

**ADAPTING ECONOMIC GAMES FOR ORGANISATION OF ARTISANAL AND  
SMALL SCALE GOLD MINERS IN TANZANIA**

by  
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## Abstract

This thesis analyses cooperation and trust as key components of organization in artisanal and small-scale mining. Significant economic, health and social issues are associated with artisanal and small-scale mining (ASM) activities. Work conducted as part of the GEF/UNDP/UNIDO Global Mercury Project has illuminated opportunities to improve the situation for artisanal and small-scale miners and their communities through enhanced organizational structures. Improvements in organization can present opportunities for groups of miners to access technology and finance, conduct work that is safe and in accordance with best practices, increase productivity and earnings, and reduce the numerous social impacts associated with involvement in the sub-sector. Upon identification of barriers to improved organisation in ASM, research by the GMP concluded that distrust and uncooperativeness among miners were two of the most significant concerns to address prior to introducing organizational alternatives. It was determined that in order to promote pro-social and trusting behaviours within ASM groups, the current nature of these components should be defined. It was believed that the adaptation of economic games to ASM contexts could contribute to an understanding of the nature of trust and cooperation. In addition, this could also provide evidence to either support reasons for distrust between groups of miners or highlight a proclivity towards trust and cooperation. It was also believed that economic games could be applied as an educational tool in the promotion of cooperative behaviours by illustrating in a tangible, direct and interactive manner the benefits of cooperation and trust over the pursuit of self interest. With current lack of organization being attributed in part to anti-social and individualistic behaviour among miners, this work demonstrates how economic games can serve as analogies of situations in ASM whereby benefits to both individuals and groups can be derived through cooperation. The following work is an examination of these applications of economic games in ASM in Tanzania.

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# **1 Introduction**

## **1.1 Significance and Contributions of the research**

This research is significant to the ongoing work to improve the social conditions of artisanal mining communities in developing countries, with a specific emphasis on gold mining communities in Tanzania. It expands current understandings of the use of economic games as a measure of behaviour in economic interactions, adapting them to assist in the characterization of cooperation and trust within artisanal and small-scale mining communities. Using appropriate cultural, regional and educational contexts, tools to evaluate and improve trust within mining communities were tested. This work successfully demonstrates that economic games can serve as educational tools in the promotion of pro-social behaviour as part of a larger objective of the Global Mercury Project to improve the livelihoods in ASM mining communities through enhanced organization.

Contributing to the areas of artisanal and small-scale mining, experimental economics, and education this research offers a new and original means by which issues of trust, cooperation and organization within ASM in can be measured, interpreted, and addressed. This work also contributes to improved understanding of mining and indigenous communities since the issues of trust and cooperation tend to dominate mineral resource development in remote areas in Canada and the rest of the world.

## **1.2 Relevance to Artisanal and Small-Scale Mining**

This work builds upon ongoing attempts to better understand and encourage cooperative behaviours, considered fundamental to improved efficiency of organizational structures, amongst artisanal and small-scale miners and their communities. In the adaptation of economic games as educational tools, this work makes a significant contribution to the Global Mercury Project's efforts to address issues within ASM that currently have negative impacts on health, safety and the environment.

### **1.3 Objectives**

- Understand trust and cooperation in an ASM context through use of literature review, interviews, economic experiments and focus group discussion.
- Use and test adaptations of economic games as educational tools to promote trust and cooperation in a mining community in Tanzania – essential components for improved organization in ASM.

### **1.4 Overview of Methodology**

Improved understanding of ASM and ASM in Tanzania was required to provide a foundation upon which the social issues impacting miners and their communities could be explored. This examination of social issues related to ASM came from a review of literature and enabled the identification of barriers to better organization. Upon identification of lack of trust and cooperation as main obstacles, it was necessary to gain an insight into the nature of these pro-social behaviours and how they manifest in the context of ASM in Tanzania – further review of literature was required. This led to the selection of economic games as a means by which these behaviours could be characterized and observed. With the overall objective of organizational change in mind, these games were adapted to serve the additional educational purpose of promoting cooperative and trusting behaviours.

Methodology for this work drew on theory from multiple disciplines. Game theory (experimental economics), Control/Choice Theory (education), and phenomenology (qualitative methodology/philosophy) were influential in both design and conceptualization.

This research used both quantitative methodology (experimental economics) and qualitative methodology. Qualitative research captures the essence of attitudes in the social world. Distinct from quantitative methodologies, which are effective for

identifying measures for comparison, qualitative research focuses on providing insights about phenomena in a social context. Methodologies are numerous and varied, they evolve in design and present multiple realities. Qualitative research considers the role of researcher as an instrument of data collection and focuses on the perspective of participants and inductive data analysis (Creswell, 1998). Mason (1996:4) describes this methodology as “grounded in a philosophical position which is broadly ‘interpretivist’ in the sense that it is concerned with how the social world is interpreted, understood, experienced or produced”. Qualitative research approaches the collection of data with sensitivity to the social context in which they are produced.

As a qualitative research methodology, phenomenology allows for the exploration of social meaning through the lens of individual experience. It prioritizes the researcher-participant relationship and focuses primarily on the lived experience of the individual. Phenomenological research and the ‘lived experience’ are best understood in terms of vicarious experiencing of phenomena with intent to describe. Individual experiences are given centrality and the objective is “to determine what an experience means for the persons who have had the experience and are able to provide a comprehensive description of it. From individual descriptions, general or universal meanings are derived (Moustakas 1994 in Creswell, 1998:54)”. Collection of verbal data in phenomenological research can result from “straightforward description, interview or a combination of the two” (Giorgi, 1997:10). As Kvale describes, “the purpose of a qualitative interview is obtaining qualitative descriptions of the life world of the subject with respect to the interpretation of their meaning” (Kvale, 1996:124). “The interview is considered the main method of data collection in phenomenological research as it provides a situation where the participants’ descriptions can be explored, illuminated and gently probed” (Wimpenny, 2000:4). The following quote provides strong rationale for the use of phenomenological methodology in this study:

“Phenomenology is well-suited to holistic questions of meaning that spring from experience. In particular, phenomena that are not well understood and that are central to the lived experience of human beings are appropriate for phenomenological research” (Carpenter, 1995, in Lavasseur, 2003:409).

Methodological tools used in this research include:

- Literature review: ASM and ASM Tanzania, trust, cooperation, and experimental economics.
- Discussions with: key community members, national experts and women miners from Rwamagasa.
- Focus group discussion: health workers, women miners in Rwamagasa.
- Economic Games: economic games were selected from a variety of tools that facilitate comparison of behaviour in economic interactions. They are quantitative tools to measure trust and cooperation that complement qualitative data obtained through focus group discussions and interviews.
- Data analysis

## **1.5 Structure of the Thesis**

The study begins, in Chapter 2, with an overview of artisanal small-scale mining and its role in Tanzania. Research and training conducted as part of UNIDO’s Global Mercury Project (GMP) provides much insight into how artisanal and small-scale mining communities operate. This chapter draws on an extensive literature review to examine some of the many issues relating to health, environmental and socio-economics affecting artisanal and small-scale miners and their communities throughout the world.

Chapter 3 locates this work within the context of the Global Mercury Project. It reviews existing literature to reveal barriers to the organisation of artisanal and small-scale mining operations in Tanzania. This analysis demonstrates that

insufficient trust and cooperation are fundamental factors underlying the lack of organisation in artisanal and small-scale mining.

Trust and cooperation are then defined and characterized, in chapter 4, through a review of research from various fields of study. This chapter provides an insight into the nature of these concepts and considers potential influential factors. This chapter enables a foundation from which to understand how trust and cooperation are manifest and influenced, thereby facilitating further understanding of the means by which these phenomena can be enhanced and measured.

Chapter 5 demonstrates how experimental economics and the use of economic games contribute to an understanding of the social dynamics of cooperation and trust. This involves a brief overview of some particular economic games and conclusions derived from their application, followed by a more detailed review of relevant research in their use with small-scale societies.

Chapter 6 examines the methodology of field studies conducted with women miners at Blue Reef Small-Scale Gold Mine, Rwamagasa, Tanzania, to test the adaptation of economic games as a means to understand the nature of trust and cooperation in ASM communities. This chapter describes the context within which this ASM subgroup operate and highlights distinguishing features that make this sample an appropriate test group for the Global Mercury Project's objective of developing capacity through improved organization.

Chapter 7 describes research results and conclusions from the fieldwork in Rwamagasa. This chapter supports the original assumption that economic games could be used as both a means of understanding and characterizing cooperation and trust within ASM groups in Tanzania, and as an educational tool in the promotion of improved organization.

Chapter 8 concludes by summarising how this study contributes to the broader understanding of trust building and cooperation, and the role of economic games as a tool for understanding as well as education. It reveals opportunities for further research emerging from the adaptation and application of economic games for enhancing cooperation and building trust in small-scale mining and other indigenous communities.

## **2 ASM and Tanzania**

This chapter examines artisanal and small-scale mining in the context of Tanzania, including the geological and socio-cultural environments in which ASM has developed. In answering the question ‘How can the lack of organization of the small-scale mining sector be addressed?’ it is essential to understand the conditions under which ASM has flourished. Tanzania, and the mining region of Mwanza, provide excellent examples of the nature of ASM. Despite multifarious risks, many of which result from a lack of organization, ASM continues to play an essential economic role in the region and the nation.

### **2.1 Artisanal and Small-Scale Mining**

“Small-scale mining means different things to different people. To some it is dirty, dangerous, disruptive, and should be discouraged. To others it is profitable, productive or simply the only way out of poverty.”  
(International Labour Organisation, 1999)

It is important to begin research with a clear definition of the area of study. There are numerous definitions of artisanal and small-scale mining, as illustrated in the various conceptualizations provided in the following paragraphs.

“Artisanal or small scale mining is largely a poverty driven activity, usually practiced in the poorest and most remote rural areas of a country by a largely itinerant, poorly educated populace with little other employment alternatives (Drechsler, 2001:4)”. It encompasses a broad range of applied technology – from unsophisticated artisanal mineral extraction involving hand tools to small-scale mining operations with about 70 workers using different machinery (Mwaipopo et al, 2004).

