no wind, 27°C	Sunny, no wind, 27°C	Sunny, no wind, 27°C
Additional Notes	--	--	--

Sample No.	004	005	006
Sample ID	UVM -080607-STW-004	UVM -080607-SW-005	UVM -080607-SW-006
Sample Location	Tap - Matanagata (Behind House M-32)	Nasivi River - Upstream of river crossing , just north of Matanagata	South shore of Slime Dam
Sample Matrix	Tap (Drinking) Water	Surface Water	Surface Water
Date Sampled	8/6/2007	8/6/2007	8/6/2007
Time Sampled	08:16	08:26	08:39
Weather Conditions	Sunny, no wind, 27°C	Sunny, no wind, 27°C	Sunny, no wind, 27°C
Additional	--	Excessive algal growth	--



Figure 2: Sample Locations

Samples were analyzed locally at the University of the South Pacific (USP) Institute of Applied Sciences (IAS) Analytical Laboratory and the Fiji Mineral Resources Department (MRD). Analytical parameters were determined based on local geology, the chemicals used in the gold mining processes, and their potential by-products. A priority list of analytical parameters was then developed based on the degree of toxicity to humans of the potential contaminants, and the analysis options available at the local laboratories. Historical analytical data, collected by the MRD, was also reviewed during the development of the sampling and analysis plan.

7.3. Hydrogen-Sulfide Testing for Bacterial Contamination

During the course of the study, the residents of Vatukoula expressed concern about the potential for contamination of drinking water and surface water due to inadequate management of human and animal wastes. Sanitation facilities at Vatukoula primarily consist of flush toilets with septic tanks and pit latrines, which do not provide adequate removal of pathogens. Additionally, many settlements are located in very close proximity to the Nasivi River and its tributaries, increasing the risk of contamination. Animals such as pigs and cows are also commonly located in the settlements, close to unprotected water supplies.

Faecal coliforms (and other bacteria in the coliform group) exist naturally within the intestinal tract of humans and other warm-blooded animals. Thus, if water is contaminated with faecal coliforms, this may indicate that the water is contaminated with faecal matter and is not safe for human consumption. Therefore, an important

indicator of water quality is the absence of faecal coliform bacteria, which may indicate that pathogens, such as typhoid or cholera, are present (Mosley & Sharp, 2004). Since most tests for pathogenic organisms are costly and difficult to perform, indicator organisms, such as total and faecal coliforms, are commonly used to assess the risk that pathogenic organisms may also be present (Mosley & Sharp, 2004). However, coliforms may occur naturally in soil and water in tropical climates, making them a poor indicator organism in such areas. As such, another test has been developed which uses a more appropriate indicator, hydrogen-sulfide reducing bacteria, to assess the risk that pathogenic organisms may exist. The Hydrogen Sulfide (H₂S) Paper-Strip Test also has many other advantages because it is very inexpensive and easy for non-technical people to learn to use. This makes the test ideal for use in rural Pacific island communities. Each test tube contains a medium in which certain bacteria in the Enterobacteriaceae group, such as *Salmonella*, *Citrobacter*, *Clostridia*, *Klebsiella*, and *Proteus* can produce hydrogen sulfide (Mosley & Sharp, 2004). The production of hydrogen sulfide is indicated in the test tube when thiosulphate is reduced and subsequently reacts with ferric salt to form an insoluble black ferrous precipitate. This black precipitate may then be interpreted to indicate a certain level of risk that pathogenic organisms may be present. The H₂S test has been recommended for testing drinking water sourced from surface water, boreholes, or rain water, for faecal contamination (Mosley & Sharp, 2004).

For the present study, several H₂S strip tests were obtained free-of-charge from the World Health Organization (WHO) in the capital city of Suva. A total of ten tests

were performed, including one control sample. The control sample was derived from chlorinated bottled water. Each sample was collected in accordance with suggested methods outlined in the H₂S Paper-Strip Test Instruction Guide provided by WHO in Fiji. For samples collected from taps, the tap were first cleaned with a clean cloth then allowed to run for 20 seconds. The sample bottle was then filled up to the marked level and immediately closed. For samples collected from surface waters, a clean plastic container was used to transfer water into the test tube. This container was rinsed several times prior to collection of the sample. The samples were then stored in a dark place to prevent sunlight from killing bacteria, which may invalidate results. Samples were monitored over a three day period, and observations of color change were recorded at the same time each day. Color change was assessed using the color code provided in the WHO Instruction Guide.



Figure 3: Paper Strip Testing - Color Variation of Black Ferrous Precipitate

CHAPTER 8: RESULTS AND DISCUSSION

8.1. Risk-Perception Survey

8.1.1. Profile of Respondents

Three hundred and sixty-nine people were randomly selected to participate in the survey. A total of 340 completed survey questionnaires were collected, representing 19 geographically distinct villages and settlements, and resulting in a response rate of 92%. Respondents were given the choice to complete the survey in Fijian or English language. 52% of respondents chose to complete the survey in English, while 48% completed the Fijian version. This nearly even split indicates that it was very important to offer the survey in both of the predominant local languages. Our sampling technique successfully captured a fairly even representation of gender, with 54% of respondents reporting female and 46% reporting male. Only adults over the age of 18 were selected to complete the survey, but no upper age limit was imposed. This technique resulted in a broad age representation; respondents ranged in age from 18-80 with a median age of 40. Fewer than 3% of respondents did not complete any formal education, while 47% of respondents completed secondary school, and 11% attended a university or other tertiary school. Education levels in Vatukoula are slightly higher on average, than those in the rest of Fiji according to 1996 census data (Asian Development Bank, 2006). 83% of respondents were ethnically Fijian. Other minority ethnicities which were reported included Rotuman, Indian, or multi-ethnic heredity. Full survey results are located in Appendix III.

Table 3: Summary of Demographic Characteristics

<i>Characteristic</i>	<i>Range (yrs)</i>	<i>Median (yrs)</i>	<i>Std. Dev. (yrs)</i>	<i>95% Confidence Interval (yrs)</i>
Age (n=330)	18-80	40	12.95	39-42
	<i>Category</i>	<i>Percent by Category</i>		
Gender (n=340)	Male	46.2%		
	Female	53.8%		
Ethnicity (n= 340)	Fijian	82.6%		
	Indo-Fijian	7.6%		
	Rotuman	4.7%		
	Chinese	0.0%		
	Caucasian	0.0%		
	Other	5.0%		
Level of Education (n=334)	No Formal Schooling	2.4%		
	Primary School	21.3%		
	Secondary School	48.2%		
	Vocational School	16.8%		
	University	11.4%		
Current or Former Mine Employee? (n=333)	Yes	57.4%		
	No	42.6%		
Work Location (n=188)	Aboveground	34.6%		
	Belowground	58.0%		
	Both	7.4%		
Born in Vatukoula? (n=337)	Yes	43.4%		
	No	56.7%		
Length of Residence in Vatukoula (n=188)	Less than 5 years	14.9		
	6-10 years	12.2%		
	11-20 yrs	28.2%		
	More than 20 years	44.7%		

8.1.2. Knowledge of Risks

When asked how they felt about the risks of mining, the majority of the population (80.4%) felt they knew about “some” or “most” of the risks of mining. Approximately 10% felt that they were not aware of any risks, while the remaining

10% felt they knew everything they needed to know about the risks of mining (n= 333). When asked about specific risks, over one-quarter (27%) of Vatukoula residents reported not knowing whether their drinking water was safe, and 19% did know about the potential risk of a tailings dam leaking or overflowing. 15.5% of residents felt they did not know how the risks of mining had changed since the closure of the mine (n=329). Interviews revealed additional risks that people in the community were not informed of. One resident explained his concern about the lack of community knowledge about the risks of cyanide-related fish kills, *“At times we have cyanide spillages into the river, because of the lack of knowledge in the community, at these times that the fish are dead in the river, we go out there and bring it and cook it and eat it, because we are not aware of that (Romeo Kivi, personal communication, July 6, 2007).”*

Only 37% of people first learned about the risks of mining from the mining company, while a nearly equally important source of risk information was other people their village or town (n= 329). Other sources of information about risks included newspapers (5%), the government (4%), television (4%), and books (4%). Some respondents indicated that they learned about the risks “somewhere else.” Of these respondents, the majority wrote in that they learned about the risks through personal experience. When interview subjects were asked an open-ended question about where they first learned about the risks, several people also indicated that they learned about the risks through personal experience, confirming the survey findings. It is thus likely

that if the survey was repeated with an additional response option of “through personal experience,” this option may have been chosen by a higher percentage of respondents.

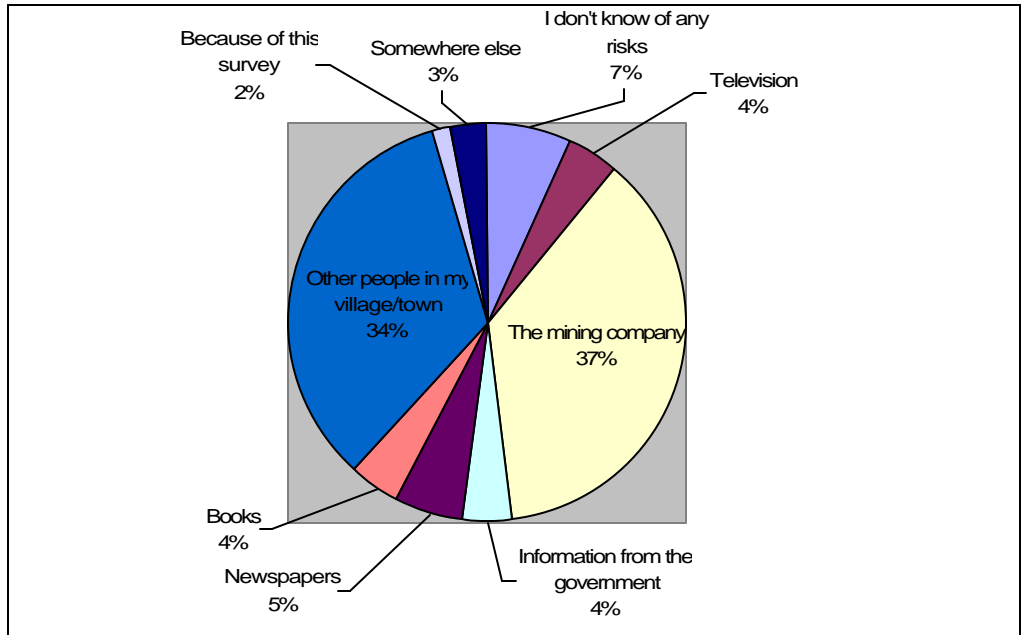


Figure 4: Sources of Risk Information

8.1.3. Level of Concern

Despite their gaps in risk knowledge, Vatukoula residents feel a consistently high degree of concern across a range of environmental and health risks, and few people question the fact that the risks are impacting their health. Air pollution is the risk which causes the greatest concern among residents, with 74.5% of people feeling “very worried” about the risk. An additional 12.2% feel “somewhat” worried about air pollution. Pollution of rivers and streams, as well as drinking water pollution were of similar concern, with 88.6% of people “somewhat” or “very” worried about the former and 86.7% of people “somewhat” or “very” worried about the latter. Over 80% of

people also feel “somewhat” or “very” worried about pollution of their garden vegetables, fish, and land. When asked about their concern for their children’s health, 89.8% of parents reported feeling worried about their children’s health because they live near the mine. 87% of people feel worried about their own health because they live near the mine. Finally, 85% of people feel worried that environmental damage from gold mining will impact future generations.

Residents were also asked about the likelihood that each of the risks had resulted in health problems for either themselves or their families. Again, people consistently feel that each of the risks is likely to have caused health problems. Air pollution is the risk that residents feel is most likely to have harmed their health, with 85% of residents reporting that air pollution is “somewhat” or “very” likely to have harmed their health, the majority of whom felt it was “very” likely (54.4%) (n= 318).

The level of concern a particular person feels about each of the risks of mining is correlated. For example, if a person feels very worried about air pollution, the same person is also likely to report they are very worried about each of the other risks. Likewise, if a particular person isn’t worried about air pollution, they are likely to also not be worried about water pollution, or any of the other risks. Spearman correlation coefficients were calculated for each pair of risks, and results indicated significant positive correlations for every pair of risks tested ($p < 0.001$ for each case).

8.1.4. Trust in Authorities

While residents are highly concerned about environmental risks and their potential health impacts, they do not necessarily feel comfortable discussing these risks with company officials. Nearly one-third of people reported that prior to the mine closure, they would not have felt comfortable telling someone from the company if they had a concern about their health or the environment (n= 288). Furthermore, 48% of people who would tell the company about their concern felt that the company would either ignore their concern or do nothing to address it (n= 329). An additional 4% felt that they would be punished for voicing their concern (n=329). One resident explained how the company reacted to his concerns during an interview, “...we have complained a lot at times, but the answer from management doesn’t satisfy us (Romeo Kivi, personal communication, July 6, 2007).”

The lack of trust in authorities at Vatukoula is likely due in part to the fact that information about risks has not been communicated in a timely and open manner in the past. Instead many residents have learned about the risks of mining over a lifetime through personal experience, or by word of mouth. When questioned about drinking water quality, Romeo Kivi the secretary of the Vatukoula Community Consultative Committee explained how the community was not informed about the results of water quality testing in the past, “No, I’m afraid not, the results are sent directly to the Mineral Resources Department. The community was not advised on that (Romeo Kivi, personal communication, July, 6, 2007).” Research has demonstrated that if risks are first discovered by a community, rather than being fully disclosed by the company

immediately following their discovery, people will be predisposed to doubt the information given to them (Fessenden-Radon et al., 1987).

8.1.5. Control

While residents feel a consistently high level of concern about risks, they also feel they have very little control to avoid the risks of mining. The majority of people, 64.1% (n= 334), feel they have “little” or “no” control to avoid the risks of mining. 15.3% of people feel they have “some” control, and 20.7% of people feel they have “enough” or “total” control to avoid the risks of mining. In order for people to feel they have some measure of control over a particular risk, they must feel they have real, actionable, and positive ways of mitigating that risk (Lundgren & McMakin, 2004). For example, a positive message about mitigating a risk would be one that tells a person what to do rather than telling them what actions to avoid. The actions must also be realistic for a person to implement. For example, after the September 11th attacks in the United States, people were told to be “vigilant.” While this message is positive, it is vague and thus difficult to implement on an individual level (Lundgren & McMakin, 2004). Such a message would not help people feel they have control to avoid future attacks. The present survey revealed that 77% of Vatukoula residents reported not having a plan to deal with a potential tailings dam disaster. This striking result reveals one of the possible reasons why the level of control people feel to avoid mining risks is so low; they do not have real, actionable, and positive information about how to mitigate potential risks.

8.1.6. Ability

Another dimension of risk perception is reflected in a person's ability to seek out and find information about risks when they would like to learn more. When asked about their ability to find additional information about risks, 15.9% of residents felt they would not know where to go if they wanted to find out more about a particular mining risk (n=327). 40% of people disagreed with the following statement, "If I have a question about the risks of gold mining, it is usually easy to find the answer (n=275)." These results indicate that although people may feel they have some knowledge about mining risks, they do not necessarily feel comfortable searching for additional information. If residents do not feel comfortable telling the company about their concerns, this clearly hinders their ability to seek out further information about risks. Thus, one way that a company can increase the flow of information about risks is by creating a more open, transparent, and welcoming relationship between company officials, employees, and community members.

8.1.7. Weighing Risks and Benefits

Some may argue that by choosing to live and work in Vatukoula, residents are making a conscious decision to accept the risks of mining in light of the economic benefits of employment at the mine. However, the results of this study highlight the underlying complexity of such risk/benefit decisions. Over half of the people of Vatukoula (52.7%) reported that they are *not* willing to accept most of the risks of mining because the benefits are worth it (n= 311). Interviews offered additional insight

into this surprising result. Kereni Marama explained why she continues to live in Vatukoula, and spoke about the feeling of community that was important to her,

“We like living here because the life is easy...when we go to Suva or Lautoka we have to pay for everything, here we can plant. Here we know each other, when we don't have anything we just go to another house and we can borrow it.”

She explained the importance of the cultural connection that Fijians feel to their land. After generations of mining, families now consider Vatukoula to be their home and feel connected through a sense of place. She also emphasized the difficulties of gaining employment in other industries. For example at Fiji Water, *“You know...you have to know somebody there so he can get you in....it's very hard (Kereni Marama, personal communication, August 3, 2007).”*

Additional insights come from the comments offered at the end of the survey. Several people chose to write about the highly limited options for employment that many of the men in the area face. *“Where else can my husband find work to support us, this is the only place he can work as he does not have any other experience elsewhere.”*

Others wrote about their personal and cultural connections to the Vatukoula community and area,

- *“I was born and bred here in Vatukoula and so were my parents and their parents before them. When the mine closed we were lost....we have nowhere else to go and there are no jobs available to miners in Fiji.”*

- *“My ancestors died here...so here we stay.”*

It is clear that cultural and personal connections to Vatukoula play an important role in the analysis of risks and the decision-making process. Additionally, the lack of alternative economic opportunities, particularly for those without higher education or specialized training, limits the choices available to miners and their families.

These limited economic options, strong personal and cultural influences, a lack of trust in company and government officials, and a lack of knowledge about many of the risks of mining, combine to result in a highly complex and imperfect decision-making process. The results of this survey can contribute to more informed decision-making by creating a transparent foundation of knowledge which may be used to build better risk communication and management strategies, specifically tailored for Vatukoula.

8.1.8. Gender and Risk Perception

A closer analysis of the responses of men and women revealed that gender is an important variable in risk perception at Vatukoula. First, the survey revealed that women and men differ significantly how much they feel they know about mining risks. Women feel they have less knowledge about the risks of mining compared to men ($p < 0.001$). More specifically, women are significantly more likely to feel that they know about some or none of the risks, while men are significantly more likely to indicate that they know about most or all of the risks.

Table 4: Respondents Knowledge of Risks: Cross-tabulation According to Gender

Question	Response	Gender		Total	
		Male	Female		
Knowledge of Risks	None	Count	11	21	32
		% within Gender	7.1%	11.8%	9.6%
		% of Total	3.3%	6.3%	9.6%
	Some	Count	53	102	155
		% within Gender	34.2%	57.3%	46.5%
		% of Total	15.9%	30.6%	46.5%
	Most	Count	68	45	113
		% within Gender	43.9%	25.3%	33.9%
		% of Total	20.4%	13.5%	33.9%
	All	Count	23	10	33
		% within Gender	14.8%	5.6%	9.9%
		% of Total	6.9%	3.0%	9.9%
Total	Count	155	178	333	
	% within Gender	100.0%	100.0%	100.0%	
	% of Total	46.5%	53.5%	100.0%	

Just as importantly, women and men also reported receiving risk information from different sources. As presented earlier, approximately 37% of all respondents reported first learning about mining risks from the mining company, and approximately 34% of all respondents reported learning about the risks from other people in their village or town. However, women were half as likely as men to receive risk information from the company, and almost twice as likely as men to receive information from other people ($p < 0.001$).

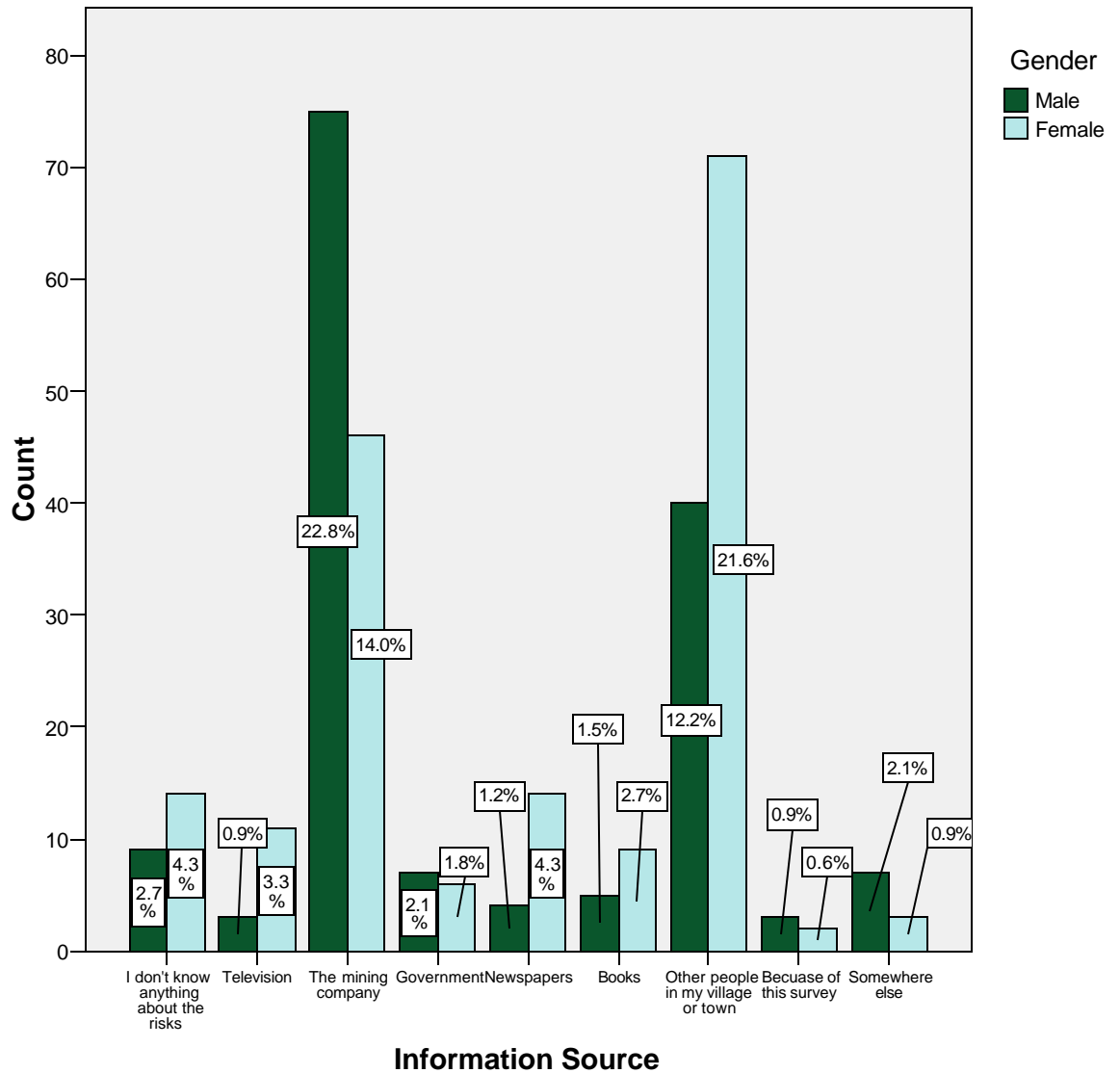


Figure 5: Risk Information Source According to Gender

While some Vatukoula residents do receive at least a portion of their risk information from the company, such risk messages are being less effectively received by women. One possible explanation for this finding is that women are less likely to work at the mine, and thus do not have access to on-the-job health and safety training,

where risk messages are often communicated. Indeed, the present study confirms that men are much more likely than women to have been employed at the mine (Fischer's Exact Test $p < 0.001$). Although the Fiji government has adopted Equal Opportunity Employment (EEO) policies for civil service, these policies have not been realized in the industrial sector. Powerful forces of occupational discrimination and segregation by gender persist throughout many industries in Fiji (Asian Development Bank, 2006). Despite the fact that there is no difference in education levels between men and women, survey results indicate that women have significantly less access to employment opportunities at Vatukoula. Additionally, women at Vatukoula are not permitted to work underground. A PLUM ordinal regression test was performed to assess how influential the variables of gender and employment at the mine were on the dependent variable knowledge of risks. The results indicated that both variables had a similar and significant degree of influence on respondent's knowledge of risks; the gender variable had a parameter effect of 0.633 and employment at the mine had a parameter effect of 0.641. Thus, it cannot be concluded from this survey that the difference in knowledge of risks and source of information were due solely to gender, and not also due in part to whether or not a person ever worked at the mine. However, the importance of these findings should not be underestimated; it is clear that both women *and* people who have not been employed by the mine have a much lower awareness of mining risks and tend to receive risk information from second-hand sources rather than from the mining company. This may be because the information is not readily available from the company or because they prefer alternate sources of information. Most of the

interviews conducted with women supported the former conclusion. For example, when asked if she ever received any information about risks from the company, Elenoa Bunulau from New Town replied, “No, maybe to my husband, but us gang staying at home, no (Elenoa Bunulau, personal communication, July, 5, 2007).”

Just as women are less likely to receive risk information from the company, they are also less likely than their male counterparts to tell the company if they have a concern about environmental or health risks. Women are more than twice as likely as men to report that they would not tell the company if they had a concern about the environment or their health.

Table 5: Company Reaction to Concern: Cross-Tabulation According to Gender

			Gender		Total
			Male	Female	
Company Reaction to Concerns	Listen and try to help	Count	59	59	118
		% within Gender	38.8%	33.3%	35.9%
	Listen and do nothing	Count	36	30	66
		% within Gender	23.7%	16.9%	20.1%
	Ignore my concern	Count	38	53	91
		% within Gender	25.0%	29.9%	27.7%
	Punish me	Count	7	6	13
		% within Gender	4.6%	3.4%	4.0%
	Would not tell company	Count	12	29	41
		% within Gender	7.9%	16.4%	12.5%
Total	Count	152	177	329	
	% within Gender	100.0%	100.0%	100.0%	

Men and women also differ significantly in the level of control they feel they have to avoid the risks of mining. Survey results revealed that women feel they have significantly less control to avoid the risks of mining compared to men (p=0.023). Women are more likely to feel they have “no” control to avoid the risks of mining,

while men are more likely to feel they have “some” or “enough” control to avoid the risks of mining.

**Table 6: Control to Avoid Mining Risks
Cross-Tabulation of Responses According to Gender**

Response:		Gender		Total
		Male	Female	
No control	Count	57	88	145
	% within Gender	36.8%	49.2%	43.4%
	% of Total	17.1%	26.3%	43.4%
Little control	Count	32	37	69
	% within Gender	20.6%	20.7%	20.7%
	% of Total	9.6%	11.1%	20.7%
Some control	Count	29	22	51
	% within Gender	18.7%	12.3%	15.3%
	% of Total	8.7%	6.6%	15.3%
Enough control	Count	27	17	44
	% within Gender	17.4%	9.5%	13.2%
	% of Total	8.1%	5.1%	13.2%
Total control	Count	10	15	25
	% within Gender	6.5%	8.4%	7.5%
	% of Total	3.0%	4.5%	7.5%
Total	Count	155	179	334
	% within Gender	100.0%	100.0%	100.0%
	% of Total	46.4%	53.6%	100.0%

It is likely that women’s lack of perceived control and their lack of knowledge about risks go hand-in-hand. As discussed previously, the control a person feels over a risk is related to whether or not they are educated and prepared to mitigate that risk (Lundgren & McMakin, 2004). This study found that approximately half as many women living in Vatukoula have a plan for a potential tailings dam release or failure, compared to men ($p=0.003$). Not only do women feel they know less about the risks of mining, but they are also less prepared to deal with potential risks than their male counterparts. This result was also obtained for people who had been employed at the

mine vs. those who had not. Those who had never been employed at the mine were also approximately half as likely to have a plan for a potential tailings dam release or failure ($p=0.002$).

It has been widely demonstrated throughout risk perception literature that men and women perceive the same risks in different ways (Gustafson, 1998). In particular, studies have consistently shown that women tend to be more concerned about environmental risks than their male counterparts (Gustafson, 1998). Another study found that men were more concerned about health risks, while women were more concerned about environmental risks (Fischer et al., 1991). This study, conducted in a differing cultural context, did not find any gender differences in respondent's level of concern about environmental or health risks at Vautkoula. This may be due in part to the fact that all respondents had such consistently high levels of concern about all of the risks; because there was so little variation across responses overall, less variation may also be present between the responses of men and women.

Women were also found to be almost half as likely as men to have personally made the decision to move to Vautkoula ($p<0.001$; $n=188$). Instead many women reported that their husbands had made the decision to move to Vautkoula for them.

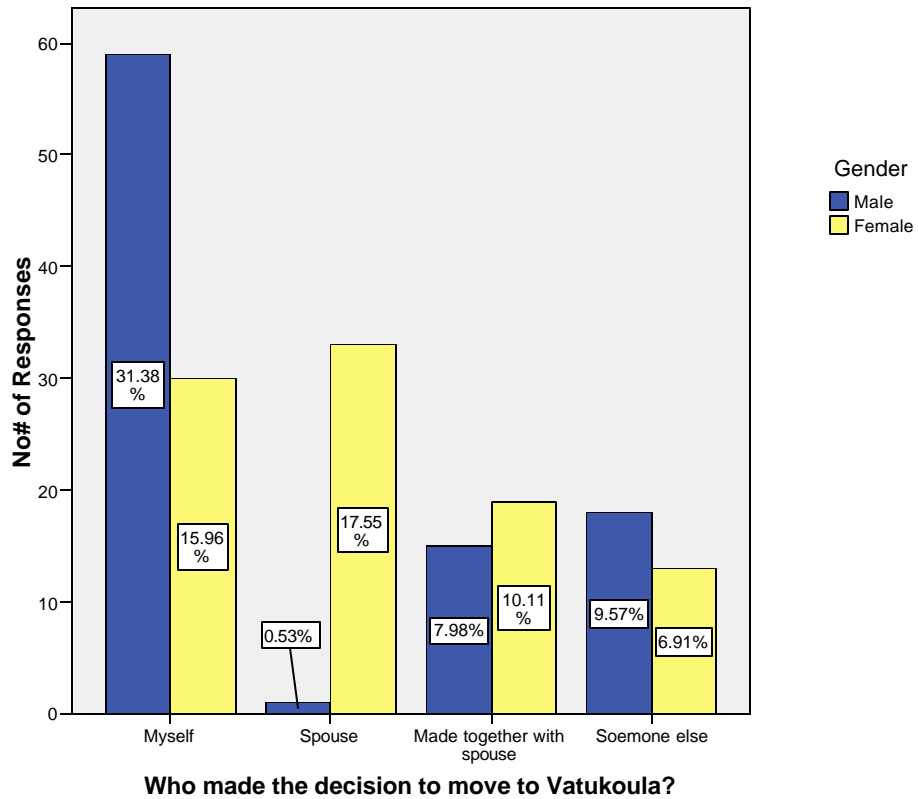


Figure 6: Decision-making According to Gender

Almost half (48%) of residents reported that they had considered moving away from Vatukoula because they were concerned about the environment or their health. Among those who had considered moving, women were more than twice as likely as men to report that the reason they decided to stay was because it ultimately wasn't their decision ($p=0.008$). Men were more likely to report that the reason they stayed was because the money they earned working at the mine was worth the risk ($p=0.008$). This result appears to be consistent with a previous risk perception study conducted in Oregon that found that women are less likely to view risks as counterbalanced by economic benefits (MacGregor et al., 1994). However, it is impossible to tell from this

study if women had equal access to employment opportunities and decision-making power, whether they would also view risks as counter-balanced by economic benefits.

It is critical that women are given an opportunity to become involved in the decision-making process, precisely because they do perceive risks in different ways. Until they are allowed to fully participate in the process of evaluating the risks and benefits of mining, the perceptions and opinions of women will continue to be marginalized. The connection between women's involvement in the decision-making process and women's empowerment is recognized in the Women's Plan of Action (1998-2008) (WPA) adopted by the Fiji government, and in the United Nations MDGs (Asian Development Bank, 2006). In Fiji, the important factors disempowering women include their minimal participation in political and other forms of decision-making, their lack of property rights, and the prevalence of family violence against women (Asian Development Bank, 2006).

Such barriers to women's empowerment are perhaps most intense in mining communities. Recently, several workshops and conferences that were organized in the Pacific region revealed some of the major concerns and barriers facing women in mining communities. The Pacific Regional International Women in Mining Network Meeting, held in Papua New Guinea in 2007, was attended by two representatives from Vatukoula (*Statement of the Pacific International Women and Mining Network Meeting, 2007*). One major concern laid out by the women at this meeting arises from the transition to a cash economy, which disrupts traditional gender roles. Women become economically dependent on men and the importance of their traditional work is

diminished. Furthermore, men discontinue their traditional work at home, thus increasing the burden of household duties for women. A lack of traditional societal controls also often results in social decay, such as increased alcohol and substance abuse, domestic violence, sexually-transmitted diseases (STD's), and prostitution (Oxfam Australia, 2008). Pollution of waterways, air, and land also undermine a women's ability to provide a safe home and healthy environment for her family (*Statement of the Pacific International Women and Mining Network Meeting, 2007*). Finally, women are often left out of the decision-making process, including negotiations about access to land and compensation (Oxfam Australia, 2008).

8.1.9. Health Data

The proportion of deaths due to cancer in Fiji in 2005 was 8.8% (World Health Organization, 2006). Only 3% of Vatukoula residents reported having been diagnosed with cancer (n= 337), indicating that it is unlikely that there is elevated incidence of cancer in the Vatukoula community relative to the rest of Fiji. Additional health data obtained from the district health office in Tavua indicated that a total of four deaths occurred in Zone 1 and Zone 2 (which encompass the Vatukoula area) during the 2nd quarter of 2007, and none of these deaths were caused by cancer.

The most commonly experienced health symptom in Vatukoula is muscle or joint pain, with 69.6% of people experiencing the symptom at least once during the past month. Severe cough (63.6% experiencing at least once during the past month) and severe headaches (59.6% experiencing at least once during the past month) were the

second and third most commonly experienced symptoms, respectively. People who had never worked at the mine were more likely to experience severe headaches more often than people who had worked at the mine ($n= 332$; $p = 0.010$).