Drechsler (2001) notes that there is no single definition of small-scale mining that satisfies all stakeholders. Instead, definitions are created to suit the specific

requirements of the various stakeholders. On the African continent, artisanal and small-scale mining is a significant economic contributor. In this context “small-scale mining refers to operations of individuals or organized groups (four to eight individuals) , or co-operatives of ten or more individuals, which are entirely financed by existing resources at a certain limit, and carried out on a full-time basis using simple traditional techniques and tools or low mechanization levels (Drechsler, 2001:3)”. The United Nations defines “small scale mining [as] any single unit mining operation having an annual production of unprocessed materials of 50,000 tonnes , or less as measured at the entrance of the mine” (Drechsler, 2001:4).

Small-scale miners can also be defined as miners who “operate in licensed claim-holdings through either leasing specific areas to pit owners or developing the pits and employing miners”. In terms of technology, it varies from “purely manual operations to those utilizing drilling machines, compressors, water pumps, and ball mills.” (Mwaipopo et al, 2004:21)

The International Labour Organization (ILO) agrees that the definition varies in terms of: level of employment or number of workers in a particular mine; annual production statistics; level of mechanization; capital investment; and size of claim being worked. (Drechsler, 2001:4)

Drechsler (2001:5) notes that “small-scale mining is commonly associated with informal, unregulated, under-capitalized and under-equipped operations, where technical and management skills are lacking”. This is accompanied by irregular production of limited quantities of minerals from uncertain reserves. Although negatively associated with environmental degradation, risks to human and animal health, and wastage of non-renewable resources, small-scale mining’s positive contribution lies in the economic benefit for disadvantaged persons and in terms of increased wealth to poor nations. As Drechsler (2001:5) points out, as a result of “its low investment costs and short lead time from discovery to

production...this sub-sector produces minerals from deposits which are not economic at large scale mining level”.

Artisanal mining can be defined as “individual work performed by low levels of mechanization, panners with rudimentary forms of mining using manual or portable equipment, and applied only to alluvial, colluvial and eluvial deposits” (Drechsler, 2001:4).

Artisanal miners tend to carry out their work in an informal, transient manner, without organization, adherence to rules and regulations, or use of appropriate technologies. Miners often come across minerals by chance, by digging pit latrines or reworking materials resulting from large-scale exploration (Mwaipopo et al, 2004). These methods result in poor mining and mineral processing techniques and consequently, in low productivity (Drechsler, 2001).

Mwaipopo et al (2004) found that artisanal activities in Mwanza Region, Tanzania involved small groups of 2-5 working in a pit. From their field observations they determined that included within the artisanal mining categorization was workers, usually women, reworking waste rock near the pit or tailings by washing sites. Also included in this group are activities in the rush areas, involving a number of pits being operated by groups of 5-10 miners, with some being licensed claims to small-scale miners. Drechsler (2001) characterizes artisanal mining as unorganized, lacking work preparation prior to production. Hinton (2005:5) reiterates this stating that “ASM is typically an informal and highly disorganized activity”.

The majority of artisanal and small-scale miners utilize basic methods to determine whether it is worthwhile to mine in a particular area. Among these methods are panning soils and collecting sediment samples along river beds, following specific mineral veins exposed at the surface of the earth. There is seldom a transition phase from exploration to mining. Once the resource has

been identified, mining begins without establishing reserve content (for example, by means of assays) or conducting appropriate feasibility studies (Kinabo, 2003a:294).

Mwaipopo et al (2004:60) outline the stages of gold mining and processing in ASM as:

- Pit excavation
- Pit drainage and ventilation
- Drilling and blasting
- Haulage and Hoisting
- Ore preparation
- Crushing and grinding
- Washing of ore
- Panning and amalgamation
- Amalgam burning – gold recovery

Tools such as hand hammers, picks, shovels and hoes are employed in the excavation of pits, with repeated crushing, grinding, gravity concentration and amalgamation to recover the gold. Elemental gold and mercury vapour is produced from the mercury-gold amalgam being fired in the open air or in a distillation system such as a retort (Kinabo, 2003a:295). Mercury enters the environment by open air firing of gold-mercury amalgam, and through the disposal of tailings and process water (Drechsler, 2001; Kinabo, 2003a:296).

Scholars agree that artisanal and small scale mining is labour intensive, and uses poor processing skills and rudimentary tools. Its unsatisfactory environmental performance can be attributed to the “poor handling of toxic chemicals, substantial mine waste and tailings, wastage of mineral resources from inefficient recovery techniques and a wide scattering of shallow and deep pits” (Kinabo. 2003).

Mwaipopo et al (2004) acknowledge the distinction between artisanal and small-scale mining as being that of “sophistication of working techniques, levels of investment, variation in knowledge of minerals extraction and marketing techniques, varying awareness of the legislation and hence varying levels of productivity and incomes” (Mwaipopo et al, 2004:21) Veiga (2004) points out that the distinction between artisanal and small-scale mining is unclear in locations such as Tanzania. Here, the assumption is that artisanal miners are illegally panning and sluicing gold at riverbanks while small-scale miners are working legal claims. He notes that in the Mineral Policy of Tanzania (Oct.1997) there is no clear distinction between these activities. Despite these differing perspectives, artisanal and small-scale mining can be considered under a broader definition of artisanal and small-scale mining (ASM) in efforts to improve the conditions under which these activities are performed.

For the purpose of this work, Mwaipopo et al’s (2004) definition of artisanal and small-scale mining as “those activities that are based on labour-intensive mining and processing techniques, whose per capita productivity is low, employ unsophisticated technology and require low capital investment” will be used (Mwaipopo et al, 2004:21).

## **2.2 ASM in Tanzania**

A geological map of Tanzania is shown in Figure 1. Rock formations belonging to the Archean, Proterozoic, Palaeozoic, Mesozoic and Cenozoic are well represented and mineralized. (Kinabo.2003:291) There is an abundance of mineral resources of international value throughout the country. Among these are: gold, diamonds, salt, gypsum, gemstones, iron ore, natural gas, phosphate, coal, nickel, cobalt, and tanzanite. (Kitula, 2004:405)

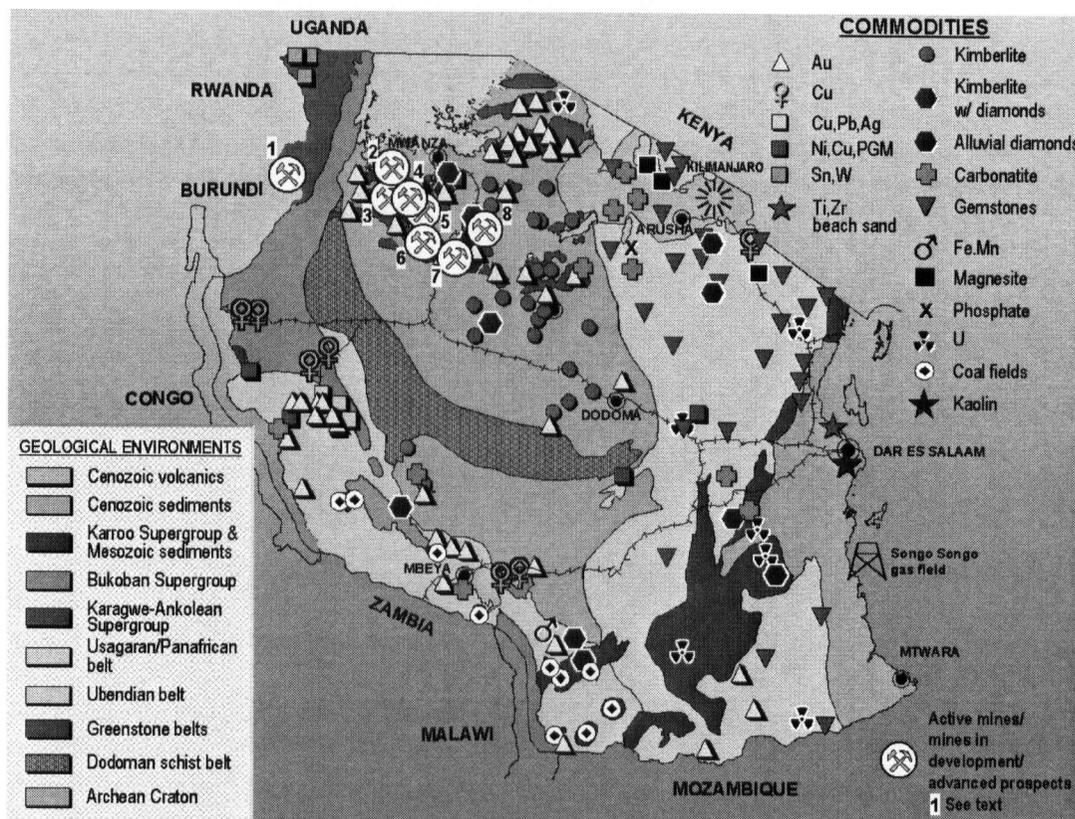


Figure 2.1 - Geological Environments and Commodities of Tanzania (Tesha, 2006)

The location of the field work done in this study is within the Lake Victoria Goldfields, a series of greenstone belts in the north of Tanzania near the border with Kenya. (See Figure 2.2). Most of the gold reserves in Tanzania are within the Goldfields. The gold occurs as auriferous quartz reefs and stringers; auriferous sulphide impregnations and, alluvial/elluvial deposits (Mwaipopo et al, 2004:38).

The Tanzanian mining industry has been dominated by gold mining for over one hundred years. The 1890's brought about organized prospecting and mining with discoveries being made in Geita, Kahama and Sekenke in the Lake Victoria Goldfields (Mwaipopo et al, 2004). Veiga (2004:1) notes that "there are seven main regions at the south of Lake Victoria where gold miners have been

operating” – these areas, referred to locally as “mining centres” were formed by the gold rushes that began in the early 1980s.

The mineral sector’s GDP contribution has been increasing steadily, from 2.3% in 2000 to 2.5% in 2001 and 2.7% in 2002. The GDP contribution for 2004 stood at 3.5% and it is estimated that it will reach 10% by 2020 (Ministry Energy and Mines, Tanzania, 2006). The increase can mostly be attributed to gold exports, the value of which increased from \$121 million in 2000 to \$597 million in 2004 (Yager, 2004). The total share of mineral exports for 2004 was 52% (Kafumu, 2005)

The significance of small-scale mining in Tanzania is evident in reports of the sub-sector employing an estimated 550,000 persons, 30-50% of which are women (Tan Discovery, 1996, ILO, 1999). Current estimates by the Ministry of Energy and Mines place the number of Tanzanians engaged in mining at over 1,000,000, more than 90 per cent of whom are engaged in the artisanal and small-scale mining sectors (Ministry Energy and Mines Tanzania, 2006). With the International Labour Organization estimating the number of artisanal and small scale mining workforce to be around 13 million in 1999, the Tanzanian workforce represents a significant percentage of the global total.

The average Tanzanian mine worker has a family dependence of eight to nine, representing between 4.4.-5 million people country-wide. Income derived from artisanal and small scale mining can be credited with supporting approximately 14% of the Tanzanian population (Kinabo, 2000).

Drechsler (2001:61) suggests that “the nature and extent of the growth of the ASM sub-sector in Tanzania is affected by the social, political and economic structure and geological setting of the country”. He attributes sectoral growth to:

- Attractive geological environment – various sites of high-grade mineralization easily workable by simple tools;

- Need for sustainable livelihood in the mining sector due to collapse of other sectors;
- Lack of public and private employment – the closure of state owned mines in 1980's and privately owned mines in early 1970's forced semi-skilled workers to engage in ASM;
- Long and complicated bureaucracy for granting mineral rights to applicants between 1970-1990;
- Discovery of gold deposits south of Lake Victoria in the mid seventies – many indigenous people entered mining as a means to “get rich quick” and
- Economic policy reforms on mineral trade liberalization and the new legal and regulatory framework.

Drechsler (2001:6) reports that in Tanzania, in addition to contributing up to 5% of GDP, small-scale miners contribute up to 25% of the total national gold production. He adds that the employment opportunities provided to many rural residents and the resulting resettlement of recently laid off cities dwellers as indicators of the importance of the small-scale and artisanal mining sector in Tanzania (Drechsler, 2001).

It is difficult to determine the exact number of Tanzanians engaged in ASM. Challenges to collecting statistics can be attributed to factors such as data collection methods, and the transient and illegal nature of the work. UNIDO (2004) estimates that there are between 450,000 and 600,000 small-scale miners in Tanzania. It has also been estimated that 550,000 persons are permanently employed in ASM in Tanzania (Tan Discovery, 1997).

According to Mwaipopo et al (2004:62), operations in artisanal and small-scale gold mining areas in Tanzania, such as Nyarugusu and Mgusu, fall into the following categories:

- Mineral rights owner manages the entire process (small-scale mining) – the payment system is: casual labourers paid in cash for determined task; mine

workers are paid 30% of realized production; a percentage (35%) is divided between the manager, mine foreman, supervisors and guards; a percentage (15%) goes to the mine owner for the cost of operating the mine; and a percentage (50%) goes to the mine owner.

- Mineral rights owner runs operations in a portion of the claim and leases out the rest to other operators (artisanal and small-scale mining) – key personnel obtain a share of production; casual workers are paid per task, operation of leased out pits (1-3) is determined by mineral rights owner, who receives a percentage from each pit (30%).
- Organization occurs at pit level and the concession is leased to pit owners by mineral rights owner (artisanal mining) – a miner or group of miners obtains consent from the mineral rights owner to have a pit. Pit members work until signs of mineralized zones are detected. They either involve labourers to mine or bring in additional persons to the group. In the case of new members, founders of the pit benefit from an upgraded status whereby they supervise or supply tools rather than excavate. New members are given a specific task and receive a proportionate share in the endeavour. The standard percentage given to the mineral rights owner is 30% of production per pit.

Operation of processing facilities (grinding mills, sluices, manual crushing) – crushing and grinding by individuals working independently is followed by semi-processed ore being given to dry grinding mill operators. After someone has sluiced, an independent panner and amalgamator takes over.

Mineral brokers buy mineral commodities in mine sites, selling them to mineral smugglers or a city official dealer. In 1996 there were an estimated 700 illegal brokers in Tanzania. Mineral dealers are either licensed or unlicensed. They deal with gold and gemstones in mine centres (Drechsler, 2001). The Ministry of Energy and Minerals reported that in 1999 there were 5 licensed mineral dealers in Tanzania.

Secondary activities at mine sites can be categorized into two types of services: those that directly support mining and processing, and community services-oriented businesses that serve the mining community. The provision of mining equipment, fuel and transportation services and customs mills is a result of the former, the latter provides bars, restaurants, retail stores, pharmacies, food vendors, etc (Phillips, 2001).

Phillips (2001) notes that Tanzania has many areas where gold veins are concentrated close to the surface but are not large enough to attract large companies. "Multinationals look for deposits over 500,000 million ounces with yields of 2-3 ounces per ton, in order to recover the capital outlay involved in exploration and mining. Small miners look for higher concentration (3-8+ ounces per ton) close to the surface, but have little capital invested so are interested even in small veins" (Phillips, 2001.p.76).

Artisanal and small-scale miners in Tanzania use two categories of mining methods: those for opencast mining and those for underground mining. The former is utilized in shallow pit excavation, for mining alluvial gold, gypsum, sands, gravel and rubies. Methods for underground mining are used for the extraction of gold from reefs, such as at Blue Reef Small-Scale Gold Mine in Rwamagasa, for mining gemstones and coal. In terms of beneficiation methods, artisanal and small-scale miners process their ore with unsophisticated technologies.

According to Drechsler (2001:61) "although small-scale and artisanal mining is such an important sub-sector in Tanzania, artisanal mining is usually carried out by people with only informal operational organization, with poor technology, using cheap crude tools and limited marketing knowledge".

There are, however, occasions whereby small-scale operations are organized on a "formal basis where operators abide to the laid down mining and mineral

marketing procedures; keeping production and sales records; which are furnished to the relevant authorities; and using appropriate technologies such as use of retort systems and special amalgamation ponds (Drechsler, 2001 .p.62)”

Artisanal and small-scale miners have succeeded in discovering significant deposits in Tanzania. Bulyanhulu Mine and Kahama Mining Corporation resulted from small-scale activities that discovered large ore bodies. Tembo Mine, Geita District, involved a foreign company and small scale miner entering into an agreement to mine, process and market the products (Drechsler, 2001).

Mining activities in Tanzania are governed by the Ministry of Energy and Minerals. The table below shows the distribution of artisanal and small-scale miners according to mineral commodity, region and gender.

Table 2.1 - Employment totals in selected segments of the Tanzanian artisanal and small-scale mining sector

(Source: Kinabo, 2003a)

Mineral Commodity	Region	Men involved	Women involved	Total
Coloured gemstones	Arusha, Tanga, Rukwa Morogoro, Ruvuma Mtwara	226,430	72,842	299,272
Diamonds	Shinyanga Kwanza	1480	1028	2508
<b>Gold</b>	<b>Shinyanga, Musoma, Rukwa, Singida, Mwanza, Mbeya, Ruvuma</b>	<b>171,113</b>	<b>51,553</b>	<b>222,666</b>
Sand	Main towns & cities	872	136	1008
Salt, lime, & Aggregates	Dar es Salaam, Tanga, Mtwara	8499	17,448	26,056
Gypsum	Kilimanjaro	590	0	590
Dimension stones	Kilimanjaro	225	45	270
<i>Totals</i>		409,209	143,161	552,370

Mwaipopo et al (2004) suggest that 50% of ASM activities in Tanzania are associated with gold, and 30% associated with gemstone mining, however, consultants such as Mutagwaba (2004), Tesha (pers comm., 2006) and Rogers (pers comm., 2006) suggest that determining reliable figures is currently impossible.

### **2.2.1 ASM in Mwanza Region**

Mwanza region covers an area of 187km<sup>2</sup> and is located in northern Tanzania next to Lake Victoria. Mwanza is comprised of eight districts: Ilemela, Nyamagana, Magu, Ukerewe, Geita, Sengerema, Kwimba and Misungwi. In 2002 the population of Mwanza was an estimated 2,942,148 persons, 712,195 of whom resided in Geita District (URT, 2003).

Most people involved in small-holder agriculture (85% of region's population) grow crops for the dual purposes of food and cash. There is a high dependence on cotton, fisheries exports and livestock keeping. With 108 cattle per sq km, Mwanza has 13% of Tanzania's total livestock (Mwaipopo et al., 2004:36). Mining and a booming fishing industry are credited with Mwanza's economic growth. Gold mining in Mwanza produced 5,777,523 grams in 2000 valued at TShs 42.2 billion (Mwaipopo et al., 2004:37, URT, 2003:93).

Participation in economic activities varies in Mwanza region. In Mgusu, people are primarily dependent on mining, in Nyarugusu people engage in farming and ASM, whereas in other areas of Mwanza Region lives are sustained by managing a combination of activities among which are farming, fishing, small business and ASM – all key components of the livelihood framework. In cases where ASM complements another income activity (such as in Nyarugusu), pits tend to be randomly located, close to homes or in the middle of a farming area (Mwaipopo et al, 2004).

Artisanal and small-scale miners in Mwanza region are primarily mining gold found in small deposits of high grade found in most shear and fracture zone structures and alluvial/elluvial deposits found within shallow lying sediments (Mwaipopo et al, 2004: 38).

Located in the Mwanza region, the administrative district of Geita covers 7825 km<sup>2</sup>, 1050 km<sup>2</sup> of which is water – mostly Lake Victoria. Situated between between latitude 2° 28'-3° 28' south and longitude 32°-32° 45' east, on the shore of Lake Victoria, it is northeast of Sengerema District, northwest of Kagera Region, southeast of Kwimba District and south of Shinyanga Region (Kitula, 2004). An all-season road, starting in Mwanza Town, provides access to Geita District. The road connects to the Biharamulo District of the Republic of Rwanda (Kitula.2004).

The table below shows the income, livelihood and location of ASM activities in Geita District.