Approximately 23% of people reported experiencing hearing loss. People who reported having worked at the mine were more likely to also report experiencing hearing loss, however this result was not statistically significant ($n=339$; $p = 0.039$). Finally, age was positively correlated with both hearing loss and memory or concentration problems ($p=0.003$ and $p=0.022$, respectively). Older residents were more likely to experience both of these symptoms, which are symptoms commonly experienced more often by people later in life.

8.1.10. Other Demographic Variables

Correlations were also identified between age and risk perception and level of education and risk perception. Besides being correlated with certain health symptoms, age was also positively correlated with how likely a person felt that pollution in their garden vegetables or pollution in their drinking water had harmed their health ($p=0.016$ and $p=0.027$, respectively). Older residents felt it was more likely that each of these environmental risks had harmed their health. Age also had an effect on where residents would look for additional information regarding environmental or health risks. Older residents were also more likely to search for risk information in a book, while younger residents were more likely to search for risk information using a computer ($n=327$, Bonferroni test significance, $p=0.015$).

A person's level of education was positively correlated with how worried they were about their own health (n =328, p=0.004), and how worried they were about pollution in their rivers and streams (n=323, p=0.048). Residents who had completed a higher level of education were more worried about their health and surface water pollution. This may be because they learned about the potential health impacts of mining risks during their education. Additionally, level of education was also related to whether or not a person had considered moving away from Vatukoula due to environmental or health risks (n=327, p<0.001). People who had completed a higher level of education were more likely to have considered moving away than those who were less educated.

34) Have you ever considered moving away from Vatukoula because you were concerned about your health or the environment?

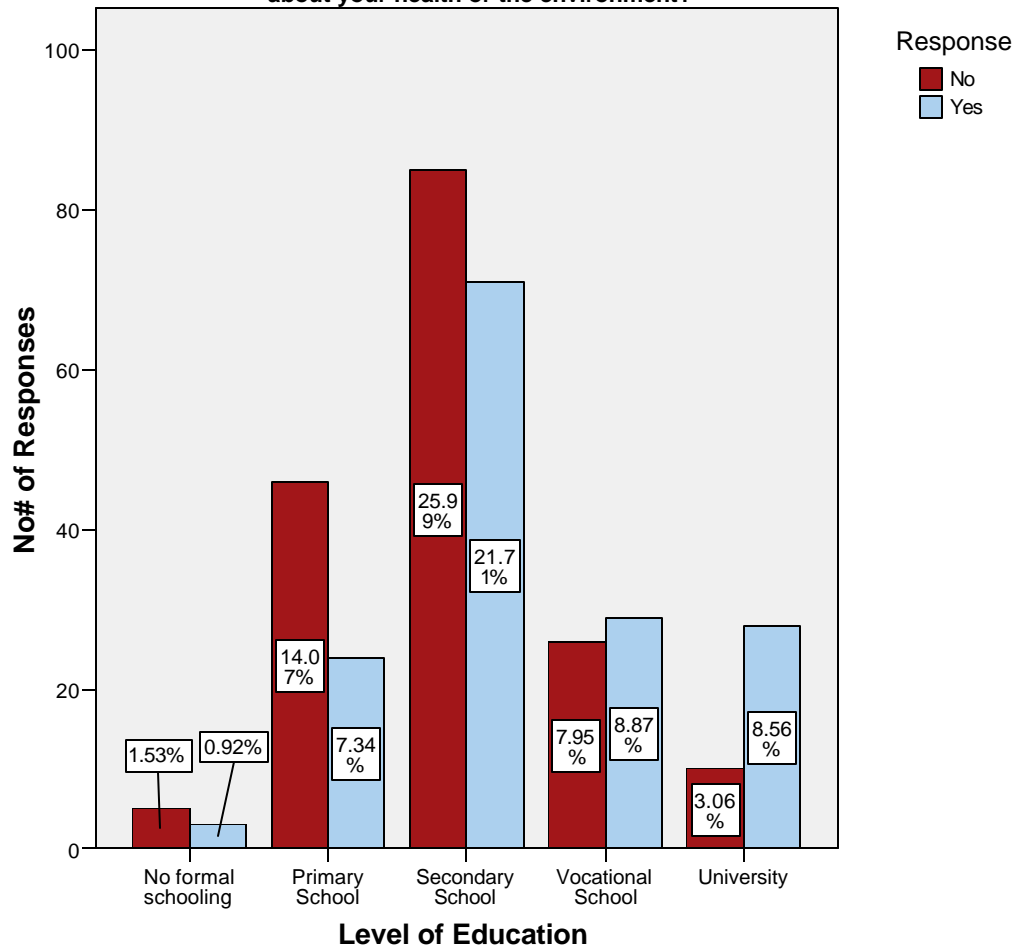


Figure 7: Considered Moving Away?: Response According to Level of Education

Because 83% of respondents were ethnically Fijian, conclusions about the relationship between ethnicity and risk perception could not be drawn from this study. Further inquiry into ethnicity and risk perception through qualitative research or quantitative research using stratified sampling techniques (if demographic data can be obtained) is thus warranted.

In most cases, the variables that were dependent upon age and/or level of education (described above) were different from those that depended upon gender. To further test the validity of gender variations in risk perception, age was held constant in a partial correlation test between gender and the variable *knowledge of risks*. Results indicated that women knew less about mining risks compared to men, even with the age and level of education variables held constant ($p < 0.001$). Additionally, there is no significant difference in the level of education of men and women at Vatukoula, so it is unlikely that a person's level of education influenced gender differences in risk perception.

8.1.11. Open-Ended Responses

Many quantitative studies have shown that women and men perceive the *same* risks differently (Fischer et al., 1991; Gustafson, 1998), however, qualitative research using open-ended questions and interviews has shown and men and women also perceive *different* risks altogether (Gustafson, 1998). Analysis of open-ended responses in the present study suggests that women have differing concerns than men; however, the word *risk* was not specifically used in this case. In the Fijian version of the one open-ended question, respondents were asked to list the three *issues* that concern them most, in decreasing order. Importantly, the Fijian-language version of this question did not limit responses to concerns related to the environment or health and thus offers insight into the relative importance of these issues. Confirming that environmental and health issues are of great concern, concerns related to the

environment and health accounted for 59.4% of all responses in the Fijian version and 95.2% of all responses in the English version. More specifically, issues related to poor water and air quality were most common in both versions, with 46 (14.7%) and 37 (11.9%) responses respectively in the Fijian language version and 103 (33.0%) and 87 (28%) responses respectively in the English language version. The English language version was more specific and asked respondents to list the three environmental or health issues that concerned them most. As a result, Fijian language responses were far less homogenous and a variety of other issues were identified. In decreasing order of frequency, financial problems, low wages and poor housing conditions were also of concern to residents. Societal problems accounted for 18.6% of responses in the Fijian version. Concerns about family problems, such as “broken home,” and “family problems everyday” were cited 12 times, with three-quarters of these respondents being female. Although the number of people citing family problems as a major concern was relatively small, these open-ended responses offer a more detailed look the wide variety of social and environmental impacts that exist in mining communities, and also suggest that women may be more concerned than men about impacts related to family life. As mentioned earlier, concerns about domestic violence and social problems were also voiced by women at the Pacific Regional International Women and Mining Network Meeting.

Table 7: Open-Ended Response Coding Categories and Relative Frequency of Occurrence

Fijian Language Survey (n=312)		English Language Survey (n=312)	
100 Environment (43.0%)		100 Environment (76.3%)	
110 Water Quality (14.7%)		110 Water Quality (33.0%)	
120 Air Quality (11.9%)		120 Air Quality (28.0%)	
130 Housing (10.9%)		130 Housing (4.5%)	
131 Poor housing conditions (9.0%)		131 Poor housing conditions (2.6%)	
132 Housing located too close to the mine (1.9%)		132 Housing too close to the mine (0.6%)	
140 General Pollution (2.6%)		133 Road condition (1.3%)	
150 Garbage (1.9%)		140 Pollution (8.4%)	
160 Tailings Dam Collapse (1.0%)		141 Specific chemicals (cyanide, sulfuric acid etc.) (4.2%)	
		142 Pollution of land (2.6%)	
		143 Signs of pollution (dying leaves, acid rain) (1.6%)	
200 Employment & Workplace Safety (22.1%)		150 Sewage (1.0%)	
210 Low Wages (8.9%)		160 Garbage (0.6%)	
220 Mine Closure (No work) (6.7%)		170 Collapse of land over mine (0.6%)	
230 Unsafe working conditions (3.5%)		180 Tailings Dam Collapse (0.3%)	
240 Complaints about the company or compensation for injuries (2.9%)			
		200 Health (18.9%)	
300 Societal (18.6%)		210 Food Safety (fish, farm, vegetables) (11.2%)	
310 Financial Problems (school fees, electricity, food, bus fare) (9.6%)		220 Concerns about specific symptoms (7.1%)	
320 Family Problems (broken home, domestic violence) (4.2%)		230 Lack of Medical Services (0.6%)	
330 Quality of Education (1.6%)			
340 Religious/Spiritual Life (1.3%)		300 Employment & Workplace Safety (3.9%)	
350 Discrimination against Indigenous Fijians (0.6%)		310 Working conditions (4.0%)	
360 Daily Hardships of Life (0.6%)		311 Unsafe working conditions (1.9%)	
370 Feeling Helpless (no assistance after mine closure) (0.6%)		312 Noise in workplace (1.9%)	
400 Health (16.4%)		400 Societal (0.9%)	
410 General Health Concerns (8.0%)		410 Financial problems (0.6%)	
420 Food safety (fish, farm, vegetables) (4.8%)		411 Electricity bills too high (0.6%)	
430 Request for Health Official (OHS, Ministry of Health) (2.2%)		420 Lack of awareness of risks (0.3%)	
440 Health/Well-Being of Children (1.3%)			

8.2 Environmental Sampling

Analytical results indicated that all six samples contained acceptable levels of Mercury (Hg), Zinc (Zn), Nickel (Ni), Cobalt (Co), Chromium (Cr), and Total Cyanide (CN), as recommended by the drinking water guidelines of the World Health Organization. There were no detections of Copper (Cu), Lead (Pb), or Cadmium (Cd), in all six samples, however, the minimum detection limit achievable by the MRD Analytical Unit was higher for these three metals than the WHO drinking water guidelines. Therefore, although no gross contamination of Cu, Pb, or Cd was detected, it cannot be concluded for these three contaminants that levels were necessarily within the WHO drinking water guidelines. Samples 003, 005, and 006 exceeded the maximum allowable WHO drinking water guideline of 10 ppb for Arsenic (As),

however, each of these three samples was collected from surface water in locations unlikely to be sources of drinking water. Sample 003 was collected from Lololevu Creek, which is not a source of drinking water; Sample 005 was collected downstream of both the PWD and EML water intake points; and Sample 006 was collected from the old tailings dam at Slime Dam, which is also not a drinking water source.

Table 8: Analytical Results

<i>Sample No.</i>			<i>001</i>	<i>002</i>	<i>003</i>	<i>004</i>	<i>005</i>	<i>006</i>
Parameter	Units	Primary Criteria *						
Arsenic (As)	(µg/L)	10.0	0.59	0.82	84.6	0.76	11.8	184
Mercury (Hg)	(µg/L)	1	ND(0.3)	ND(0.3)	ND(0.3)	ND(0.3)	ND(0.3)	ND(0.3)
Copper (Cu)	(mg/L)	2.0	ND(0.02)	ND(0.02)	ND(0.02)	ND(0.02)	ND(0.02)	ND(0.02)
Zinc (Zn)	(mg/L)	3.0	0.354	ND(0.02)	ND(0.02)	ND(0.02)	ND(0.02)	ND(0.02)
Nickel (Ni)	(mg/L)	0.07	ND(0.02)	ND(0.02)	ND(0.02)	ND(0.02)	ND(0.02)	ND(0.02)
Lead (Pb)	(mg/L)	0.01	ND(0.02)	ND(0.02)	ND(0.02)	ND(0.02)	ND(0.02)	ND(0.02)
Cadmium (Cd)	(mg/L)	0.003	ND(0.02)	ND(0.02)	ND(0.02)	ND(0.02)	ND(0.02)	ND(0.02)
Cobalt (Co)	(mg/L)	NC	ND(0.02)	ND(0.02)	ND(0.02)	ND(0.02)	ND(0.02)	ND(0.02)
Chromium (Cr)	(mg/L)	0.05	ND(0.02)	ND(0.02)	ND(0.02)	ND(0.02)	ND(0.02)	ND(0.02)
Total Cyanide (CN)	(mg/L)	0.07	ND(0.01)	ND(0.01)	ND(0.01)	ND(0.01)	ND(0.01)	ND(0.01)

Abbreviations/Symbols

*	Based on World Health Organization (WHO) Drinking Water Quality Guidelines (2006)
--	Not analyzed.
NA	Not applicable.
NC	No criteria established.
ND (0.2)	Not detected at detection limit identified in parentheses.
3.7	Exceeds the established primary criteria

When compared with historical water quality data collected during mining operations, the results of this study show an improvement in water quality. However, it is important to recognize that samples were collected after the mine had been closed for eight months. Additionally, samples were collected during the dry season (May to

November). Waterways probably experienced heavy sediment and water movement during the wet season, which lasted for several months following the mine closure (December- April). This movement probably caused a large degree of natural remediation of metals, while cyanide was likely largely evaporated as HCN gas. For example, many common arsenic compounds can dissolve in water, but over time the majority of As will be present in sediment rather than in water (Agency for Toxic Substances and Disease Registry, 2007). Given the large volumes of mine wastes discharged into the river during operation, a significant degree of natural remediation appears to have occurred in surface waterways, however, conclusions cannot be drawn from this study regarding the potential contamination of sediment.

Results also indicate that natural processes of remediation have led to an improvement in water quality in the old tailings dam near Nademo (Slime Dam). This is a positive indicator of the potential of all of the former tailings dams for successful rehabilitation through a program of re-vegetation and monitoring.

Residents are currently using the old tailings dam at Nademo for fishing. Although some fish accumulate arsenic in their tissues, most of this arsenic is in an organic form called arsenobetaine (commonly called "fish arsenic"), which is less harmful (Agency for Toxic Substances and Disease Registry, 2007). A recent study by the University of the South Pacific found that arsenic consumption in Fiji is already close to the provisional tolerable weekly intake (PTWI)⁴, however, this study only

⁴ A Maximum Allowable Daily Body Load (MADL) of total arsenic of 50 µg/kg bw/day was set in 1967 by WHO, however, more recently the Joint FAO/WHO Expert Committee on Food Additives (JECFA) set a PTWI of 15 µg/kg bw/week for *inorganic* arsenic, the more toxic form (Aalbersberg, 2007).

tested for total arsenic, while the toxic form is *inorganic* arsenic (Aalbersberg, 2007). The report recommended that further study of the inorganic and organic arsenic levels in fish in Fiji be undertaken as a priority matter (Aalbersberg, 2007). Additionally, the risk of mercury and other heavy metal contamination in fish from the tailings dam has not been assessed. It is thus recommended that a study of the safety of fish for human consumption be undertaken at the tailings dam at Nademo and in all of the waterways in the Vatukoula region as a priority matter. This is an important issue because variations in pH could potential mobilize additional metals into waterways in the future. pH levels were not tested as part of this study, but given the lack of metal detections, it is unlikely that pH levels in surface and drinking water were acidic at the time samples were collected. However, when mining operations resume, excessive sulfur dioxide emissions from the roaster stack could potentially create acidic surface water conditions. pH measurements should thus be an integral part of future monitoring programs.

Although the samples of drinking water tested as part of this study did not exceed WHO drinking water guidelines, the study cannot be considered a substitute for a comprehensive Environmental Impact Assessment (EIA). Despite the fact that untreated water is drawn from upstream of the contaminated Nasivi River sample site (003), it cannot be concluded from this study that all untreated water drawn from upstream is necessarily safe from contamination of metals and/or cyanide. During past mine operations, when wastes were routinely discharged into surface waterways, the risk of heavy metal and cyanide contamination was much higher than the current post-

closure risk. The 1994 environmental audit conducted by Sinclair Knight & Merz found that “maintaining human drinking water quality at the point of discharge is an unrealistic expectation (Sinclair Knight Merz Pty Ltd, 1994).” It is thus recommended that signs be clearly posted if future discharge occurs, advising people not to drink from streams and rivers in the Vatukoula area. Now that Westech has resumed mining operations, a consistent environmental monitoring program and a full EIA must also be undertaken.

8.3. Hydrogen-Sulfide Testing for Bacterial Contamination

Nine samples and one control sample (a total of ten) were tested for the risk of bacterial contamination. Using the H₂S Color Code provided by the WHO, eight out of nine samples were coded as noticeably black (+++) by the end of the three day observation period, indicating a high level of risk of bacterial contamination.

Table 9: Hydrogen-Sulfide Water Quality Testing Results

Sample ID	Water Source	Date	Time	Location	Additional Remarks	Day 1	Day 2	Day 3
1	Control: Bottled Water	7/26/2007	06:55	Tawua	Hawaiian Fresh	NA	-	-
2	Nasivi River	7/26/2007	08:20	Upstream of pumping station		NA	-	+
3	Tank - PWD Supplied	7/26/2007	10:40	Home E55		NA	-	-
4	Lololevu Creek	7/26/2007	12:15	Upstream of bridge (Lololevu I)		NA	-	++
5	Tap Water	7/27/2007	12:30	Nasomo drinking water source		NA	-	+
6	Tap Water	7/27/2007	3:15	Matanagata		NA	-	-
7	Boiled Tap Water	7/27/2007	3:25	Matanagata		NA	-	+
8	Boiled Tap Water	7/27/2007	3:25	Matanagata		NA	-	++
9	Tap Water	8/3/2007	10:15	Slime Dam	Kereni Marama's Tap	NA	-	+++
10	Nasivi River	8/4/2007	12:30	Turtle Rocks swimming area		NA	-	+
<i>H2S Color Code</i>								
(-) No change								
(+) Slight change, the paper strip or water sample has turned grey								
(++) the paper strip or water sample is partially black								
(+++)								

These samples were collected from both surface water and tap sources. One of the samples was taken from a tap inside a residence in the Nasomo settlement. This was a source which residents insisted was safe, because it came from the mountains.

Two other samples were actually boiled water that residents were drinking from tea cups at the time of testing. The only remaining sample that was not coded a (+++) was coded as (+), a slight change to grey color, indicating a slight possibility of bacterial contamination.

H₂S test results indicate that the majority of drinking water sources available to Vatukoula residents are not safe for human consumption due to the high risk of bacterial contamination. Residents must take care to boil water, including water originating from taps. Residents must also take care to avoid cross-contamination, which may originate from contamination on hands, taps, or dishes. Because the H₂S test kits are readily available from WHO, it is recommended that a longer term monitoring program be undertaken. This program could potentially be administered initially with the help of the U.S. Peace Corps volunteer based in Tavua town. The program could then be continued by local residents under the direction of the Vatukoula Community Consultative Committee. WHO also provides an easy to use Sanitary Survey Sheet, which may be used in conjunction with the H₂S testing, to assist in identifying the potential source of contamination for a particular water source.

8.4. Impacts of Mine Closure

The closure of the Vatukoula gold mine served to accentuate and accelerate the already existing social, environmental, and economic consequences of mining, and was indeed a very important risk, unforeseen to many. The impacts of the mine closure are evident throughout Fiji, beginning at the local level in the Vatukoula community itself,

continuing to create regional effects, especially on the nearby town of Tavua, and finally extending to the national level, where all Fijian citizens are concerned.

Local Impacts

Although three generations of experienced miners, engineers, and administrators were trained as a result of mining operations, little was done to prepare these workers for alternative livelihoods after the mining industry. Few locals held upper level management positions and the vast majority of those affected by the mining closure were underground miners. Forced to leave the only job they had even known, over a thousand mine employees, many of whom were the primary income earners for their families, were suddenly left to search for alternative ways to earn a living. Most were forced to look outside their home community for work, and the majority of able-bodied men left to find work cutting sugar cane. These men had to leave their families for months at a time, causing considerable social disruption. One resident explained his concerns at a community meeting with the mayor of neighboring Tavua town,

“...there are consequences, and when I say consequences, it’s sad, because we have family problems. When I say family problems that’s where the father goes and works somewhere else, and he never comes back. He’s looking after another family now, and their kids during this period of time are looked after by a different father or a different mother, and that’s the consequence I’m talking about (Vatukoula resident, personal communication, July, 28, 2007).”

Furthermore, cane cutters are paid a dismal wage in Fiji. While mining wages were not high by any standard, ranging from approximately F\$1.75/hr to F\$4.17/hr for skilled machine mining, groups of several men cutting cane are paid approximately \$13/ton. These groups of men are able to cut close to two tons per day and split the per-ton payment resulting in a wage of only F\$2-3 per day (Vatukoula resident, name withheld, personal communication, July 28, 2007). Even with these earnings, some men work for months without bringing any money home. After deductions for transportation, food rations, and housing, these men come home with no money at all.

“My husband is there, one month today, one month today, he never bring any money here (Solute Marama, personal communication, July 28, 2007).”

Those who chose to stay in Vatukoula resorted to subsistence farming, planting taro roots, cassava, and other vegetables. However, the residents of Vatukoula do not own their own land and are thus primarily confined to small, piecemeal, or marginalized areas for farming. Additionally, most were not able to purchase sugar, flour, and other staples without their regular income. Others, who had the option, became taxi drivers. But these men were forced to drive long distances to other cities to find work. One resident elaborated on some of the difficulties related to working far from home:

“You have to wake up at 5am in the morning...sometimes I go and my kids never wake up...I was getting more at the mine (J. Narayan, personal communication, July 31, 2007).”

Residents reported that finding the money to feed their children became exceedingly difficult just weeks after the mine closed. Romeo Kivi, a member of the Vatukoula Community Consultative Committee, explained that there were many children whose families could no longer supply them with lunches for school (R. Kivi, personal communication, July 28, 2007). The 2007 government profile of the Vatukoula Primary School indicated that approximately 26% of students were affected by moderate or severe under nutrition in 2007 (Anjali et al., 2007). According to the Head Teacher, many female students between the ages of 10-13 were also depressed and under stress due to inadequate breakfasts and lunches (Anjali et al., 2007).

Salote Marama, the women's representative on the Vatukoula Community Consultative Committee spoke about some of the specific concerns of women at the community meeting,

“Men do not know what is the problem in the house...it's hard for us to share it out. I think no other women can speak it out this morning. The fathers they do not know anything about this, it's us the mothers. Sometimes it's hard for us to explain to our child, oh, we've got no money, you just got to school without food. Us women we cry everyday...for our children (Salote Marama, personal communication, July 28, 2007).”

A small minority of people did report that they were able to maintain a similar standard of living before and after the closure of the mine. In fact, women who were never employed in the mining industry represented the few who were able to earn a living. Lapanoni Naivuqa, the wife of a former mining supervisor, was able to earn a

modest living selling kava, a traditionally important beverage in Fiji, in the markets (L. Naivuqa, personal communication, July 22, 2007). Another woman took advantage of government training to start a small bakery business that was locally successful (Salote Marama, personal communication, August 1, 2007). The government did provide F\$600,000 worth of assistance, including small business training, which was attended by 604 people (Ministry of Youth: Government of Fiji, 2007) . However, this training was only provided *after* the mine closure. Furthermore, the effectiveness of this training has not been well established. Starting small businesses in a severely economically depressed community where people have no disposable income can only realistically be successful to a certain extent. Local government officials reported that they willingly withheld business licenses because they believed the licenses were being misused. One official claimed that people only applied for the licenses to use the start-up money for immediate expenses (D. Chand, personal communication, July 2007). Other residents reported that most people who attended the training were only interested in the per diem cash payment that was given to each attendee, and never felt they would start their own business (Salote Marama, personal communication, July 31, 2007).

In general, the more highly trained employees (such as engineers), who were a minority in the workforce, were able to find work in industries overseas or locally in the tourism industry (R. Venkalesh, personal communication, July 30, 2007).

“In Fiji, compared to other industries...technology wise, Emperor was the best. (R. Venkalesh, personal communication, July 30, 2007).”

In this way, the mining industry provided valuable technical training and skills for some employees, which, if locally retained could be seen as a valuable investment in human capital. However, the same former employee explained that his work at Emperor adversely affected his health, representing a decrease in human capital,

“Working at the HCL pump, it wasn’t good for our health. I was really hospitalized in 2005 for a good four months...because of my work. In fact I was told by the doctors I was sick because of my work, because of working in the HCL pump (R. Venkalesh, personal communication, July 30, 2007).”

One of the community’s most pressing concerns was, and still remains, the issue of substandard housing and the need for relocation post-closure. The mining industry could have made a significant contribution to local built capital in the form of housing; instead many of the structures that were created in the 1930’s have only deteriorated and in fact have become liabilities. The land underlying all the Vatukoula communities is freehold land, which prior to the sale of the mine, was owned by EML. However, several years ago, EML began selling the houses to employees and their families, without selling the land beneath the houses. Families entered into contracts with EML that required them to take down their houses and move when they no longer worked for the mine (A. Wesson, personal communication, August 15, 2007). Indeed, EML gave employees three months notice to vacate their houses following the closure of the mine. However, the houses are now worth little or nothing without the mining operations, and the families have nowhere else to go. Thus, the contract terms have now proven to be

unrealistic, and hundreds of former employees are currently living in dilapidated houses on company land.

Open-ended survey responses revealed that residents were also very concerned about the lack of medical care available in Vatukoula after the mine closed. The community was served by medical professionals who were employed by the company and these doctors and nurses left when the mine closed. This situation could have been avoided if the company and government worked together to plan for government medical services equivalent to those provided in other areas of Fiji. There is also a conflict of interest if company medical services are the only health services available to residents. This is another reason why the availability of government medical services is critical. The population of the Vatukoula region is large enough to warrant a public health center, however, the former company (EML) did not allow such a facility to be built on their private land (Timothy Young, personal communication, August 9, 2007).

Regional and National Impacts

The neighboring town of Tavua, which also developed as a result of the mining industry at Vatukoula, experienced a similar economic and social shockwave with the closure of the mine. Tavua, by all accounts, is totally dependent on the mine. Although Westech is resuming operations at Vatukoula, employment levels will never return to their former height and the mine will eventually close again. If Tavua does not develop alternative sustainable industries the town will not thrive.

The town of Tavua is located only a few kilometers downstream of the mine, along the Nasivi River. It is therefore also susceptible to the environmental risks associated with gold mining. However, the mayor expressed his concern that the community felt totally unprepared for a potential release of mining wastes or a tailings dam failure. In fact, it was his perception that Emperor had actually tried to conceal information from the public regarding environmental releases in the past (C. Singh, personal communication, August 3, 2007).

The mayor described the town's situation approximately six months after the mine closure as,

"...quite a desperate situation (C. Singh, personal communication, August 3, 2007)."

He explained that the town was given absolutely no notice from the company that the mine would close. EML admitted to him that in Australia the company be required to give one year's notice if they were going to close a mine of similar magnitude, and that they would not do the same thing back home (C. Singh, personal communication, August 3, 2007). The mayor specifically described the following impacts of the mine closure on the town of Tavua:

- an estimated F\$75 million in lost revenues, including F\$25 million in annual wages, and F\$42 million in service providers; and
- a drop in business of 60%.

Most families, after living without any significant income for over six months, were in very difficult financial situations. During his six years as mayor, Chandra

Singh approached the interim government repeatedly for assistance in developing alternative industries, including the creation of tax-free zones or concessions, but he did not feel that enough was being done,

“...the current government lacks the political will to do it (C. Singh, personal communication, August 3, 2007).”

According to Sada Reddy, the Deputy Governor of the Reserve Bank of Fiji, F\$50-\$60 million in export earnings were lost during the period the mine was closed (“\$50 Million Lost in Mine Closure,” 2007). With the closure of the mine occurring just one day after the December, 2006 military coup, it is no surprise that it was challenging for the interim administration to respond quickly to the needs of the Vatukoula community. A committee was established to examine the impacts of the mine closure. The chair of the committee was the Permanent Secretary for the Prime Minister’s office, and other members included the Ministries of Labor, Environment, Health, Social Welfare, and Education (E. Nasome, personal communication, August 9, 2007). The sudden closure of the mine also challenged the wherewithal of the Mineral Resources Department (MRD). For example, because of the shortcomings of the environmental monitoring process, the MRD was forced to go back to the company (EML) to retrieve important environmental data post-closure (E. Nasome, personal communication, August 9, 2007). This data was necessary for the MRD to make an accurate assessment of the impacts of the mine and the associated rehabilitation that may be required.

8.5. Mining in Fiji and the Natural Resource Curse

Although Fiji has achieved some level of economic diversification, a closer examination of the mining industry in isolation reveals an experience plagued by many of the common pitfalls associated with the natural resource curse. Unfortunately for Fiji, when Emperor announced the sudden closure the mine the morning after the country's fourth military coup within two decades, a number of serious challenges related to the sale and negotiation process were created for the interim administration. The negotiation process relating to natural resource contracts is usually dependent on time-sensitive factors. The changing price of the resource, and perhaps more importantly in Fiji's case, the current economic and political conditions in the country are critical factors which influence the negotiation process (Radon, 2007).

Immediately following the initial shut down of operations at Vatukoula, EML stated that the company intended to keep the mine under a care and maintenance program, and conduct further exploration before selling the mine (Gordon, 2007). However, they claimed that the presence of the military at the mine site beginning in January, 2007 compromised their ability manage the mine and this placed an additional financial burden on the company. The company stated that this military presence, combined with conditions imposed by the interim government after a subsequent cabinet meeting (that EML claimed would cost the company more than FJD \$51 million) led the company to sell the mine shortly after it was shut down (Gordon, 2007).

By any account, the sudden and significant unemployment created by the closure of the mine made negotiating an agreement with a new mining company a pressing task. This was not an unfamiliar situation for the government of Fiji. Beginning in the 1950's, the government granted an increasing number of concessions to EML and its principal Fiji subsidiary, Emperor Gold Mining Company Ltd. (EGM) (Grynberg et al., 1997). The desire to maintain levels of employment at Vatukoula was a significant factor in the series of concessions that were granted to Emperor over the next three decades, which reached their height with the signing of the VTA in 1983, after which EML and EGM paid negligible amounts of tax and royalties (Grynberg et al., 1997). In their 1997 financial analysis of EGM and EML, Grynberg et al. showed that EML, domiciled in the tax haven of the Isle of Man, reported profits of approximately A\$50 million for the period 1986-1992 and a return on assets of approximately 12%, clearly demonstrating that the Vatukoula operations were profitable (Grynberg et al., 1997). However, while the operations were profitable, the company paid little or no tax. The VTA provided the necessary conditions for this to occur, by offering concessions on all of the taxable portions of mining revenues, including income tax, royalties, customs duty, and fiscal duty (replaced in 1992 by a general goods and services tax) on imported chemicals and explosives, the only exception being export tax (Grynberg et al., 1997).

With a history of subsidizing mining operations, the government was finally in a position to renegotiate a better deal with the new mining company, however, the timing and conditions of the negotiations left the government in a weakened bargaining

position. The problems began with the sale of the mine to Westech, a small newly incorporated company, owned by Brian and Amelia Wesson, who were actually former Vatukoula residents. In fact, Brian Wesson was previously employed by the former owners, EML, as chief engineer for a period of seven years (A. Wesson, personal communication, August 15, 2007). Thus, it appeared that the new company had an information advantage when purchasing the mine. Similar conditions of asymmetric information have been documented to cause resources to be sold at lower values during the privatization and bidding processes (Radon, 2007). Although this case differs because the mine ownership was being transferred between private entities, the timing of the sale, coupled with an informational advantage on the part of Westech, at the very least allowed the new company to enter into the negotiation process in a powerful position. The government did make one attempt to secure a better deal by placing an ad in the Fiji Times for expressions to operate the Vatukoula mine on August 4, 2007 (Department of Lands and Mineral Resources, 2007). However, the fact that Westech had clearly been associated with the former owners surely did not encourage other interested parties to submit bids that would lead to the best deal for the mine (Radon, 2007). The sale eventually took place through the legal transfer of all assets and liabilities from EML to Westech (estimated at over FJD \$20 million), with a cash check issued by Westech to EML for a total of AUD \$2.00 (A. Wesson, personal communication, August 15, 2007).

Further empowering Westech, the interim administration's negotiating team probably did not have the technical expertise to successfully argue for its fair share of

the remaining resources at Vatukuola. The team did not include key members of the Fiji Mineral Resources Department (MRD), many of whom held valuable technical expertise (I. Fong, personal communication, August 9, 2007). Information about the negotiations was also not available publicly, even though the Vatukoula community expressed repeatedly that it wished to be involved in the negotiation process. The Vatukoula community indeed holds a wealth of technical expertise, having produced three generations of experienced miners and engineers. Community advocates were reportedly pressured by police officers and the military to stop speaking out about community concerns relating to the lack of transparency in the negotiation process (Ravula, 2007).

The negotiations eventually resulted in key concessions to Westech, including:

- a reduction in royalty from 6% to 3% on ore extracted for five years;
- exemption from import duties for two years on automotive diesel oil or industrial diesel oil imported for use in relation to the operation of the mine at the national rate;
- exemption from export taxes for a period of 5 years;
- exemption from fiscal duty for a period of 3 years on importation of all plant equipment, machinery and motor vehicles required to conduct operations; and
- eligibility to seek an exemption from paying withholding tax on overseas payments of interest on loans, consultant's fees, and dividends

to shareholders in accordance with Fiji's Income Tax Act (River Diamonds PLC, 2007).

In another important concession, Westech was not required to post a bond for future environmental damage. Westech stated that,

"...we've got all this money that we have to pay right now, it's not a good time for us to put any more money into a fund for rehabilitation later on, at this stage, we need money to do the mining (A. Wesson, personal communication, August 15, 2007)."