*Table 2.2. - Basic Information on Geita District*

<b>Area</b>	7825 km <sup>2</sup>
<b>Administration</b>	7 divisions, 33 wards, 185 registered villages
<b>Population</b>	712, 195 (2002 national census) 355,823 males, 356,372 females
<b>Household Size (2002)</b>	6.2
<b>Income per Capita</b>	TShs 140,755.30 (US\$112.60)
<b>Major Livelihood Activities</b>	Livestock keeping, agriculture, ASM, small business
<b>Major Economic Sectors</b>	Forestry, Geita Gold Mine Ltd
<b>ASM Activities</b>	Gold mining in Rwamagasa, Nyarugusu, Mgusu, Nyakagwe, Nyamtondo, Tembo Mine, Rwamchele, Ibondo

(Source: Mwaipopo et al., 2004: 36)

Kitula's 2002 field survey in Geita district reported that among respondents living in the mining communities, many were involved in diverse economic activities, with 33.8% citing mining as their primary occupation, 47.3% in agriculture and 1.4% in being engaged in both<sup>1</sup> The number of respondents reporting involvement in both agriculture and farming is significantly smaller than in the sample of women workers at Blue Reef Mine, Rwamagasa, where all reported engaging in multiple economic activities.

Although artisanal mining has a long history in Geita District, people were traditionally engaged in agriculture, fishing, hunting and livestock management. "As the industry developed, it became the main source of income, attracting not only locals but also individuals from other regions" (Kitula, 2004,p.407). Geita District has the highest growth rate of all districts in Mwanza (3.6% from 1988-

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<sup>1</sup> Data related to the socio-economic activities of respondents in Kitula's 2002 field survey in Geita District. Respondents residing in a mining community N=74. 12 were women (16.2%). (Kitula, 2004. p.407).

2002). This can be attributed to the influx of people brought in by increased ASM and large scale mining activities (Geita Gold Mine Ltd, 2005).

According to Kitula (2004) participation in artisanal mining in Geita District, as a complimentary source of income, can be attributed to two primary factors: the need to supplement income at the end of an agricultural season, and poor agricultural yields due to adverse weather. Many opt for agriculture as the primary source of income because of the unpredictability of mineral recovery resulting from inadequate mining methods (Kitula, 2004.p.407).

Geita District has over 15 artisanal and small-scale mining centres. The district experienced a boom during the 1980s and 1990s. Geita Hill and Ridge 8 are small areas that attract migrant miners (Mwaipopo et al, 2004). As noted by Mwaipopo et al (2004:38), "Geita District is believed to have the highest population of artisanal and small-scale miners in Tanzania".

Mwaipopo et al's 2004 study of mining livelihoods in Misungwi and Geita Districts revealed that a small percentage of miners actually own semi-sophisticated technology such as engine-powered crushers, and compressors or water pumps. Current organizational arrangements for the exploitation of gold ores by artisanal miners in Geita District are mostly individualistic, labour intensive and inefficient. Technology tends to be unsophisticated and lacking in efficiency. Miners do not work in an organized manner and as a result, they are not working in the most productive and safe way. Practices are usually copied from others and the use of technologies such as modern comminution and classification, and the use of retorts is limited. Production and resulting gold recovery is low, and the specific mercury emissions from these activities is high (Scoble et al, 2006)

In addition to the issues around inefficiency and lack of safety, a significant portion of the artisanal and small-scale miners in this region are illegal panners (Veiga, 2004). Regulation and legalization of the ASM sector is a priority for the

Tanzanian government and programs like UNIDO's Global Mercury Project. In 2004, the Lake Victoria Zonal Mining Office reported the number of licensed holders for gold mining in Geita District at 335 (Mwaipopo et al, 2004).

Co-existing with ASM in Geita District is the Geita Gold Mine (GGM), owned by AngloGold Ashanti. It is located 80 km south-west of Mwanza and 5km from Geita town. It began production in 2000 and is the largest of the company's open-pit mines in Africa (Geita Gold Mine Ltd., 2005). Veiga (2004) notes that in 2002 the mine produced close to 21 tonnes/a of gold and paid the Federal government annual royalties of 3% (US\$7 million). He adds that Tanzanian mining law does not define that percentage of taxes returns to the community, "as a result, the town of Geita is visibly not receiving the benefits of this massive gold production in the region" (Veiga, 2004:2).

At GGM, mining is performed by standard open-pit mining methods, with drill and blast followed by loading of 100-tonne trucks by ten hydraulic excavators. The operation has a 6-million-tonne-per-annum carbon-in-leach (CIL) plant. The mine produced about 21,500kg of gold in 2004 compared with 20,600kg in 2003. In 2005, 2,280 persons were employed by the mine, 1,214 of whom were contractors. In April of that same year, GGM encountered a problem when 7,000 gold seekers invaded the area after hearing that artisanal miners found a large nugget of gold. Most left of their own accord, however, police forcibly removed those who refused to vacate the area. (AngloGold Ashanti, 2005).

### **2.3 Benefits of ASM**

Mwaipopo et al (2004:8) found that ASM has "considerable potential to reduce poverty" and that "ASM communities fare better in terms of poverty levels than other communities". They consider ASM in terms of its contribution to wealth creation, asset accumulation and investment and also in the possible enhancement of livelihood security, which, consequently, decreases vulnerability.

Jennings (1999) reports that small-scale mining is an essential component of the livelihood strategy for more than eleven million people around the world.

Artisanal mining offers employment to persons with no formal skills and little to no capital. The lack of formal training and acquisition of skills on an apprenticeship basis tends to attract significant numbers of immigrants and accounts for low earnings among artisanal miners. Involvement in artisanal mining as a licensed dealer/claim holder, or pit owner, however, necessitates capital, experience and an understanding of how the industry functions (Mwaipopo et al, 2004).

ASM makes a significant contribution to the Tanzanian economy. Drechsler (2001) notes that the artisanal and small-scale mining sector contributes to the Tanzania economy: by generating income; creating employment, production of marginal reserves that would otherwise be ignored, and in the discovery of large ore bodies.

The Mineral Policy of Tanzania, Oct. 1997 "recognizes the positive contribution of the artisanal and small-scale mining sub-sector to the economy" (Veiga, 2004:2) Artisanal and small-scale mining will continue to make a significant contribution to Tanzania's economy, through direct and indirect employment, due to increased rural poverty, decreasing agricultural opportunities, and the opening up of these activities as legitimate activities (Mwaipopo et al, 2004)

#### **2.4 Risks of ASM**

Despite the potential of ASM to improve quality of living for many involved, the risks involved are significant. Levels of vulnerability can be tremendous when high risks accompany chronic poverty (In 1998 the World Bank reported that 45.5% of the Tanzanian population made less than US\$2/day). Among those most vulnerable are children and elderly women participating in gold processing activities (Mwaipopo et al, 2004). Livelihood sustainability of ASM communities,

according to Mwaipopo et al (2004:12), is subject to two challenges: it “is based on production of non-renewable resources” and “the limited geological knowledge of miners about the resource potential in their areas”<sup>2</sup>.

Many artisanal and small-scale miners lack knowledge and capacity that has made them vulnerable to exploitation and dispossession of mining rights (Mwaipopo et al, 2004:9). This physically demanding activity provides work for persons often lacking education, money and access to alternative employment opportunities.

There are a number of socio-cultural impacts resulting from mining in ASM communities. Considered among these impacts is unemployment and displacement, and child labour (Kitula. 2004:410). Kitula reports that the establishment of Geita Gold Mine resulted in the displacement of some 1800 persons in the villages of Mtakuja, Nyamalembo, and Nyamange (Kitula, 2004:411). A mining company’s arrival can have serious social impacts for communities – even displacement. Communities may be forcibly relocated, or displacement results from attempts to “seek refuge from the adverse effects of a mine” (Keenan et al, 2002:4).

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<sup>2</sup> Mwaipopo et al’s (2004:21) definition of livelihoods: “people’s means of living, including the activities they carry out to sustain themselves, the property or assets they hold, and the linkages between their livelihoods and institutional and physical environments. Livelihood does not just refer to how people gain cash income but the many ways, monetary and non-monetary, they make a living. It can also suggest people’s particular lifestyle, their inheritance and their future aspirations”. Income poverty is defined as that expenditure (and by implication income) required to provide either minimum calorie requirements (the food poverty line) or goods and services to meet basic needs (the basic needs poverty line) (Mwaipopo et al, 2004:22). The idea that some groups within society are more vulnerable to impacts on their livelihood or/and survival, has led to the development of the concept of vulnerability (Mwaipopo et al, 2004, citing Teslieu & Lindert, 2002). Included in the concept of vulnerability are: exposure to risk (natural, social, political and environmental) that adversely affects wellbeing such as drought, HIV/AIDS and worsening terms of trade (URT, 2004:19); responses to risk (actions before or after); and the outcome (increased vulnerability and poverty or improved resilience and wellbeing). Holzmans and Jorgensen (2000), consider vulnerable persons to be those who are poor and also those above the poverty line who, as a result of inability to manage potential shocks, will fall into the poverty category.

Disputes resulting from displacement of local persons have occurred at the Kahama, Merelani and Mara mines. Lasting implications of the loss of mine sites and agricultural lands by small-scale miners and farmers have been increased poverty, accelerated food insecurity to landless classes and intensified environmental degradation (Kitula, 2004). Mwaipopo et al (2004:26) note that large mining companies and artisanal miners have a long history of "mutual mistrust and resentment, with both sides having misguided preconceptions and strong feelings regarding each other and their alleged rights". This strained relationship can be attributed to the shared pursuit of mineral resources and incompatible objectives – artisanal and small-scale miners high-grade shallow deposits while companies "bulk mine a larger but lower grade deposit of which the high grade areas constitute only a minor part" (Mwaipopo et al, 2004:27)".

Phillips (2001) points out that as a result of artisanal and small-scale miners using traditional tools and processing equipment, recovery is 40% or less and they are forced to select shallow rich veins. "Due to lack of modern technology artisanals mine in some concessions up to 25 metres and then stop because it is no longer economic to go deeper" (Phillips, 2001.p.76) There are also dangers associated with going deeper such as collapses and suffocation.