In return for these concessions, a Community Rehabilitation and Social Assistance Deed (RASD) was signed, in which Westech agreed to contribute to rehabilitation of certain social and environmental issues at Vatukoula. However, the specifics of this deed have not been released publicly by the interim administration. Amelia Wesson did disclose in an interview that the assistance called for under the RASD amounted to approximately FJD \$6 million (A. Wesson, personal communication, August 15, 2007). In addition Westech will refund to the government the expenditures incurred for care and maintenance since May, 2007 which amounts to approximately FJD \$5.4 million (River Diamonds PLC, 2007).

It follows from the above analysis that, as a result of the timing of the closure (and the associated economic and social pressures to resume mining operations), a lack of appropriate negotiation and technical expertise on the part of the interim administration, a lack of public participation and transparency during and after the negotiation process, and the conditions of the mine sale to a company with an

informational advantage, the government again failed to secure the best deal for the remaining gold resources at Vatukoula. This is evidence that the country did fall into one of the major traps associated with the resource curse – foreign companies having the upper hand in negotiations (Radon, 2007). Additionally, while not directly linked to mining as a result of this study, Fiji's history of four military coups in the past 20 years, weakened democratic system, and the military intervention at the mine are also issues commonly attributed to the resource curse. In a larger sense, however, Fiji was able to escape the more severe resource curse fate. Unlike its close island neighbor, Nauru, which was totally dependent on phosphate mining for economic development (McDaniel & Gowdy, 2000), Fiji also derives wealth from tourism, agriculture and several other small economic sectors. This has allowed the country to escape the dismal fate it may have encountered if gold was the sole source of national wealth.

CHAPTER 9: CONCLUSION

This was the first risk-perception study conducted in both the cultural context of Fiji and the industrial context of gold mining. As such, all of the survey results are valuable to a more informed discussion about risk communication and management at Vatukoula. Furthermore, research has shown that two of the major principles of effective risk communication are: 1) understanding and addressing audience concerns, and 2) whenever possible, account for existing beliefs and perceptions (Lundgren & McMakin, 2004). The results of this study may thus also serve as a preliminary step in the development of a more effective audience-tailored risk communication program.

A prominent finding of this study is that gender is an important variable in risk perception at Vatukoula. More specifically, women feel they have less knowledge about the environmental and health risks of mining compared them men, women feel they have less control to avoid the risks than their male counterparts, and women tend to find information about the risks from secondary sources. Institutional and cultural structures have contributed to this particular form of marginalization of women in Vatukoula. The traditional roles and status of women in mining communities have changed, placing women in a position of weakened economic and social power relative to men in Vatukoula. The Fiji government has endorsed MDG #3, to promote gender quality and the empowerment of women, and has developed a Strategic Development Plan (SDP), which includes five major goals for gender and development. The first of these goals is “to mainstream gender perspectives, issues and concerns in the planning process (Asian Development Bank, 2006).” If disseminated and applied, the results of

this study can contribute to the mainstreaming of gender issues, because they highlight the key differences in the perceptions of men and women regarding the risks of mining, both during mining and post-closure. The following sections include many recommendations specifically targeted at addressing the gender differences in risk perception identified in this study. Incorporating these recommendations into future mining activities will be critical if the citizens of Fiji wish to fully realize their stated development goals, particularly as they relate to gender equality and empowerment of women.

9.1. Recommendations for Risk Communication and Management

Perhaps the most important obstacle to effective risk communication at Vatukoula is the existing level of distrust that has developed between the community, the former mining company, and the government. However, because the mine was recently purchased by a new company, this challenge may also be a golden opportunity to build a new reputation of openness and trust. For this to be the case, the new company must start from the very beginning with a well-planned and open commitment to risk communication. Timely and full disclosure of risk-related information will be crucial to this transition. It may be helpful to invite a credible organization which is trusted by the community, such as a civil society group that has not yet been involved in any of the past conflicts at Vatukoula, to participate as a partner in a new risk communication program. It is critical that the community view the source of risk

information as credible, and a partner organization may help in the transition to a more trusting relationship (Lundgren & McMakin, 2004).

One potential source of distrust arises from a conflict of interest that exists in the environmental monitoring process at Vatukoula. The Mineral Resources Department (MRD) is the agency that is responsible for monitoring the environmental impacts at Vatukoula, but it is this same agency that is responsible for promoting the mineral industry in the country (E. Nasome, personal communication, August 9, 2007). This conflict of interest has the potential to further increase distrust of authorities when it comes to full disclosure of risk. In order to correct this situation, the environmental monitoring component of the MRD must be separated. This monitoring could instead be facilitated through monitoring agents under the recently passed Environment Management Act of 2005.

The former environmental officer for the mining company reported that community meetings were held on a monthly basis to address community concerns related to environmental risks, through an initiative called the Community Visitation Program. However, these meetings only achieved an approximately 30% attendance rate (J. Feresi, personal communication, July 16, 2007). In another conflict of interest, residents reported concern that the environmental officer was ultimately paid by the company, and thus had motives other than purely protecting the environment. While little is known about the content and conduct of the Community Visitation Program, it is clear from the low level of attendance and lack of community knowledge about risks that it was not highly successful. It has been demonstrated that risks can be

downplayed in public gatherings, and that moderation and careful planning is required when group interactions relating to risk communication are to take place (Fessenden-Radon et al., 1987). Specific strategies that may be employed to improve the efficacy of such meetings include the following:

- An appropriate time and place that is not associated with any negative feelings for the participants must be selected (Lundgren & McMakin, 2004). In the case of Vatukoula, this may mean having meetings away from company property, perhaps rotating between the various *vale-ni-koro* (community halls);
- Make sure all participants have a clear idea of the purpose and objectives of the meeting in advance. This could be accomplished through written notice to all households (addressed to the entire family, not just the mine employee) or through the various *turaga-ni-koro* (traditional village leaders) and through women's groups (*soqosoqo vakamarama*);
- Westech (the current company) should demonstrate support for the group by providing the necessary financial and technical resources for the meetings, including training of meeting facilitators and moderators;
- Citizen's groups and the MRD may be able to offer additional resources, particularly to bolster technical and facilitation training needs; the elected members of the Vatukoula Community Consultative Committee

(a community group formed to represent community interests in the mining town) may be able to serve as moderators of these meetings if training was provided;

- Guidelines should be established for communication and organization, i.e. Who will facilitate and mediate the meeting? Will decisions be made by written ballot or a show of hands? Who will make decisions? (Lundgren & McMakin, 2004); and
- Specific attention should be paid to the inclusion of women at every stage of the risk communication process, including adequate and full notification of women regarding meeting times/venues, and separately allocated time for women to voice concerns and questions.

A firm commitment to the inclusion of gender considerations in the development of future risk communication and management strategies will be critical in addressing many of the gender inequities in risk-perception revealed in this study. The new mining company should support and encourage the participation of women during the development of new risk communication strategies. Women who participate in strategic development can offer insights into the best outlets for communicating risks to other women in Vatukoula. These insights will build upon the findings of this study to create a knowledge base regarding the most effective methods of communicating risks to a female audience. Financial resources and support should also be provided for women who wish to attend regional workshops and conferences aimed at educating and

empowering women in mining communities. Finally, the Vatukoula Community Consultative Committee membership should be expanded to include equal representation of women and men. Currently the committee includes one female representative; additional women should be elected to increase women's access to, and participation in, the decision-making process.

One specific risk which has not been effectively communicated to the residents of Vatukoula is the risk of a tailings dam collapse or failure. There are six large tailings dams located in the region. However, while failures and releases of similar tailings dams have been documented worldwide (Akcil, 2006; Stenson, 2006), 77% of respondents in Vatukoula reported not having a plan to deal with this risk. In response to another question, 19% of respondents reported not knowing much about this particular risk, and wanting to learn more, while 53% reported being "worried" about the risk. This is clearly an area where risk communication could and should be improved. Although signage was placed at tailings dams, most signs were reportedly vandalized or removed, indicating that they have not been accepted by the community (A. Wesson, personal communication, August 15, 2007). Clearly, this issue will not have one simple solution, but must be addressed through the development of increased trust and confidence in risk managers. Additionally, accurate and specific information should be provided to all community members regarding the nature of the risks of tailings dams, and this must be accompanied by a plan to address a potential disaster. If accurate information is combined with a plan, then residents will feel that there is

something they can do to personally address the risk. This will potentially lead to greater acceptance of future risk messages.

In addition to the intentional, official verbal and written risk messages that have been sent by the authorities at Vatukuola, it is important to recognize that unintentional, and non-verbal messages are also being sent. Indeed, unofficial risk messages can sometimes have more impact than official messages, in part because they may appear to respond to the real concerns people are facing, or are delivered by unofficial messengers who are more trusted than their official counterparts (Fessenden-Radon et al., 1987). One example of an unofficial risk message that may exist in Vatukoula relates to drinking water quality. In Vatukoula socio-economic divisions have historically existed according to race (Emberson-Bain, 1994). Today, many of the poorest villages remain ethnically Fijian, while housing settlements with better quality housing still belong to primarily ex-patriate, or ethnically mixed owners. The poorer, often ethnically Fijian villages also have reduced access to treated water. Instead, these areas are supplied with untreated drinking water directly from the Nasivi River. When company officials and authorities drink a different source of water, this sends an unofficial risk message that the untreated water is unsafe. These types of unofficial risk messages must be recognized and addressed or eliminated wherever possible. Fortunately, the new company has pledged to supply treated drinking water to all villages and settlements, and this will represent a step in the right direction.

Due to cultural considerations, Fiji may also be particularly prone to the challenge of collective interpretations of risk. These are another source of unofficial

risk messages that should be recognized and addressed. For example, residents in Vatukoula perceive there to be a high incidence of asthma related to sulfur dioxide emissions from the roaster stack. In fact, 82 % of residents reported that they felt that air pollution was “somewhat or very likely” to have caused them health problems. As a result, even those individuals who have not directly experienced asthma symptoms may be less likely to accept official messages that sulfur dioxide is not responsible for asthma (Fessenden-Radon et al., 1987). In Fijian culture, a high degree of respect and trust are placed in traditional leaders (A. Emberson-Bain, personal communication, July 18, 2007). This means that if these local leaders are also affected by either personal or vicarious experience, or by the inter-community grapevine, people may be more likely to be influenced by the opinions of these leaders instead of risk messages from the authorities.

General environmental education, specifically as it relates to mining could also be an important long-term compliment to a risk communication program. There are three primary schools and one secondary school located nearby the mine. Currently, no environmental education is taking place in these schools. One teacher commented,

“We don’t know that it (mining) is a dangerous job, smoke coming in, sulfur coming in, we just thought it was normal. But if there was advanced education on mining, maybe it’s a different story (Vatukoula primary school teacher (name withheld), personal communication July 22, 2007).”

A wide variety of educational outlets should be considered. An educational video and website were created as part of this study; these resources represent two

forms of communication that have not yet been explored in this community context. The projects could be considered as a test of these two communication outlets, and their effectiveness could be gauged so that improvements and recommendations for future projects may be developed.

Finally, there has been a relationship demonstrated between actual economic dependence on an activity and lower levels of perceived risk associated with that activity (Fessenden-Radon et al., 1987; Williams et al., 1999). Although this study did not find a statistically significant difference in level of perceived risk between people who had been employed by the mine and those who hadn't, there was a trend towards a slightly lower level of concern about certain risks among people who had been employed by the mine. However, nearly all of the people who participated in this study were economically dependent on the mine in some way, if not directly through employment. As long as residents feel that there are highly limited alternatives to living and working at Vatukoula, risks will likely continue to be downplayed and underestimated. As such, an important compliment to any risk communication program will be the continued commitment by government and local industries to foster and develop viable economic alternatives to mining in the region.

An open dialogue must be established as soon as possible between the new mining company, the community, and other stakeholders. This could represent an important opportunity for the introduction of increased public involvement and an improvement in the relationship and level of trust between stakeholders. The new company has pledged to hire only local people for management positions, and this

would be a great way to begin getting respected and experienced local Fijian leaders involved in the risk communication process (Radio New Zealand International, 2007). In the cultural context of Fiji, having local leaders trained and placed in positions of authority could be a great way to increase trust and confidence in the risk communication process. However, it is critical that those authorities who will be responsible for developing and implementing the risk communication policies have the necessary technical training and the capability to translate this knowledge into terms that can be understood by the general public. The new company has a responsibility to provide this training; no risk communication program will succeed if authorities are not trusted and viewed as technically competent.

If an increase in the number of management positions available to local people occurs, it must also be ensured that women are encouraged to apply for and secure an equal proportion of these management positions. The development of additional training programs and scholarship opportunities aimed specifically at women, would help build capacity. Improved access to employment opportunities for women at Vatukoula will help address their lack of perceived control and lack of knowledge about environmental and health risks.

Ultimately it will also be important in the case of Vatukoula, that a more in-depth understanding of the perceptions and knowledge of the community be obtained. The risk-perception survey performed as part of this study represents a first step in this direction, however, further inquiries must be undertaken by the company and government if effective risk communication strategies are to be developed. The

important role of the receiver of risk information, the Vatukoula community in this case, must be fully recognized; strategies for communication of risks must subsequently be tailored to the unique characteristics of this particular audience. The findings of this research indicate a clear need for risk communication to be improved specifically for women and residents who are not employed in the mine. These two groups appear to seek out information about risks from secondary sources. Programs must be developed which communicate risk information directly to these groups.

9.2. Lessons for Mine Closure and Transition

The inherently temporary nature of mining was overlooked in Fiji, or perhaps intentionally pushed aside by some, until the time inevitably arrived when Vatukoula was forced to close. Only then did it become clear that the economic, environmental, and social impacts of the short-term venture could no longer be ignored. The ramifications of inadequate planning for mining closure are now borne by the citizens of Fiji. The residents of Vatukoula were totally unprepared economically and otherwise for the closure of the mine. In a recent article for *Islands Business*, Parmesh Chand, chief executive officer at the Prime Minister's office explained that Fiji learned an important lesson regarding mining closure.

"The laws of Fiji are very broad in terms of mining closure. Mining companies can just pull out and not meet their broader obligations in areas of environment, alternative livelihood, care and maintenance (Tabureguci, 2007)."

Mr. Chand's comment highlights an important lesson that comes from the recognition of the phenomenon of the resource curse; legislation and institutional structures must be strengthened *before* mining activities are undertaken (Stiglitz, 2007). In Fiji's case, this means that if the mistakes of the past are to be avoided, much work is needed to strengthen tax and environmental legislation, and the institutional structures necessary for the enforcement of such legislation, before further mining takes place. In 2005, Fiji passed the Environment Management Act, however, the specific standards, manpower and court system needed to enforce the Act were not in place when the negotiations with Westech were completed (Eveli Nasome, personal communication, August 9, 2007). In addition to the potential long-term environmental consequences of this lack of regulation, it also resulted in Westech not being required to conduct a formal Environmental Impact Assessment (EIA) before beginning operations at Vatukoula (A. Wesson, personal communication, August 15, 2007). This was an important missed opportunity which may have negative consequences extending far into the future.

Secondly, the negotiation process is always critically important when it comes to resource extraction in developing countries. In this case, the concessions offered to Westech will limit Fiji's ability to capture and invest resource rents in other types of capital far into the future (which is a fundamentally required for sustainable development). It would certainly be prudent to seek out and employ expert negotiators in future negotiations with mining companies, so that the majority of gold wealth is not captured and exported overseas.

The contract being what it is, however, the government should now focus on making carefully planned investments in education, including the communication of the environmental and health risks of mining to communities in the Vatukoula region. The government should also work with Westech and other companies in the region, including Fiji Water, to make investments in alternative industries so that human and social capital can be effectively utilized after mining. Tourism would be an intelligent initial investment for the Vatukoula region. The mine is located along the road between two major tourist hubs, Nadi and diving island of Nananu-i-Ra. During this study, tourists expressed interest in potentially visiting a mining heritage site to learn about the history and culture of the Vatukoula mine. Westech does have plans to create an on-site museum and to employ the long-time strikers as storytellers (A. Wesson, personal communication, August 15, 2007). The company also mentioned plans to develop small scale tourism efforts aimed at the local hot springs in the region (A. Wesson, personal communication, August 15, 2007). These attempts to develop tourism could bring employment and financial benefits to the region while the transition towards more sustainable industries is developed. In the longer-term, the development of sustainable agriculture has enormous potential. Sugar cane is Fiji's primary agricultural good and developing sustainable methods of producing this product could bring a sustainable source of income to the country, especially with a developing international biofuels market.

Westech has promised to employ only local people in management positions at Vatukoula, and this could be not only a socially responsible move, but also a great

investment in human and social capital for Fiji. Although mistakes have been made, one advantage for Fiji now is the amount of mining expertise that the industry has developed throughout the years. Experienced local Fijians successfully maintained the mine, without pay, during the period of shut down. Particularly if more business and management expertise were developed, there would be no reason why Fiji could not operate its own mining company in the future. However, this may require leaving at least a portion of their resources in the ground for some time, while capital (financial, human, and social) is further accrued.

Presumably the issue of substandard housing and relocation will be addressed at least partially in the RASD agreement. However, Westech admitted that the housing issue is extremely complicated and will not be resolved with one simple solution. Westech has proposed taking small steps to address the issue. They described a potential program in which monthly village clean-up competitions would be held in each village, with the winning village awarded a sum of approximately \$500 to go towards modifying and cleaning the village (A. Wesson, personal communication, August 15, 2007). Although this may help relieve some immediate housing problems, this solution does not address the underlying problem: wages are poor and employees cannot afford to maintain their own homes. A certain level of responsibility is required of a company if a mining operation is to be socially sustainable. If a private company cannot or will not pay wages that allow workers to maintain a reasonable standard of living, then it is unlikely that it will be socially sustainable in the long term. In addition, the fact that Westech could not afford to post a bond for the rehabilitation of

potential environmental damages further indicates that the company is not prepared to deal with the inevitable environmental and social consequences of the mining operations it plans to undertake.

As international pressure for improved environmental and social performance continues to increase, it will be advantageous for both the citizens of Fiji and Westech if the company establishes a voluntary and transparent reporting policy, including annual reports with full disclosure of social and environmental information. From a business perspective, international campaigns aimed at exposing poor social and environmental performance, such as the Oxfam Mining Campaign, draw negative attention to the mining industry in Fiji. Additionally, the financial sector is paying attention to corporate social responsibility, and mining companies have been excluded from socially responsible investing funds (Jenkins & Yakovleva, 2006). It also became clear during the negotiation process that the community itself is demanding increased transparency, especially related to social and environmental performance. Westech should thus follow the lead of many of the larger mining companies by establishing a company website and beginning to publish annual sustainability reports.

Many valuable lessons may be drawn from the story of Vatukoula for other mining communities throughout the world who wish to plan for longer-term sustainable development. At the same time, Vatukoula itself has an opportunity to learn from past mistakes and work towards improved environmental, social, and economic outcomes during this time of transition. This will require a strong commitment from Westech and the Fiji Government to work together in a cooperative and transparent manner. Such

cooperative stakeholder collaboration will compliment the effective implementation of the recommendations which have resulted from this study.

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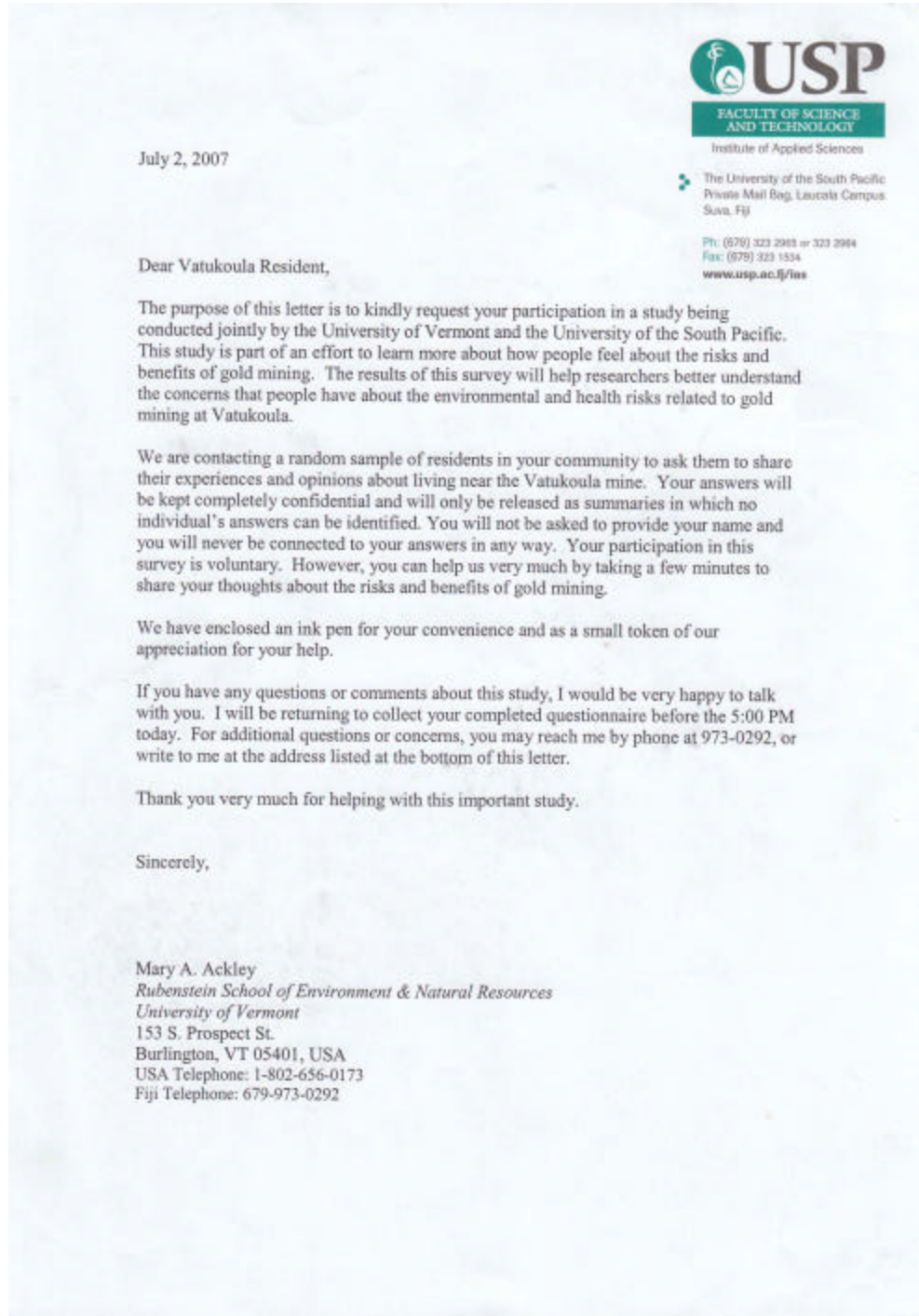
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APPENDIX I: SURVEY INSTRUMENT (ENGLISH LANGUAGE)



INFORMED CONSENT TO PARTICIPATE

Evaluating Environmental Risks in Gold Mining: A Perceptual Study at the Vatukoula Gold Mine in Fiji

Your voluntary participation in this study is requested so that we may learn more about how the environmental and health risks of gold mining are perceived in your community. The purpose of this form is to provide a clear explanation of the nature of this study. The necessary procedures for participation are described below. If you have any questions or concerns after reading this form, please contact the researcher, Mary Ackley. Mary can be contacted by telephone at 973-0292 any time before, during, or after your participation is completed. Once you are entirely satisfied with this explanation and freely choose to participate in the study, you may indicate your willingness to do so by signing below. You are free to end your participation in the study at any time.

The purpose of this study is to collect information on how people in mining communities perceive the environmental and health risks associated with gold mining. If you consent to participate, you will be asked to complete a survey questionnaire. You will not be asked to write your name on any part of the questionnaire and your responses will be kept anonymous. There is no predictable physical risk associated with participation in this study. You may become more aware of your personal thoughts and attitudes regarding the risks and benefits of gold mining when answering some of the questions. If you choose, you are free to refuse to answer any or all questions without penalty, even after signing this form.

I have read and understand this consent form and the procedures involved in this study. I received a copy of this consent form to keep for myself, and I voluntarily agree to participate in this study.

Participant Signature

Date

Researcher's Signature

Date

Environmental & Health Risk Perception Survey
 Vatukoula Gold Mine, Fiji

University of Vermont
Rubenstein School of Environment & Natural Resources
 2007

Please answer the following questions by placing a checkmark next to only *ONE* answer, like so:

1) Which statement *best* describes how you feel about the risks of mining?

- I am not aware of any risks.
- I only know about some of the risks.
- I know about most of the risks.
- I already know everything I need to know about the risks.

2) How did you *first* learn that there were risks associated with gold mining?

- I don't know anything about the risks
- Television
- The mining company
- Information from the government
- Newspapers
- Books
- Other people in my village or town
- Because of this survey
- Somewhere else

3) Please circle the answer that *best* describes how much you are worried or not worried about each of the following potential risks:

a) Pollution in your drinking water	<i>Not Worried at all</i>	<i>Somewhat Worried</i>	<i>Very Worried</i>	<i>Don't Know</i>
b) Pollution in your rivers and streams	<i>Not Worried at all</i>	<i>Somewhat Worried</i>	<i>Very Worried</i>	<i>Don't Know</i>
c) Pollution in the air	<i>Not Worried at all</i>	<i>Somewhat Worried</i>	<i>Very Worried</i>	<i>Don't Know</i>
d) Pollution in your garden vegetables or root crops	<i>Not Worried at all</i>	<i>Somewhat Worried</i>	<i>Very Worried</i>	<i>Don't Know</i>
e) Pollution in the fish you eat	<i>Not Worried at all</i>	<i>Somewhat Worried</i>	<i>Very Worried</i>	<i>Don't Know</i>
f) Pollution of your land	<i>Not Worried at all</i>	<i>Somewhat Worried</i>	<i>Very Worried</i>	<i>Don't Know</i>

Environmental & Health Risk Perception Survey
Vatukoula Gold Mine, Fiji

4) What is the likelihood that pollution in your drinking water has caused health problems for you or your family?

- Very unlikely
- Somewhat unlikely
- Somewhat likely
- Very likely
- I don't know

5) What is the likelihood that pollution in your rivers and streams has caused health problems for you or your family?

- Very unlikely
- Somewhat unlikely
- Somewhat likely
- Very likely
- I don't know

6) What is the likelihood that pollution in the air has caused health problems for you or your family?

- Very unlikely
- Somewhat unlikely
- Somewhat likely
- Very likely
- I don't know

7) What is the likelihood that pollution in your garden (such as vegetables or root crops) has caused health problems for you or your family?

- Very unlikely
- Somewhat unlikely
- Somewhat likely
- Very likely
- I don't know

8) What is the likelihood that pollution in the fish you eat has caused health problems for you or your family?

- Very unlikely
- Somewhat unlikely
- Somewhat likely
- Very likely
- I don't know
- None, I don't eat fish

Environmental & Health Risk Perception Survey
Vatukoula Gold Mine, Fiji

Please pick a number on the scale that shows how much you agree or disagree with the following statements:

9) I worry that gold mining will cause environmental damage that will impact future generations.

1-----2-----3-----4-----5
Strongly Disagree Disagree Agree Strongly Agree (Don't know)

10) I am worried about my children's health because we live near the gold mine.

1-----2-----3-----4-----5
Strongly Disagree Disagree Agree Strongly Agree (Don't know)

11) I am worried about my health because I live near the gold mine.

1-----2-----3-----4-----5
Strongly Disagree Disagree Agree Strongly Agree (Don't know)

12) I have all of the information I need to decide how I feel about the risks of gold mining.

1-----2-----3-----4-----5
Strongly Disagree Disagree Agree Strongly Agree (Don't know)

13) I feel capable of finding the information I need to decide how I feel about the risks of gold mining.

1-----2-----3-----4-----5
Strongly Disagree Disagree Agree Strongly Agree (Don't know)

14) I am willing to accept most of the risks of gold mining because the benefits of mining are worth it.

1-----2-----3-----4-----5
Strongly Disagree Disagree Agree Strongly Agree (Don't know)

15) If I have a question about the risks of gold mining, it is usually easy to find the answer.

1-----2-----3-----4-----5
Strongly Disagree Disagree Agree Strongly Agree (Don't know)

Environmental & Health Risk Perception Survey
Vatukoula Gold Mine, Fiji

16) Before the mine closed, I felt comfortable telling someone from the company if I had a concern about my health or the environment.

1-----2-----3-----4-----5
Strongly Disagree Disagree Agree Strongly Agree (Don't know)

Please check only *one* answer to each of the following questions:

17) Which statement *best* describes how you feel about the risk of unsafe drinking water in your community?

- I feel my drinking water is safe based on what the company has told me.
- I feel the drinking water is safe based on my own traditional knowledge of the area.
- I do not know whether my drinking water is safe, and I would like to learn more about it.
- I am worried that the drinking water is unsafe, but I feel that I do not have any choice but to drink it anyway.

18) Which statement *best* describes how you feel about the risk of mine wastes overflowing or leaking from a tailings dam?

- I do not know much about this risk, and would like to learn more about it.
- I do not feel worried about this risk because the company has told me that it will probably never happen.
- I do not feel worried about this risk, because we have prepared for it and have a plan for how we will deal with it.
- I feel worried about this risk because it could be dangerous to my health or the environment.
- I feel worried about this risk, but I am willing to accept it because working at the mine is worth the risk.

19) Which statement *best* describes how much control you feel you have to avoid the risks of gold mining?

- I feel I have **no** control to avoid the risks of mining.
- I feel I have **little** control to avoid the risks of mining.
- I feel I have **some** control to avoid the risks of mining.
- I feel I have **enough** control to avoid the risks of mining.
- I feel I have **total** control to avoid the risks of mining.

20) I have a plan telling me what to do in case there is an overflow or leak in one of the tailings dams.

- No
- Yes

Environmental & Health Risk Perception Survey
Vatukoula Gold Mine, Fiji

Next we would like to ask you to tell us about your health during the past month. Please think back and try to remember if you have been sick, and if so, how often you were sick during this time period.

21) Please check the box that describes how often you have experienced each of the following symptoms within the past month:

	<i>Never</i>	<i>Between 1 and 5 times</i>	<i>5 times or more</i>	<i>Everyday</i>
a. Difficulty breathing				
b. Severe cough				
c. Muscle and/or joint pain				
d. Memory or concentration problems				
e. Severe headaches				
f. Nausea				
g. Vomiting				
h. Skin irritation				
i. Problems sleeping				
j. Hearing loss				
k. Weakness or exhaustion				

Please check only *one* answer to each of the following questions:

22) Have you ever been told by a doctor or other health professional that you have cancer?

- No
- Yes → If yes, what kind of cancer was it? _____

23) What ethnicity do you *mostly* consider yourself?

- Fijian
- Indian
- Rotuman
- Chinese
- Caucasian
- Other

24) Are you male or female?

- Male
- Female

Environmental & Health Risk Perception Survey
Vatukoula Gold Mine, Fiji

25) Have you ever worked at the Vatukoula Gold Mine?

- No → **SKIP to QUESTION 28**
- Yes

↳ 26) If yes, where did your work *mostly* take place?

- Aboveground
- Belowground

27) If the mine re-opens, would you choose to work there again?

- Yes
- No

28) Has anyone else who *currently* resides in your household (other than yourself) ever worked at the Vatukoula Gold Mine?

- No → **SKIP to QUESTION 30**
- Yes

↳ 29) Is this person (or any one of these people if more than one) currently under the age of 18?

- No
- Yes

30) Were you born in the Vatukoula area?

- Yes → **SKIP to QUESTION 34**
- No

↳ 31) How long have you lived in the Vatukoula area?

- 5 years or less
- Between 6 and 10 years
- Between 11 and 20 years
- More than 20 years

32) Why did you move to this area?

- Marriage
- To gain employment at the mine
- Because one of my family members began working at the mine.
- Other: _____

33) Who made the decision to move to this area?

- I made the decision by myself
- My husband made the decision for me
- My wife made the decision for me
- I made the decision together with my spouse
- Someone else made the decision for me

Environmental & Health Risk Perception Survey
Vatukoula Gold Mine, Fiji

34) Have you ever considered moving away from Vatukoula because you were concerned about your health or the environment?

- No → **SKIP to QUESTION 36**
 Yes

↳ 35) Which statement *best* describes the reason you decided to stay, despite your concerns?

- The money earned working for the mine was worth the risk.
 I didn't want to move away from my family or my village.
 It wasn't my decision.
 Other (please list): _____

36) Are you *currently* planning to move away from Vatukoula?

- No → **SKIP to QUESTION 38**
 Yes

↳ 37) Why are you planning to move?

- I am planning to move to start a new job.
 I am planning to move because my spouse is starting a new job.
 Other (please list): _____

38) What is the highest level of education you have completed?

- I have not completed any formal schooling
 Primary school
 Secondary School
 Vocational/Trade School
 University/College

39) What is your current age in years? _____

40) What is the name of village, town, or settlement in which you *currently* live? _____

Please check only *one* answer to each of the following questions:

41) If I have a concern about my own health or the health of my family, I am *most* likely to:

- Tell my spouse.
 Tell a friend in my village.
 Tell the village nurse or doctor.
 Keep the concern to myself (tell nobody).

Environmental & Health Risk Perception Survey
Vatukoula Gold Mine, Fiji

42) If I have a concern about my health, my family's health, or the environment, my spouse will normally:

- Listen to my concern and try to help.
- Listen to my concern and do nothing.
- Ignore my concern.
- None of the above, I normally don't tell my spouse about my concerns.
- None of the above, I am not married.

43) Before the mine closed, if I told the company I was worried about my health or the environment, the company would normally:

- Listen to my concern and try to help.
- Listen to my concern and do nothing.
- Ignore my concern.
- Punish me for speaking out about my concern.
- None of the above, I would not tell the company about my concern.

44) If I want to learn more about a particular mining risk, I am *most* likely to:

- Ask a friend or family member
- Look the information up in a book
- Use a computer to find the information
- I would find the information somewhere else
- None of the above, I would not know where to find the information

45) Which of the following statements *best* describes how the risks associated with mining have changed or not changed since the mine has closed?