In addition to these dangers, processing techniques using mercury create serious health and environmental issues. Van Straaten (2000:46) notes that approximately 3-4 tonnes of mercury are released from gold processing in small-scale mining operations in the Lake Victoria Goldfields. Veiga (2004) reports that for Tanzanians living around Lake Victoria, the main pathways for mercury bioaccumulation are: miners exposed the Hg vapours when burning amalgam (Ikingura, Mutakyahwa, Kahatano, 1997); fish ingestion (Ikingura & Akagi, 1996; Campbell, Dixon & Hecky, 2003); soil geophagy (ingestion of geological materials); and Hg-rich beauty creams (NERI, 1999). Research into the health impacts of ASM at Rwamagasa revealed that "in terms of health problems, the main evident problem is Hg vapour inhaled by miners burning mercury in open

pans". As Drechsler (2001.p.77) notes, "gold burners, women and children, are the main victims because most of them lack information about the dangers of mercury. This means that future generations in mining sites will be severely affected by the continuing discharge of mercury to the environment".

## **2.5 Social Issues facing ASM Communities**

### **2.5.1 Child labour**

"Child labour is a serious issue in relation to artisanal and small-scale mining in Tanzania due to the potential for exploitation, risk of accident, arrested physical development through health problems and potential for serious illness (Mwaipopo et al, 2004: 33).

Child labour in ASM is a global concern. Children's participation in mining activities presents risks to health, exposing them to mercury, dust, and other occupational hazards. Child labour in ASM also adversely impacts educational attainment as the contribution to the family earnings supersedes the benefits of school attendance (Kitula, 2004.p.411). The percentage of the population of children living in mine areas in Tanzania is high. Mine families need money to survive, and children are a source of additional income (Drechsler, 2001.p.65).

### **2.5.2 Prostitution and Sexually Transmitted Infections**

Prostitution is a growing concern for health care workers in Geita district and other mining areas within the country. "Migration of young ladies into mining centres in search of non-existent jobs...has increased prostitution and the spread of venereal diseases including HIV and AIDS (Kitula, 2004:411). In a 2002 field survey on the impact of mining on human health, Kitula compared HIV/AIDS cases in a mining community and non-mining community. Results showed the prevalence of HIV/AIDS cases in the mining community (37.8%) to be twice that of the comparison community (18.9%) (Kitula, 2004:411).

Severe consequences of the popularity of the commercial sex trade in Tanzanian mining areas is exposure of sex workers, miners and their families to sexually transmitted infections, HIV/AIDS, stress and psychological problems and, for women - physical assault. HIV/AIDS is a major issue as 50% of hospital beds are occupied by patients with HIV/AIDS related illness (TACAIDS, 2003).

The estimated number of Tanzanian adults and children living with HIV was 1,400,000 in 2005, with 140,000 HIV/AIDS related deaths in the same year (UNAIDS, 2006). A May 2006 GMP training workshop included a discussion with health care providers on "health issues concerning artisanal and small scale miners". Among the health concerns discussed were several pertaining to unhealthy behaviours. These include: HIV/AIDS and STIs from unsafe sex in mining areas, high levels of promiscuity and the adverse effects on the family; and the cycle of increased income-increased alcohol/drug abuse-increased risky behaviour<sup>3</sup>.

Participants in the GMP training discussion group also expressed concern over the misuse of earnings by miners. Sudden, large gains are often spent on alcohol and/or drugs, and prostitution. In 2003, AVERT reported that with approximately 980,000 children without parents, Tanzania has the third largest number of AIDS orphans in sub-Saharan Africa. "It is estimated that Geita District has about 3,000 orphans due to the death of one or both parents from AIDS, accidents or illness (AngloGold Ashanti, 2005:2)".

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<sup>3</sup> GMP Training of the Trainers 10-day program in Geita, May 2006. Author conducted workshop session on "health issues concerning artisanal and small scale miners" with 12 health care workers, some of whom have been directly involved in ASM. The workshop led to the formation of a health brochure, as part of the ongoing GMP awareness campaign, on topics specific to artisanal miner's health in Geita district. Discussion highlighted the importance of addressing basic health behaviours, adopting an holistic approach to improving miner's wellbeing as part of the overall effort to promote safe mining practices. As it was pointed out by a community nurse and former artisanal miner, attempts to reduce mercury use and promote safe mining practice are futile unless basic healthy behaviours are adopted.

The AMREF Mine Health Project's baseline survey found that approximately 40% of female guesthouse and bar workers in Geita town are HIV positive, while a 2001 survey determined HIV prevalence rates of 19% for men and 16% for women within the community (AMREF, 2006). There were approximately 2,280 workers at Geita Gold Mine in 2005, the majority of whom are men. In response to a high demand, commercial sex is available in Geita, with women working out of guesthouses and bars. Clift et al (2003) found high prevalence of HIV and STIs in communities neighbouring new goldmines in Tanzania. Female food and recreational facility workers were found to be those with the highest infection rates.

In 1993 the prevalence of HIV and STI was higher in artisanal mining settlements than in other rural communities. In the study populations in Kahama District and Geita District, 15% of males and 23% of females aged 15-54 were HIV infected compared to 2% of males and 3% of females in other villages (Clift et al, 2003:2). It is important to note that large-scale gold mines opened in areas with a pre-existing high HIV prevalence such as Geita Gold Mine in Geita, and Bulyanhulu Mine in Kakola. While the influx of large numbers of single men and female sex workers is a factor in the increased HIV infection rates in these communities, the problem was already present. In their discussion of social impacts in communities coexisting with mines, Keenan et al (2002) point out that it is not unusual to see an increase in alcoholism, prostitution, domestic violence, family breakdown and health problems.

In the community around Geita Gold Mine high risk sexual behaviour is common. Compared to 11% of women in the general community, 43% of female food and recreational facility workers reported having multiple sex partners. Receiving payment for sex was reported by 50% of these women compared to 20% of other women in the community. Among mine workers, 55% reported paying for sex in the last year compared to 61% of other men. Of the mine workers, 14% reported never using condoms, and 15% reported occasional use. 46% of men from the

general population reported never using a condom, with 25% claiming occasional use (Clift, 2003: 7).

A sex worker in Geita Town highlighted both the seriousness of the risk of HIV/AIDS and the impact of Geita Gold Mine on this problem. Sally, a 28 yr-old prostitute makes a weekly trip from her home in Mwanza Town to Geita Town in order to meet mine workers from the nearby Geita Gold Mine (located 5km from the town). The clients are mostly expatriates working at GGM or contractors providing services to the mine. When it is payday at the mine, Sally and about six other prostitutes anticipate a rise in the number of clients.

Observing Sally at work, it appears that the younger women are in her charge, as she often takes care of finances, collecting debts and providing directives to the other women. Sally is HIV positive and has two children. She explained that both children are the result of unprotected sex with expatriates working at/with GGM and that she receives no financial support. Sally justifies engaging in unsafe sex, despite her HIV positive diagnosis, as she has no alternative source of income to support her children (Sally, personal comm. 2006).

The current situation of the commercial sex workers observed in Geita town appears to be one in which poverty and lack of opportunity are compounded by the fact that the women are already HIV positive and condom use to protect themselves is considered unnecessary. There seems to be little incentive to engage in safe sex when offered additional money to refrain from condom use as the responsibility for protecting the client rests with the client.

Inadequate health and educational services contribute to the severity of the impact of HIV/AIDS and STIs in the area and present a serious challenge to health workers in terms of prevention and treatment (Pers Comm., Health Worker Geita Town, 2006).

### **2.5.3 Alcoholism and Spending Issues**

The sudden influx of money into mining life often results in additional social concerns. While women usually use their income to purchase essentials for the maintenance of their families, “men are more likely to spend their wages on gambling, alcohol, and prostitutes” (MMSD, 2002:317)

Mwaipopo et al (2004:55) note that it is common for “merrymaking and extravagant drunken behaviour” to occur in ASM communities and that there is a ‘striking it rich’ mentality followed by changing patterns of consumption if this actually occurs. To support this conclusion they quote the following miners:

*“Kwanza watu wanapata vishawishi vya kuiga wenye hela wakifanya starehe, unapomwona mwingine anatanua wakati wewe huna hela – basi ukipata na wewe unaenda kujichana – firstly people are tempted to copy the lifestyle of those with money, and when you get money you also indulge yourself”.*

*“Kukaa muda mrefu bila hela. Siku ukizipata unataka ukidhi matakwa yote ya starehe kwa wakati mmoja – staying for a long period without money, the day you get it you want to entertain yourself to the maximum at the same period”*

“Mining activity may introduce or greatly enhance the cash economy, and local communities may be unprepared to navigate this system (Keenan et al, 2002:4)”  
The impact of poor spending habits impacts on the individual, his family and is a challenge for the successful implementation of micro-credit and loan programs.

Issues related to sudden increase in income, albeit through success in ASM or from acquiring a loan can be understood in terms of:

- Unhealthy behaviours around change of finances (prostitution, gambling, alcohol/drug abuse)

- poor decision making regarding use of loaned money
- absence of experience with loan repayment and/or saving
- Risk-taking during ASM activities (working while intoxicated)

Christopher Kadeo, owner of Blue Reef Mine, emphasized the difficulties he has encountered when miners at his operation were given loans. Rather than use the money for the specified purpose of equipment purchasing or business development, miners misused the loaned money to buy alcohol and drugs. Kadeo was faced with workers showing up to the mine intoxicated, which not only violated safety regulations, but adversely impacted productivity and production (Kadeo, personal comm, 2006).

Theft is also a problem associated with increased mining activity in the area – as individual wealth increases, opportunities for thieving increase. Distrust of migrant workers is apparent as local people attribute blame to non-locals for the rise in social problems such as theft, banditry and prostitution (personal comm.2006). Kitula (2004) reports how “high numbers of migrants seeking employment at Geita Gold Mine has led to a rise in the incidences of banditry, prostitution, changes to indigenous lifestyle and increased competition among local residents for natural resources”(Kitula. 2004.p.410). Crop theft was cited as a growing problem in the communities surveyed by Kitula in 2002. Involvement in thievery can be attributed to “economic hardship, induced by the uncertainty of finding minerals” and to “the existence of markets for food crops in mining areas (Kitula, 2004:411)”.