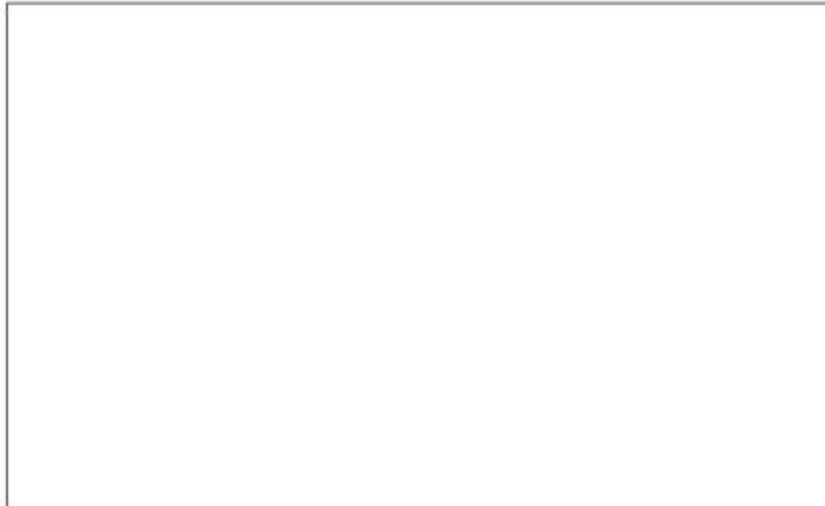
- The risks have not changed at all.
- There are more risks now that the mine has closed.
- There are fewer risks now that the mine has closed.
- There are no risks now that the mine has closed.
- I don't know if the risks have changed.

46) Please list the three environmental or health issues that concern you the **MOST** in decreasing order:

1. _____
2. _____
3. _____

Environmental & Health Risk Perception Survey
Vatukoula Gold Mine, Fiji

Thank you for taking the time to complete this survey. Your assistance in providing this information is very much appreciated. If there is anything else you would like to tell us about this survey, please do so in the space provided below.



Please place your completed survey in the envelope provided. We will return before 5pm today to collect your completed questionnaire. If you have any additional questions, please do not hesitate to contact us by phone at +1 802 656 0173 (USA) or 973-0292 (Fiji Mobile) or write to us at:

Mary Ackley
University of Vermont
George D. Aiken Center
81 Carrigan Drive
Burlington, Vermont 05405 USA

Note: Some of the questions in this survey were adapted from the following sources:

Ontario Ministry of Health. (1990). 1990 Ontario Health Survey Data File Retrieved March 3, 2007, from <http://www.chass.utoronto.ca/datalib/codebooks/utm/ohs/ohs90.htm>
Trumbo, C. W. (2002). Information processing and risk perception: An adaptation of the Heuristic-Systematic Model [electronic version]. Journal of Communication, 52(2), 367-382.

APPENDIX II: SURVEY INSTRUMENT (FIJIAN LANGUAGE)

July 9, 2007



The University of the South Pacific
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Suva, Fiji

Ph: (879) 323 2965 or 323 2964
Fax: (879) 323 1534
www.usp.ac.fj/ias

Kivei Kemuni na Vakaitikotiko e Vatukoula,

Nai naki ni i vola oqo e kerei tiko yani vakabibi na nomuni veitokoni ena dua na vakadidike erau cakava na University ni Vermont kei na University ni Ceva ni Pasifika. Na vakadidike oqo, e tiki tiko ni dua na gagadre me vulici kina na veika era sota kaya kei na nodra nanumi na lewe ni vanua, me baleta na veileqa kei na veika vinaka e kune enai qaqi ni koula. Nai lotua ni vakadidike oqo ena vakayagataki me vukei iratou na cakava tiko na vakadidike me ratou kila vinaka kina na veika e yacovi ira kei na nodra nanuma me baleta na veileqa ni veikabula e volivoliti keda kei na leqa ni tiko bulabula e yaco baleta na kena cakacakataki vaqara e Vatukoula.

Keitou sa veitaratara tiko kei na so na lewe ni vanua ena nomuni I tikotiko, ka kerei ira me ra wasea ni veika era sotava kei na nodra nanuma me baleta na nodra bula volekata tiko nai qaqi ni koula e Vatukoula. Na nomuni I sau ni taro ena maroro'i sara vakamatua. E na sega ni vakayagataki na yacamuni ka na sega talega ni vakaraitaki na nomuni I sau ni taro me tukuni kina na nomuni veitokoni ena vakadidike oqo. Koni na vukei keitou sara vakalevu moni taura e vica na miniti, vakasamataka ka wasea vei keitou na nomuni nanuma me baleta na veileqa kei na veika vinaka me baleta na qaqi ni koula.

Keitou sa solia tiko yani e dua na peni ni volavola moni vakayagataka, ka sa neitou I vakavinavinaka vei kemuni ena nomuni veivuke.

Au sa tu vakarau me'u sotavi kemuni, kevaka e tu e so na nomuni vakatataro, se nomuni nanuma, O ni gadreva moni vakaraitaka. Au na mai kumuna tiko na vei vola ni taro O ni sa vakalewena oti, ena 5 pm nikua. E rawa talega ni O ni volavola mai, se talevoni mai, vei au ena noqu I tikotiko ka toqa toka e ra.

Vinaka vakalevu na nomuni veivuke ena vakadidike bibi oqo.

Nomuni dau veiqaravi,

Mary Ackley
Rubenstein School of Environment & Natural Resources
University of Vermont
153 S. Prospect St.
Burlington, Vermont 05401, USA
USA Telephone: 1-802-56-0173
Fiji Telephone: 679-973-0292

Na Soli ni Veivakadonui Me'u Vakaitavi e na Vakadidike Oqo

Na vakadidike ni veika e nanumi se vakabauti ni na vakavurea na leqa e tara na veika bula era volivoliti na vama ni qaqi koula

E gadrevi na nomuni veitokoni ena vakadidike oqo, meda kila kina na veileqa eso e tara na veikabula era volivoliti keda kei na bula ni tamata ka basika mai ena kena keli na koula. Nai naki ni tiki dua oqo, me vakamatatataki kina nai balebale ni vakadidike oqo. Nai tuvatuva ni veitokoni, sa vakamacalataki toka era. Na nomuni vakatataro me qai vagolei vua na dau vakadidike O, Mary Ackley, talevoni: 973-0292. Mo ni qai sainitaka na yacamuni era, ni sa matata vei kemuni nai vakamacala oqo, ka O ni sa vakadonuya moni veitokoni ena vakadidike oqo. E tu vei kemuni na dodonu, mo ni muduka na nomuni veitokoni, ena loma ni gauna ni vakadidike oqo.

Nai naki ni vakadidike oqo, me kumukuni kina, nai tukutuku ni veika e nanumi se vakabauti ni na vakavurea na veileqa ni veikabula era volivoliti keda, kei na tiko bulabula, O ni sotava e na i qaqi ni koula. Kevaka O ni vakadonuya, O ni sa kerei tiko mo ni vakalewena e dua na fomu ni vakatataro. Ena seqa ni volai na yacamuni enai vola ni vakatataro oqo, ka na maroro'i vakamatua sara na nomuni veitokoni. E seqa ni dua na leqa ni yago e salavata na nomuni veitokoni ena vakadidike oqo. Ena gauna O ni sauma kina e so na taro oqo, ena basika mai kina eso na vakasauma kei na so na ka e yaco, me baleta na vei leqa kei na ka vinaka ka salavata na kena dau keli na koula. E nomuni na dodonu mo ni kua ni sauma na taro oya, se na taro taucoko, kevaka madaga, O ni sa sainitaka oti na fomu.

Au sa wilika ka kila na fomu ni veivakadonui oqo, kei nai tuvatuva e salavata na vakadidike oqo. Au sa ciqoma e dua na i lavelave ni fomu oqo me noqu, ka'u sa vakadonuya me'u veitokoni ena vakadidike oqo.

Participant Signature

Tiki ni Siga

Researcher's Signature

Tiki ni Siga

Environmental and Health Risk-Perception Survey
 Vatukoula Gold Mine, Fiji

*University of Vermont
 Rubenstein School of Environment & Natural Resources
 2007*

Sa kerei mo ni sauma na vei taro e tarava, ka toqa ga e dua na kenai sau ena vanua vakarautaki, me vaka oqo:

1) Nai yatu vosa cava e vakamatatataka, na veika o vakila me baleta na veileqa e nai qaqi?

- Au sega ni vakila edua na veileqa.
- Au kila ga e so na veileqa.
- Au kila e levu na veileqa.
- Au sa kila oti na veika kecega e dodonu me'u kila me baleta na veileqa.

2) Koa kila taumada vakacava nia tiko e so na leqa, ka basika mai enai qaqi?

- Au sega ni kila e dua na ka me baleta na veileqa.
- Ratio yaloyalo
- Na kabani ni qaqi ni koula
- Nai tukutuku mai na matanitu
- Na nuisipepa
- Nai vola
- O ira na lewe ni nogu koro se taoni
- Baleta na vadidike oqo
- E na dua tale na vanua

3) Sa kerei mo ni qai toqa e dua na rigi enai sau ni taro, ka rawa ni vakamatatataka na nomuni kauwai se sega ni kauwai ena veileqa ka tarava:

a) Na benu ena vei wai ni gunu	<i>Sega ni kauwaitaka</i>	<i>Kauwaitaka vakalailai</i>	<i>Kauwaitaka vakalevu</i>	<i>Sega ni Kila</i>
b) Na benu ena vei uciwai	<i>Sega ni kauwaitaka</i>	<i>Kauwaitaka vakalailai</i>	<i>Kauwaitaka vakalevu</i>	<i>Sega ni Kila</i>
c) Na benu ena cagi	<i>Sega ni kauwaitaka</i>	<i>Kauwaitaka vakalailai</i>	<i>Kauwaitaka vakalevu</i>	<i>Sega ni Kila</i>
d) Na benu ena nomuni teitei ni kakana draudrau	<i>Sega ni kauwaitaka</i>	<i>Kauwaitaka vakalailai</i>	<i>Kauwaitaka vakalevu</i>	<i>Sega ni Kila</i>
e) Na benu ena ika koni kania	<i>Sega ni kauwaitaka</i>	<i>Kauwaitaka vakalailai</i>	<i>Kauwaitaka vakalevu</i>	<i>Sega ni Kila</i>
f) Na benu ena vanua	<i>Sega ni kauwaitaka</i>	<i>Kauwaitaka vakalailai</i>	<i>Kauwaitaka vakalevu</i>	<i>Sega ni Kila</i>

Environmental and Health Risk-Perception Survey
Vatukoula Gold Mine, Fiji

4) Na cava na kenai i rairai ni benu ena nodai gunugunu ka vakavuna eso na leqa ni tiko bulabula ena nomu matavuvale?

- E sega ni tiko
- E rairai ni sega ni tiko
- E rairai ni tiko
- E vaka ni sa tiko
- Au sega ni kila

5) Na cava na kenai rairai ni benu ena nomuni vei uciwai, ka vakavuna eso na leqa ni tiko bulabula kin a nomu bula se matavuvale?

- E sega ni tiko
- E rairai ni sega ni tiko
- E rairai ni tiko
- E vaka ni sa tiko
- Au sega ni kila

6) Na cava na kenai rairai ni benu ena cagi, ka vakavuna eso na leqa ni tiko bulabula vei iko se nomu matavuvale?

- E sega ni tiko
- E rairai ni sega ni tiko
- E rairai ni tiko
- E vaka ni sa tiko
- Au sega ni kila

7) Na cava na kenai rairai ni benu ena nomu teitei se na kakana draudrau, ka vakavuna eso na leqa ni tiko bulabula vei iko se nomu matavuvale?

- E sega ni tiko
- E rairai ni sega ni tiko
- E rairai ni tiko
- E vaka ni sa tiko
- Au sega ni kila

8) Na cava na kenai rairai ni benu e tu ena ika o kania ka vakavuna eso na leqa ni tiko bulabula vei iko se nomu matavuvale?

- E sega ni tiko
- E rairai ni sega ni tiko
- E rairai ni tiko
- E vaka ni sa tiko
- Au sega ni kila
- Sega, au sega ni dau kana ika.

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Vatukoula Gold Mine, Fiji

Moni qai digitaka e dua na mata ni fika era, me vakaraitaki kina na nomuni vakadonuya se sega ni vakadonuya na vei yatu vosa ka tarava:

9) Au kauwaitaka vakalevu na vei cakacaka, e yaco tiko enai qaqi ni koula, ena vakavuna na leqa vei ira na veikabula era volivoliti keda, ka na tara na nodra bula, na kawai Viti nimataka.

1-----2-----3-----4-----5
Au sega ni tokona vakalevu Au sega ni tokona Au tokona Au tokona vakalevu (Au sega ni kila)

10) Au leqa taka na nodra bula na gone, ni keimami tiko volekata tiko nai qaqi ni koula.

1-----2-----3-----4-----5
Au sega ni tokona vakalevu Au sega ni tokona Au tokona Au tokona vakalevu (Au sega ni kila)

11) Au leqa taka na noqu bula, niu tiko volekata tiko qaqi ni koula.

1-----2-----3-----4-----5
Au sega ni tokona vakalevu Au sega ni tokona Au tokona Au tokona vakalevu (Au sega ni kila)

12) E tiko vei au nai tukutuku kece meu vakalewa kina na vei leqa enai qaqi?

1-----2-----3-----4-----5
Au sega ni tokona vakalevu Au sega ni tokona Au tokona Au tokona vakalevu (Au sega ni kila)

13) Au san a rawa ni vaqara ga na vei tukutuku me baleta na leqa e tu ena maini ni koula.

1-----2-----3-----4-----5
Au sega ni tokona vakalevu Au sega ni tokona Au tokona Au tokona vakalevu (Au sega ni kila)

14) Au sa na tu vakarau tu meu ciqoma na veileqa baleta ni veisotavi vata na veika vinaka e solia nai qaqi.

1-----2-----3-----4-----5
Au sega ni tokona vakalevu Au sega ni tokona Au tokona Au tokona vakalevu (Au sega ni kila)

15) Kevaka e mani dua na vakatataro me baleta na veileqa enai qaqi, e dau rawarawa ni kunei na kenai sau.

1-----2-----3-----4-----5
Au sega ni tokona vakalevu Au sega ni tokona Au tokona Au tokona vakalevu (Au sega ni kila)

16) Ni a bera ni sogo nai qaqi, au dau taleitaka me'u tukuna vua e dua mai na kabani kevaka e tu e dua na leqa me baleta na noqu bula se na veika bula era volivoliti keda.

1-----2-----3-----4-----5
Au sega ni tokona vakalevu Au sega ni tokona Au tokona Au tokona vakalevu (Au sega ni kila)

Environmental and Health Risk-Perception Survey
Vatukoula Gold Mine, Fiji

17) Nai yatu vosa cava e vakamatatataka, na veika o vakila, me baleta na leqa ni gunuvi ni wai ca ena nomuni tikotiko se koro?

- Au vakila ni vinaka na wai e gunuvi tiko, me vaka nai vakavakadewa e solia na kabani.
- Au vakila ni vinaka na wai e gunuvi tiko, me vaka na noqu kila vinaka na vanua oqo.
- Au sega ni kila na vinaka ni gunuvi ni wai eke, kau gadreva me'u kila na kena dina.
- Au kauwaitaka na gunuvi ni wai eke, ni sega ni vinaka, ia sa sega tale ni dua na sala meu levea kina.

18) Nai yatu vosa cava e vakamatatataka na veika o kila me baleta na leqa, ni dau vua bale mai se kasova mai na tailings dam?

- Au sega soti ni kila na kena leqa, kau gadreva meu vulica na vaika e vakavuna.
- Au sega soti ni kauwaitaka na kena leqa, baleta ni na sega beka ni yaco, me vaka nai vakamacala ni kabani vei au.
- Au kauwaitaka vakalevu na leqa oqo, baleta ni na vakaleqa na noqu bula, se na veikabula era volivoliti au.
- Au sega ni kauwaitaka na leqa oqo, baleta ni kemami sa vakarautaka oti ka virikotora e dua nai tuvatuva me sotavi kina na leqa kevaka e mani yaco.
- Au kauwaitaka na leqa oqo, ia au sa ciqoma ga, baleta ni sega tale ni dua na noqu vurevure ni lavo.

19) Nai yatu vosa cava e vakamatatataka na kaukauwa cava e tiko vei iko, mo levea kina na vei leqa enai qaqi ni koula?

- Au vakila ni sega vei au na kaukauwa meu levea kina na vei leqa enai qaqi ni koula.
- Au vakila ni lailai wale sara na kaukauwa e tiko vei au, meu levea kina na vei leqa enai qaqi ni koula.
- Au vakila ni tiko vei au e so na kaukauwa meu levea kina na vei leqa enai qaqi ni koula.
- Au vakila ni vakarauta ga na kaukauwa e tu vei au, meu levea kina na vei leqa enai qaqi ni koula.
- Au vakila ni tu vei au na kaukauwa kece meu levea kina na vei leqa enai qaqi ni koula.