#### **2.5.4 Health & Safety**

As a result of inadequate technologies, technical knowledge, capital and sanitation, miners' health and safety are at serious risk. Phillips (2001) cites poor sanitation facilities, same source of water for household use and mineral processing, and crushing, grinding and amalgamation within living quarters, as visible health hazards. Inadequate sanitation facilities within mining camps is a

significant concern, for example: pit latrines, although uncommon, present a threat to water safety as they are often too shallow and poorly located (Phillips, 2001).

Mutabwaba et al (1997), emphasize the hazardous conditions within which artisanal and small-scale miners and their families exist. In comparison to accidents rates in pits, threat of disease, sickness and other health risks are more alarming (Phillips, 2001. p.64). "Airborne contaminants, such as rock dust, are mainly produced during drilling operations, mineral getting, loading and crushing of rock or ore, and blasting. Persons exposed to excessive dust for prolonged periods may suffer from permanent lung diseases, such as silicosis (Walle & Jennings, 2001, p.11)

"Many aspects of mining work carry risk of injury to the upper and lower limbs or spine, either because of the manual handling tasks involved or because of awkward postures"(Walle & Jennings, 2001.p.16). Working techniques, use of proper tools, and appropriate work-rest patterns are recommended to improve the ergonomics of this type of work. "The main causes of injury are heavy loads, awkward working positions, repetition, and working under pressure (Walle & Jennings, 2001, p.16)".

As noted by Phillips (2001), accidents in mine areas result from the use of poor technology and insufficient technical know-how. Collapsing walls and tunnels due to inadequate scaffolding, accidents and suffocation (from toxic gases accumulating) due to poor ventilation, and improper use of surface drilling equipment underground, are examples of serious health and safety risks<sup>4</sup>.

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<sup>4</sup> Veiga (2004) reports that children in Rwamagasa, Geita District, often lose their lives by falling into abandoned shafts, 5-10 metres deep.

Susceptibility to accidents and health risks is compounded by the absence of protective gear “most miners work barefoot, without gloves, safety belts, helmets and even adequate lighting for underground works (Phillips, 2001 .p.64).

As Phillips (2001) notes, the capability and willingness of miners to invest in retorts, fence pits and to dispose of fill and tailings appropriately is impacted by their mode of operation – and a cycle from which they cannot escape. Poor infrastructure hinders business in mining areas as roads may be impassable during the rainy season, and electricity and cable telephones are unavailable. Food preservation is adversely impacted without electricity, and business development is a challenge (Phillips, 2001).

### **2.5.5 Equity**

The barriers preventing Tanzanian women from improving their position within the ASM sector are numerous. Although men working in ASM usually lack technical knowledge to ensure efficient, safe mining, women have even less. They are also prevented from expanding this knowledge-base due to time constraints from competing responsibilities such as child rearing, chores and farming, and as a result of illiteracy. Cultural constraints are also important considerations as the role of women within society, community and home determines access to this type of opportunity. Tanzanian heads of household are men, and women lack land ownership, representation, decision-making power and control over finances – making operating a mining business without family, and other support, impossible (Kinabo,2003:318).

In addition, “the anarchic nature of artisanal and small-scale mining, along with the poor working and living conditions at mine sites, are sometimes sufficient reasons in themselves to prevent women from getting involved in the first place”(Kinabo.2003:318). With improvements in the sector, women’s participation might be greatly enhanced.

In extended understanding, capacity building also includes development of institutional, financial, political and other resources, such as technology at different levels and sectors of the society”(UN/ISDR). To build capacity for women in ASM in Tanzania, Kinabo (2003:319-321) suggests some of the following:

- Improving literacy;<sup>5</sup>
- Increasing education and training related to technology, economics, social and environmental activities at sites;
- Involving women in local government programs (family planning, reproductive health, nutrition);
- Providing schooling for their children;
- Providing hands-on assistance from extension service workers from government institutions and the private sector;
- Assuring access to credit institutions, promoting the formation of informal financial institutions such as rotating savings and credit associations;
- Promoting the acquisition of mining licenses and participation in joint ventures; and
- Encouraging the formation of women’s associations<sup>6</sup>.

It is important to note, however, that “small scale/artisanal mining itself is far from homogeneous. So women’s experiences and participation may vary quite dramatically depending on the nature and type of operation” (Burke, 2006:47).

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<sup>5</sup> Literacy rate for adults 15+ in 2004 was 69.4% (World Bank, 2004), literacy among women in 2003 was 78.1% (UNESCO, 2003).

<sup>6</sup> The Tanzanian Women Miners Association (TAWOMA). A non-profit and non-governmental organization whose mission it is to “facilitate women miners to organize and access required financial, technical, and marketing services so that they can carry out mining activities that are both economically and commercially viable and environmentally sustainable and thereby raise the standard of living for women miners and their families”. (TAWOMA mission statement).

This chapter has demonstrated the complex and significant role ASM plays in the Tanzanian economy. It has also illustrated the significant risks and social challenges faced by miners and mining communities. A lack of organization is identified as a powerful contributor to poor working conditions. The following chapter examines the work of the Global Mercury Project in identifying barriers to improving organization, improved environmental performance, safer working conditions and enhanced living conditions for ASM communities.

### **3 Global Mercury Project**

An integral component to any study of artisanal and small-scale mining is the work of the Global Mercury Project (GMP). This chapter examines the GMP's role and work to date in identifying and addressing issues faced by small-scale mining communities in Tanzania and elsewhere in the world. These insights create a basis from which to understand issues impacting the organization of small-scale mining activities, and the basis for further field investigations to address them.

#### **3.1 Project Overview**

Environmental, health and social impacts resulting from the application of mercury in the processing of gold within the artisanal mining sector and their effects on international water bodies require a concerted and coordinated global strategy (Bamber, 2005).

The Global Mercury Project (GMP) is an initiative sponsored by the Global Environment Facility (GEF) and United Nations Development Program (UNDP), and executed by the United Nations Development Organization (UNIDO) for the removal of barriers to the introduction of cleaner technologies in artisanal and small-scale gold mining in Brazil, Lao PDR, Indonesia, Sudan, Zimbabwe and Tanzania.

Contributions from work by the GMP will manifest in the introduction and demonstration of cleaner, more efficient technology and in improvements to miner's organization that, will improve earnings and production, improve health and safety for mining communities, facilitate access to micro-credit and micro-finance, and minimize environmental impacts.

The ultimate goals of the project are:

- 1) to reduce mercury pollution of international waters by emissions emanating

from small-scale gold mining,

2) to introduce cleaner technologies for gold extraction and to train people in their application,

3) to develop capacity and regulatory mechanisms that will enable the sector to minimize mercury pollution,

4) to introduce environmental and health monitoring programmes,

5) to build capacity of local laboratories to assess the extent and impact of mercury pollution

In terms of broad development objectives, the GMP seeks to transform current ASM activities into organized activities to improve incomes, minimize negative environmental impacts, and enhance the development of the mineral sector and, consequently, the economy of participating countries (GMP, 2004).

### **3.2 GMP in Tanzania**

“Simple technologies and capacity-building can help miners improve their livelihood – to get more gold and to use less mercury”

A.Tesha, Ministry of Mines and Minerals, Geita, 2006.

Mercury use in ASM is a serious concern. In Tanzania, artisanal miners recover gold using mercury, with gold smelting or amalgam being burned in the open air, within the home or in processing areas. Miners use their bare hands when handling mercury – exposing themselves to risk both from vapour and from direct contact in liquid form. The estimated ratio of mercury lost to gold produced is 1 to 1.5 and Hg lost (tonnes/a) is 0.003 to 0.06 (Tesha et al, 2004). In Rwamagasa, Geita District, 30kg of mercury is released into the environment every year and raised levels of mercury in urine samples from those living in area show mercury to be a serious hazard (Ibrahim, 2004).

Between 2002 and 2006, links between artisanal and small-scale gold mining and health, ecosystem and the social factors were examined. Progress to date

includes sociological, environmental and health assessments related to mercury released in project sites in six participating countries – Tanzania is among them. In addition, the identification of appropriate technologies and practices to reduce or eliminate mercury emissions from these areas, as well as the building of capacity in local laboratories to assess the health and environmental impacts of regional mercury pollution on an ongoing basis have also been examined.

The next phase of the project was to implement a program of education and awareness amongst stakeholders in each country, and to introduce miners to a range of affordable mining and mineral processing technologies and practices. To this end Transportable Demonstration Units (TDUs) containing a selection of cleaner gold processing options and educational materials are being assembled for all six countries and are to be introduced to the project's target mining communities beginning. These TDUs will provide a multi-purpose forum for community demonstrations and training (Bamber, 2005).

Over the last two decades, along with the price of gold, the number of artisanal and small-scale miners has been increasing. With close to one million Tanzanians depending on this sub-sector for their livelihood, poverty reduction efforts in rural areas recognize a huge potential in this area (GMP press release, 2006).

Training is an essential component of the GMP activities in Tanzania, and the main means by which local capacity building can be achieved. Training has taken place in Geita, focusing on mercury pollution prevention measures, mine safety, mercury and health, and technology transfer. In addition, GMP training in Tanzania included training in business skills, leadership and trust-building.

Scoble & Bamber (2005) found that obstacles to successful technology transfer, improved organization, and collaboration and cooperation, were lack of business knowledge, lack of leadership and high levels of distrust. The following section

examines the barriers to organisation such as lack of cooperation and trust, and demonstrates the significance of addressing these issues in order to improve organisation thus improving conditions in ASM communities.

### **3.3 Current Organisation of Artisanal and Small-Scale Miners**

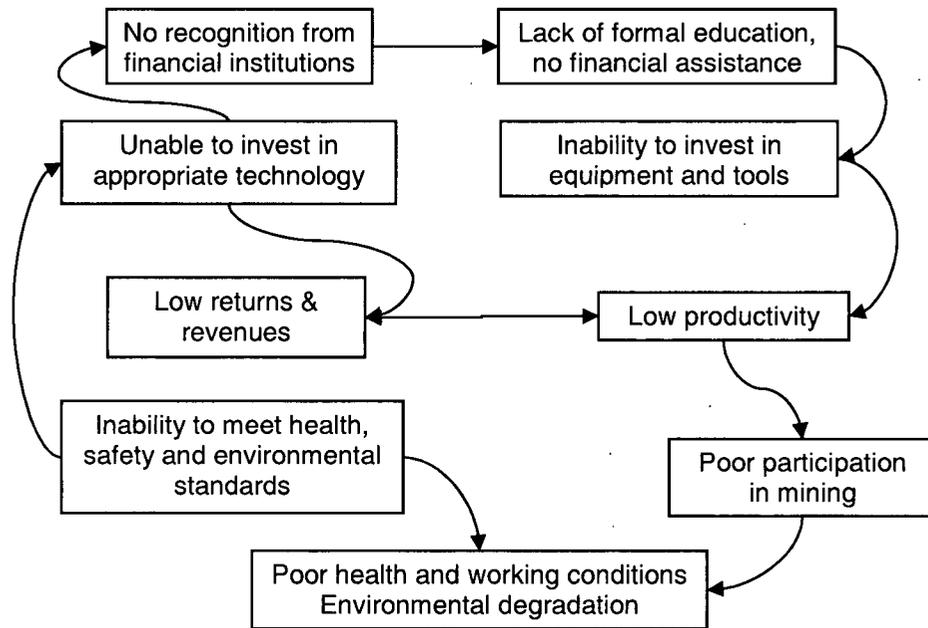
“The organization of illegal miners is widely recognized as an important precursor to providing the support needed to formalize and legalize activities as well as facilitate improvements in ASM communities. The criteria to access financing, technical support and legal tenure often presents a major challenge for many ASM operators, particularly given limitations related to language, literacy, transportation to government offices and mistrust towards government agencies. Organization of activities presents an opportunity for miners to share the burdens of these challenges (Hinton, 2005: 103)”

Artisanal miners tend to carry out their work in an informal, transient manner, without organization, adherence to rules and regulations, or use of appropriate technologies. The result of these is that poor mining and mineral processing techniques result in low productivity (Drechsler, 2001).

As Mutagwaba (2006) notes, “small-scale miners face a chronic shortage of capital for investment and operation of mining activities. Apart from a negative vicious circle that limits miners’ earnings and hence their abilities to invest, the conditions for accessing credit finance that exist within the financial institutions are difficult to meet by most small-scale miners. The requirements for collateral, a project feasibility study, registered business name and others, can hardly be met by the current miners (Mutagwaba, 2006:1)”.

He describes the largest group of artisanal and small-scale miners in Geita District as poorly organized, using rudimentary equipment and mining methods that result in scant earnings that are insufficient to enable investment in

appropriate technology. Access to finance for investing in their projects and to business training, Mutagwaba suggests, would permit these miners to “break from the poverty cycle” (Mutagwaba, 2006:5). He adds that less organized miners are considered at high risk of defaulting on bank loans due to the migratory nature of ASM and the major obstacle: lack of collateral.



**Figure 3.1 - Influence diagram of artisanal and small scale mining activities**  
(Drechsler, 2001)

Drechsler's influence diagram illustrates the circles of cause and effect that prevent both the Tanzanian government and miners from improving the current situation. In the existing self-reinforcing cycle, lack of organization prevents miners from being recognized and assisted by financial institutions.

Lack of access to micro-finance, combined with inadequate education and training, serve as barriers to investing in technology. Without improved technology and the accompanying training, miners are unable to shift from low productivity, poor participation and low returns, to a situation of increased income and productivity. This denies them the opportunity to invest further, save, train or

improve poor health, unhealthy working conditions and environmental degradation. In sum, organization is the only means of enabling miners to access components necessary for improved working conditions and standards of living. With organization and access to capital, they can improve their production, acquire training and technology, reduce negative health and environmental impacts of current practices and acquire capacity to address some of the many ASM-related social impacts.

Group lending through the formation of savings and credit cooperative societies (SACCOS) has been recommended by Tanzanian micro-finance experts like Mutagwaba (2006) and GMP experts like Spiegel (2006) but miners in Geita District have expressed a lack of trust for other miners, fearing that they will cheat them out of money:

### ***3.3.1 Nature of Mining Activities***

“The organization structure of small-scale mining varies according to: legality of the working area; driving forces like credit mechanisms and technologies applied; presence of mine rush areas and; the ability and efficiency of government institutions to service the sub-sector (Drechsler, 2001.p.90)”.

In terms of business, constraints facing artisanal and small-scale miners relate to production sharing arrangements and sub-letting of pits to small operators or financiers. These constraints arise out of a lack of education and business knowledge and result in unnecessarily high production costs, poor record keeping, misuse of gains from operations and lack of reinvestment in mining (Tan Discovery, 1999).

Referring to a 1996 study by Tan Discovery Minerals Ltd, Drechsler (2001) suggests that mining groups can be classified according to skills and legality of the operation. These highly interdependent groups can be categorized as; mine

rush gangs, special service gangs/operators; formal/informal mine claim organizations and village/association organizational structures.

Mine workers are usually young, rural men who are either supplementing an existing income from agriculture, working towards a short-term financial goal (acquisition of money to start a business), or participating year-round. Working in the pit or shaft is tough and exposes the miner to a variety of occupational health and safety risks. The work is not without its rewards and miners who attain a certain level of success have the option of becoming brokers, dealers or claim holders. An attractive feature of this work to some is that it is, in actual fact, self-employment. The four or five men who make up a gang determine how long they work and the mining practices they use (Phillips, 2001).

Mine workers demand the production-sharing mode of mining. Only during the removal of unproductive overburden do they obtain wages and/or food. A claim holder with capital can ensure himself a fair portion of the ore by funding the start up operations. Without investing money in the mine, he has no choice but to come to an agreement with the mine gangs, who have already started working before the claim is registered, for his share. In this situation, cheating and thievery are commonplace.

“A single licensed claim is divided into smaller blocks, each of which is allocated by the owner in small sections to pit gangs and/or their funders. Often the gangs have staked out their pit before the claim validation is received, so the claim owner is in the position of negotiating with existing groups and work in progress (Phillips, 2001:62)”.

Phillips (2001) notes that mine workers report that their position is a coveted one, requiring men to pay their dues by performing manual labour in the mining community until he has acquired the funds and friends necessary for membership in a mine workers' group.

Phillips (2001) estimated the daily wage of a manual labourer in a mining area as a shadow reservation wage. The shadow wage was “based on the opportunity cost of their time and the shared costs of food and lodging provided by the mine owners” (Phillips, 2001.p.26). In the northern, Lake Victoria and central zones the average was 2000-3000 TSH per day (US\$1.54 - 2.31). They sell their products to mine brokers, claim holders, or pit funders at the miner site or in the closest village.

As part of the GMP initiative to devise a strategy for improved organization in ASM in Tanzania, a comprehensive literature review and fieldwork were undertaken. The result of this work was the conclusion that existing work practices at ASM sites in Tanzania are primarily individualistic, with the same person typically taking responsibility for all of the steps in the process as well as performing associated tasks such as metal sales or obtaining food and supplies (Scoble & Bamber, 2005).

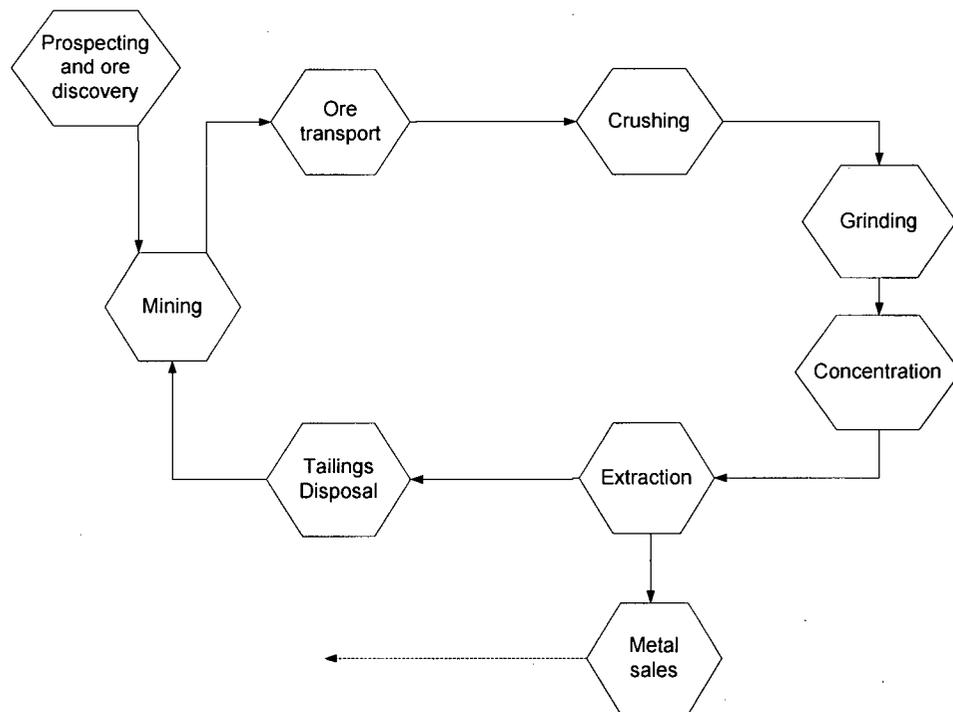


Figure 3.2 - Activities in the Artisanal Mining Cycle(Bamber, 2005)

Performed in an individualistic model each activity can take as much as a day, with additional time being required for transportation, planning and allowing for potential delays at each stage.