20) Esa tiko vei au nai tuvatuva, ka vakamatatataka na veika e dodonu meu cakava kevaka e mani vuabale se kacabote e dua na tailings dam?

- Sega
- Io

Environmental and Health Risk-Perception Survey
Vatukoula Gold Mine, Fiji

E tarava oqo, na neitou via tarogi kemuni, me baleta na veika e tara na nomuni bula ena vula sa oti. E kerei moni vakasama lesu, ka tovolea mo ni nanuma kevaka e a mani tauvi kemuni e dua na mate, kevaka e a yaco vakakina, e a yaco vakavica vei iko na mate oqo ena vula sa oti.

21) Sa kerei moni qai toqa e dua na tiki ena vanua e vakarautaki, me vakamatatataki kina na vei mate e tauvi kemuni ena vula sa oti:

	<i>Sega Vakadua</i>	<i>Vakadua kina Lima</i>	<i>Vakalima se Levu Cake</i>	<i>Veisiga</i>
a. Cequ di				
b. Vu vakalevu				
c. Momosi ni masela se veisema ni yago				
d. Guigui leca				
e. Mosi kaukauwa ni ulu				
f. Lomalomaca				
g. Lualue				
h. Momosi ni kuli ni yago				
i. Dredre ni moce				
j. Vara ni daliga				
k. Malumalumu se cegu oca				

Sa kerei mo ni toqa e dua ni tiki ena vanua vakarautaki me i sau ni nomuni taro:

22) Sa bau dua beka na vuniwai se vakilesilesi ni tiko bulabula, e a vakasalataki kemuni ni sa tauvi iko tiko na kenisa?

- Sega
 Io → Vakamacalataka mada se kenisa vakacava ? _____

23) O vakatokai iko mo:

- I Taukei
 Ira tale e so

24) O iko turaga se marama?

- Turaga
 Marama

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Vatukoula Gold Mine, Fiji

25) E a dua mada na gauna o a cakacaka kina enai qaqi ni koula e Vatukoula?

Sega → **QAI SAUMA NA TARO 28**

Io

↳ 26) O a cakacaka ena:

Taudaku ni qara

Loma ni qara

27) Kevaka ena mani dola tale nai qaqi, ena tu beka vei kemuni na gagadre mo na cakacaka tale kina?

Io

Sega

28) E dua tale beka e tiko ena nomu matavuvale e sa cakacaka oti enai qaqi e Vatukoula?

Sega → **QAI SAUMA NA TARO 30**

Io

↳ 29) Na nona yabaki ni bula (se nodra kevaka e sivia na le dua) e se bera ni yacova na yabaki 18?

Sega

Io

30) O a sucu beka ena vanua O Vatukoula?

Io → **QAI SAUMA NA TARO 34**

Sega

↳ 31) E sa yabaki vica beka na nomu bula voli e Vatukoula?

Lailai mai ena 5 yabaki

Mai na yabaki 6-10

Mai na yabaki 11-20

Mai na yabaki 20 ka lako cake

32) Na cava beka na vuna ko a gole mai kina ena vanua oqo?

Vakamau

Mo mai rawata kina na cakacaka

Baleta e a cakacaka tiko kina e dua na lewe ni noqu matavuvale

So tale: _____

33) Na lewa beka i cei ko a gole mai kina ena vanua oqo?

Na noqu vakatulewa

Na nona vakatulewa na watiq

Na neirau vakatulewa vakaveiwatini

Na vakatulewa ni dua tani tale

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Vatukoula Gold Mine, Fiji

34) O sa bau vakasamataka mada mo toki tani mai Vatukoula baleta ni ko sa kauwaitaka na nomu bula se na veikabula era volivoliti keda?

Sega → QAI SAUMA NA TARO 36

Io

☞ 35) Nai yatu vosa cava e vakamatatataka na nomu vakadeitaka mo tiko ga e Vatukoula veitalia na nomu kauwai?

Nai lavo au saumi kina, niu cakacaka enai qaqi e sa veiganiti kei na noqu sotava na vei leqa.

Au sega ni taleitaka meu toki tani mai na noqu matavuvale se noqu koro.

E sega ni noqu vakatulewa

So tale: _____

36) Ko sa lalawataka tiko mo toki tani mai Vatukoula?

Sega → QAI SAUMA NA TARO 38

Io

☞ 37) Na cava beka nai naki ni nomu lalawa?

Me'u vakasaqara tale e dua tani tale na cakacaka

Baleta ni sa kunea tale e dua na nona cakacaka na noqu lewe ni vale

So tale: _____

38) Na cava beka nai vakatagedegede ni vuli ko sa yacova?

Sega ni vuli

Kalasi 1-8

Fomu 3-7

Vuli cakacaka

University

39) Na cava beka na yabaki ni nomu bula? _____

40) Na cava beka na yaca ni tikotiko, taoni, se koro ko sa vakaitikotiko kina ena gauna oqo? _____

Sa kerei mo ni toqa e dua ni tiki ena vanua vakarautaki meu sau ni nomuni taro:

41) Kevaka au sa kauwai tiko me baleta na noqu bula se na bula ni noqu matavuvale, au na gadreva me'u:

Tukuna vua na noqu lewe ni vale

Tukuna vua na noqui tau ena koro

Tukuna vua na nasi ni koro se vuniwai

Maroroya na noqu kauwai ka kakua ni tukuna vua e dua

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Vatukoula Gold Mine, Fiji

42) Kevaka au sa kauwaitaka na noqu bula, na bula ni noqu matavuvale, se na veikabula era volivoliti keda, na noqu lewe ni vale ena:

- Vakatudaliga ka tovolea me vukei au ena noqu kauwai
- Vakatudaliga ka sega ni via veivuke ena noqu kauwai
- Sega ni via kila no noqu kauwai
- Au sega ni tukuna vua na noqu lewe ni vale na noqu kauwai
- Au se bera ni vakawati, ka sega ni rawa niu sauma na taro oqo

43) Ni bera ni sogo nai qaqi, kevaka au vakaraitaka niu kauwaitaka na noqu bula se na veikabula era volivoliti keda, na kabani ena:

- Vakatudaliga ka tovolea me vukei au ena noqu kauwai
- Vakatudaliga ka sega ni vukea na noqu kauwai
- Sega ni via kila na noqu kauwai
- Totogitaki au me baleta na noqu kauwai
- Au na sega ni vakaraitaka vua na kabani na noqu kauwai

44) Kevaka au gadreva me'u vulica e so tale na mataqali leqa ka tara nai qaqi, au na viavia:

- Taroga e dua nai tokani se lewe ni matavuvale
- Vakasaqara na kenai tukutuku ena kenai vola
- Vakayagataka e dua na "computer" me'u kunea kina na kenai tukutuku
- Kunea na kenai tukutuku ena dua tale na vanua
- Sega ni kila na vanua au na kunea kina na kenai tukutuku

45) Nai yatu vosa cava beka e vakamatatataka na vei leqa ka sala vata na veicakacaka enai qaqi kasa mai veisau se, e sega ni veisau, me yacova mai na sogo ni qaqi?

- E a sega ni yaco e dua na veisau
- E sa qai levu na veileqa ena gauna mai sogo kina nai qaqi
- E a qai kune vakalilai ga ena gauna mai sogo kina nai qaqi
- E sega ni kune e dua na leqa ena gauna mai sogo kina nai qaqi
- Au sega ni kila kevaka e mai veisau na leqa.

46) Sa kerei moni tuvalaka e tolu na vei ulutaga ka dodonu me veivosakitaki, ko sa rui kauwaitaka vakalevu, ena kenai tavutuva na ka lelevu kina ka lalai.

1. _____
2. _____
3. _____

Environmental and Health Risk-Perception Survey
Vatukoula Gold Mine, Fiji

Vinaka vakalevu na nomuni solia na nomuni gauna moni vakalewena kina na fomu ni vakadidike oqo. E ka taleitaki vakalevu na nomuni veivuke mo ni solia nai tukutuku oqo. Kevaka e mani tu tale e so na ka, ko ni gadreva mo ni vakaraitaka me baleta na vakadidike oqo, e sa kerei mo ni qai vakalewena ena vanua vakarautaki ka tarava.



Sa kerei mo ni qai tawana na vei fomu ni vakadidike kasa vakalewena oti oqo ena kena “envelope” vakarautaki. Keitou na mai kumuna tiko na “envelope” oqo ni bera na 5 kaloko ena yakkavi nikua. Kevaka e mani tu eso na taro moni qai veitaratara mai ena talevoni +1802 656 0173 (USA) se 973-0292 (Fiji Mobile), se volavola mai vei:

Mary Ackley
University of Vermont
George D. Aiken Center
81 Carrigan Drive
Burlington, Vermont 05405 USA

Note: Some of the questions in this survey were adapted from the following sources:

Ontario Ministry of Health. (1990). 1990 Ontario Health Survey Data File Retrieved March 3, 2007, from <http://www.chass.utoronto.ca/datalib/codebooks/utm/ohs/ohs90.htm>

Trumbo, C. W. (2002). Information processing and risk perception: An adaptation of the Heuristic-Systematic Model [electronic version]. Journal of Communication, 52(2), 367-382.

APPENDIX III: SURVEY RESULTS

The following tables contain summarized data for all survey questions except those related to demographic characteristics. Demographic characteristics are summarized in Table 3. Some questions and response categories have been abbreviated to facilitate readability in table format. Please refer to the original survey instrument in Appendix I for original question and response wording.

<i>Question</i>	<i>Response Category</i>	<i>Percent by Category</i>
1) Knowledge of Risks (n=333)	Not aware of any risks	9.6%
	Only know some risks	46.5%
	Know most of the risks	33.9%
	Know everything about the risks	9.9%
2) How did you first learn about the risks of mining? (n= 329)	I don't know anything about the risks	7.0%
	Television	4.3%
	The mining company	36.8%
	Government	4.0%
	Newspapers	5.5%
	Books	4.3%
	Other people in my village or town	33.7%
	Because of this survey	1.5%
Somewhere else	3.0%	

Question 3: Percent Response by Category

	Not worried at all	Somewhat worried	Very Worried	Don't know
3a) Worried about drinking water pollution? (n=330)	10.3%	17.9%	68.8%	3.0%
3b) Worried about pollution in your rivers and streams? (n=332)	8.7%	17.8%	70.8%	2.7%
3c) Worried about air pollution? (n=339)	9.4%	12.2%	74.5%	4.0%
3d) Worried about pollution in your garden vegetables? (n=329)	8.8%	22.8%	63.8%	4.6%
3e) Worried about pollution in your fish? (n=329)	7.9%	19.1%	63.8%	9.1%
3f) Worried about pollution of your land? (n=326)	8.9%	23.0%	60.4%	7.7%

Questions 4-8: Percent Response by Category

	Very unlikely	Somewhat unlikely	Somewhat likely	Very Likely	Don't know
4) Drinking water pollution (n=338)	12.1%	7.7%	30.8%	39.3%	10.1%
5) Pollution in your rivers and streams (n=339)	12.1%	6.5%	32.7%	42.2%	8.0%
6) Air pollution (n=339)	9.4%	4.4%	28.9%	51.0%	6.2%
7) Pollution in your garden vegetables and root crops (n=339)	15.0%	9.1%	33.6%	34.5%	7.7%
8) Pollution in your fish (n=333)	16.8%	8.1%	30.6%	31.5%	12.9%

Questions 9-16: Percent Response by Category

	Strongly disagree	Disagree	Agree	Strongly agree	Don't know
9) I worry that gold mining will cause environmental damage that will impact future generations. (n=334)	4.5%	4.2%	42.5%	42.2%	6.6%
10) I am worried about my children's health because we live near the gold mine. (n=335)	3.0%	4.5%	38.5%	51.3%	2.7%
11) I am worried about my own health because I live near the gold mine. (n=334)	2.4%	8.7%	44.3%	42.8%	1.8%
12) I have all of the information I need to decide how I feel about the risks of gold mining. (n=331)	5.1%	20.2%	36.6%	21.1%	16.9%
13) I feel capable of finding the information I need to decide how I feel about the risks of gold mining. (n=329)	2.4%	17.9%	42.2%	20.4%	17.0%
14) I am willing to accept most of the risks of gold mining because the benefits of mining are worth it. (n=334)	14.4%	34.7%	26.9%	17.1%	6.9%
15) If I have a question about the risks of gold mining, it is usually easy to find the answer. (n=334)	6.9%	25.7%	38.9%	10.8%	17.7%
16) Before the mine closed, I felt comfortable telling someone from the company if I had a concern. (n=329)	7.9%	19.5%	43.2%	17.0%	12.5%

Questions 17-20: Percent Response by Category

<i>Question</i>	<i>Response Category</i>	<i>Percent by Category</i>
17) How do you feel about the risk of unsafe drinking water? (n=335)	Feel my water is safe - based on company information	11.0%
	Feel my water is safe - based on traditional knowledge	13.1%
	Don't know if safe or unsafe	26.6%
	Worried my water is unsafe - but have no choice	49.3%
18) How do you feel about the risk of mine wastes overflowing or leaking from a tailings dam? (n=335)	Do not know about this risk, would like to learn more	18.5%
	Not worried, company told me this will never happen	3.9%
	Not worried, I am prepared to deal with this risk	23.9%
	I'm worried about this risk because it may be dangerous to my health or the environment	35.8%
19) How much control do you have to avoid the risks of mining? (n=334)	I'm worried about this risk, but willing to accept it	17.9%
	No control	43.4%
	Little control	20.7%
	Some control	15.3%
	Enough control	13.2%
20) Do you have a plan for a tailings dam collapse/overflow? (n=332)	Total control	7.5%
	No	76.8%
	Yes	23.2%

Health Data (Question 21): Percent Response by Category

	Never	Between 1-5 times	5 Times or more	Everyday
21a) difficulty breathing (n=339)	50.4%	31.0%	12.1%	6.5%
21b) severe cough (n=338)	36.4%	35.2%	21.3%	7.1%
21c) muscle/joint pain (n=339)	30.4%	35.1%	22.4%	12.1%
21d) memory or concentration problems (n=339)	60.8%	22.7%	12.4%	4.1%
21e) severe headaches (n=339)	40.4%	38.3%	18.9%	2.4%
21f) nausea (n=339)	67.8%	22.1%	6.5%	3.5%
21g) vomiting (n=339)	73.5%	19.8%	4.4%	2.4%
21h) skin (n=339)	55.8%	29.2%	10.6%	4.4%
21i) problems sleeping (n=337)	58.5%	24.3%	11.3%	5.9%
21j) hearing loss (n=339)	76.7%	11.8%	8.6%	2.9%
21k) weakness or exhaustion (n=339)	51.9%	27.7%	15.9%	4.4%

<i>Question</i>	<i>Response Category</i>	<i>Percent by Category</i>
22) Have you ever been told you have cancer? (n=337)	No	97.0%
	Yes	3.0%
27) If the mine re-opens would you work there again? (n=200)	No	30.5%
	Yes	69.5%
28) Has anyone else in your household ever worked for the mine (besides yourself)? (n=333)	No	24.6%
	Yes	75.4%
29) If so, was that person under the age of 18 at the time? (n=251)	No	86.9%
	Yes	13.1%
32) Why did you move to Vatukoula? (n=191)	Marriage	14.7%
	To gain employment at the mine	30.9%
	Because one of my family members began working at the mine	38.7%
	Other	15.7%
33) Who made the decision to move to Vatukoula? (n=188)	Myself	47.3%
	My husband	17.6%
	Wife	.5%
	Made together with spouse	18.1%
	Someone else made the decision	16.5%
34) Have you ever considered moving away because you were concerned about the environment or your health? (n=331)	No	52.0%
	Yes	48.0%
35) If so, why did you stay? (n=210)	Money was worth the risk	33.3%
	Didn't want to leave family or village	28.1%
	Wasn't my decision	19.5%
	Other	19.0%
36) Are you currently planning to move? (n=321)	No	53.9%
	Yes	46.1%
37) If yes, why? (n=167)	Start a new job	43.1%
	Spouse starting new job	23.4%
	Other	33.5%
41) If you have an environmental or health concern, who would you tell? (n=334)	Spouse	47.9%
	Friend	4.8%
	Nurse or Doctor	43.4%
	Keep to myself	3.9%
42) If you told your spouse, what would their reaction be? (n=335)	Listen and try to help	81.5%
	Listen and do nothing	2.7%
	Ignore my concern	3.9%
	Normally wouldn't tell my spouse	3.0%
	Not married	9.0%
43) If you told the company about your concern, they would normally: (n=329)	Listen and try to help	35.9%
	Listen and do nothing	20.1%
	Ignore my concern	27.7%
	Punish me	4.0%
	Would not tell company	12.5%
44) Where would you go to learn more about a mining risk? (n=327)	Friend or family member	33.3%
	Book	24.2%
	Computer	18.3%
	Somewhere else	8.3%
	Wouldn't know where to find information	15.9%
45) How have the risks of mining changed since the mine closed? (n=329)	No change	18.8%
	More risks now	38.3%
	Fewer risks now	20.4%
	No risks now	7.0%
	Don't know if risks have changed	15.5%