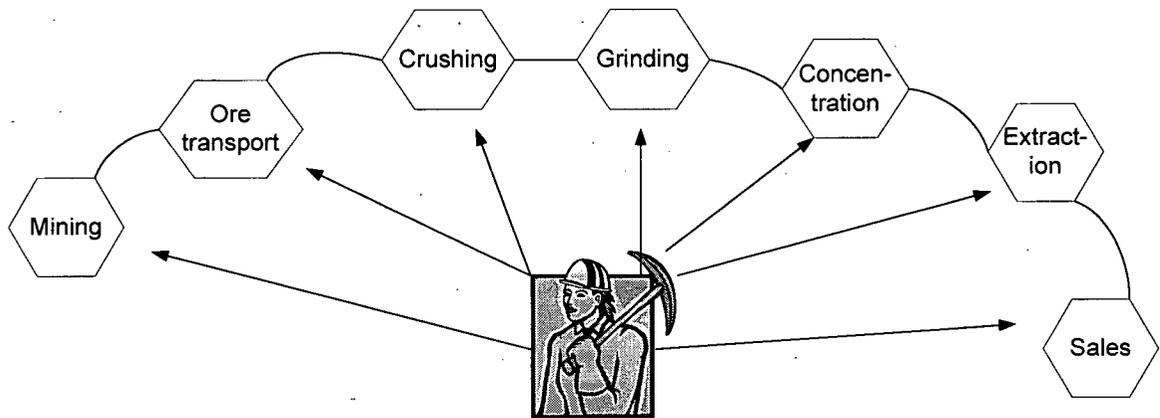


Figure 3.3 - Individual mining activities (Source: Bamber, 2005)

Small changes to planned workflow, and equipment selection and arrangement present challenges in terms of worker relocation and displacement, training, change behaviour and absence of trust.

Some organizational structures in place at the sites observed in Tanzania include the traditional village council, panners-, miners- and millers associations, sole proprietorships (claim owners) as well as milling centres (either individual, collective, toll or custom milling operations).

Organization among the individual miners is poor, as are relationships between miners and millers. These can be characterized by significant distrust and lack of cooperation (Mtetwa & Shava, 2003, Wagner, 2003). In addition to the problem of inefficiency, the current organizational structure allows for the exploitation of the disadvantaged by the advantaged – millers take advantage of miners' lack of knowledge and those with equipment can easily exploit those without who depend on them for mining and processing. Organizational structures that can

maximize benefits to the largest number of stakeholders, increase efficiency and foster cooperation and trust are ideal.

It was found that the current inefficient organizational structure (Scoble and Bamber, 2005):

- Provides the individual with perceived control over the process at the expense of time and profit.
- Perpetuates the lack of trust and lack of cooperative behaviours among workers who, in fact, share a common goal and may benefit from working together.
- Prevents individuals from pursuing alternative income activities with the available time that would result from group work.
- Averts opportunities to benefit from specialization, collective ownership of equipment and facilities, and increased production rates.
- Does not make use of improved Au processing technologies.
- Results in an unsafe working environment

In order to improve efficiency, the adoption of a set-up involving group work and co-operation is necessary. Facilities (e.g. tractor/trailers and the custom mill) are currently provided for individuals to use and do require basic forms of cooperation, business agreements and transactions, but these cannot be equated with optimal cooperative behaviour.

### ***3.3.2 Improving Organizational Structures: Cooperatives***

The GMP developed criteria for the selection of an improved business organization model for ASM sites based on the following considerations, principles and commitments (Scoble and Bamber, 2005):

- 1) Commitment to community capacity-building and infrastructure development
- 2) Emphasis on a cooperative work arrangement, to facilitate sharing of equipment and resources, and to provide maximum benefits to the collective.

- 3) Structure conducive to the encouragement/promotion of cooperative behaviours considered essential for optimal production.
- 4) Consideration, respect for and incorporation of traditional, local values – model selection is site-specific and should match culture, needs and values.
- 5) Shift from an inequitable distribution of benefits to the most equitable redistribution of benefits.
- 6) Minimization of negative socio-economic impacts of intervention and technology transfer
- 7) Commitment to training and education – selecting a model best suited to meet educational needs of workers.
- 8) Alignment with principles of 'best practice' and sustainable development.
- 9) Provision of best structure for optimal production, profit making and safe mining activities
- 10) Consideration of gender issues with the goal of enhancing women's lives, work, and participation.
- 11) Flexibility and ability to address different site-specific needs.
- 12) Consideration of the key findings of the sociological reports.

Analysis of the above criteria determined that the establishment of an organizational structure that requires and teaches cooperative behaviours and allows for the integration of improved technologies is optimal for ASM contexts in Tanzania. It was determined that the formation of cooperatives were a long term organizational goal for the GMP but that due to differing levels of capacity among miners and the various subgroups within ASM, improved organization, cooperation and trust in all types of work arrangements should be considered.

With improved organization, ranging from small organized work groups to larger cooperative structures, it is believed that miners and their families can access finance, technology and training, and consequently, enhance their standards of living.

Structured cooperation, albeit in the form of workers cooperatives or more basic organized work groups, has the potential to promote change behaviour and permanent acceptance of process modifications. Cooperatives, or alternative arrangements, require collectivistic behaviours that may be transferred into areas outside of production. These organized setups also demonstrate, via enhanced efficiency, the tangible benefits of cooperation and collaboration in ASM.

With work currently occurring mostly in an individualistic manner, the absence of cooperative behaviours is clearly a major factor resulting in inefficient functioning. Existing individualistic work arrangements could be greatly improved by shifting from individual work to a team of three dedicated people. This would include a miner, miller/concentrator, and a supervisor to look after transport. With the simple introduction of cooperation between workers, significant improvements in productivity can be realized.

In more basic organizational arrangements, improved cooperation between miners and others involved in mining activities could also be significant in terms of increased efficiency. This can be realized with the successful transfer of new technology (safer/improved mining methods), and capacity building (education, training and financing) as accompaniments to organizational enhancement. Increased efficiency is characterized by the adoption of improved practices, cessation of unsafe behaviours and inefficient processes, enhanced equity for stakeholders, augmented profits and higher production rates.

### ***3.3.3 Barriers to improved organization***

Barriers to the introduction of more efficient technology and complementary organizational structure can be understood in psychosocial terms. Psychosocial barriers arise as a result of either social or psychological factors, or a combination of both. A review of the sociological reports for Geita district and Kadoma-Chakari, and field reports from Bamber (2005), revealed several psychosocial barriers.

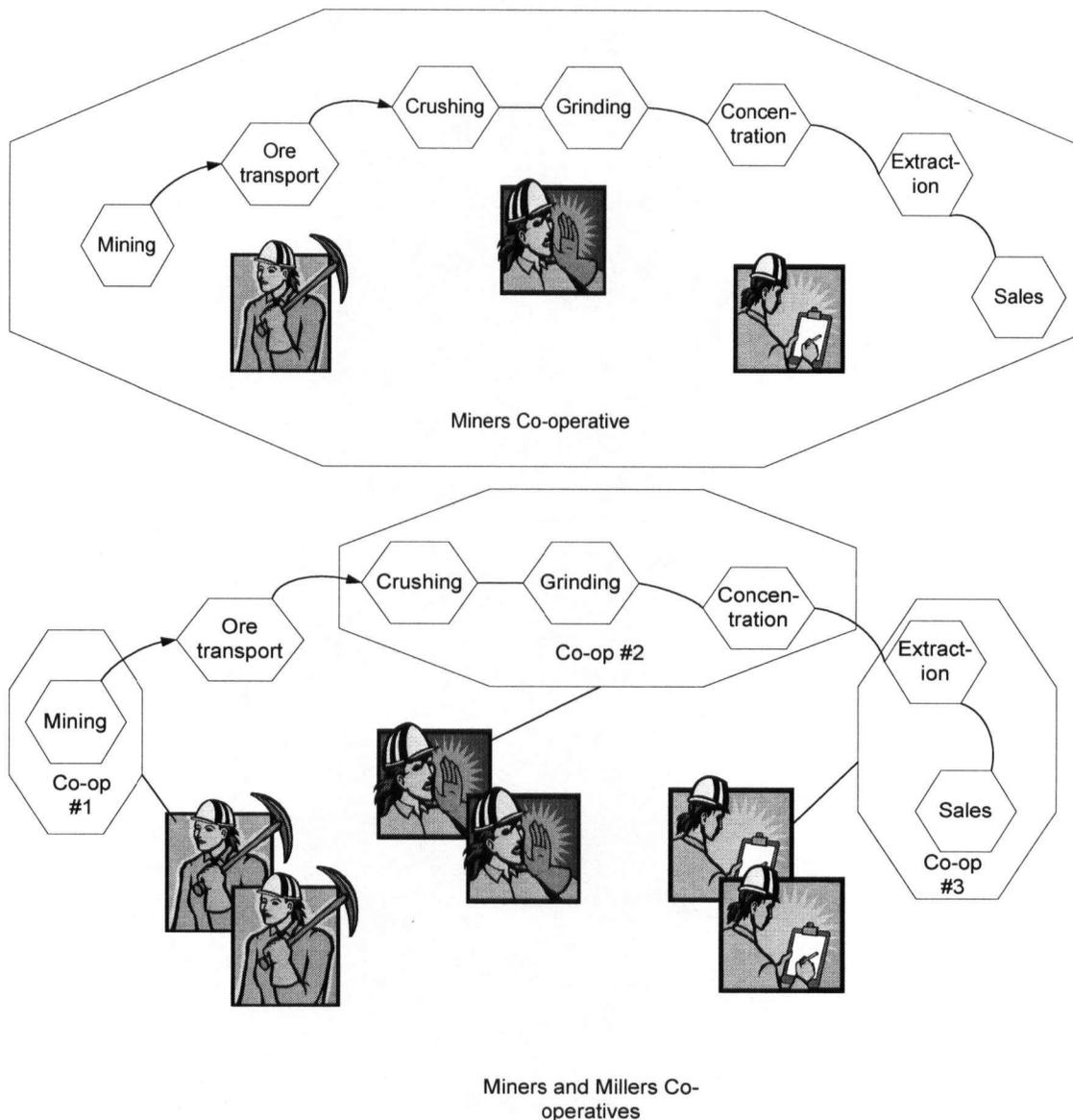


Figure 3.4 - Organizing mining activities (Bamber, 2005)

Mtetwa & Shava (2003) describes claim holders/miners feeling “short-changed” in business interactions with millers. They also report efforts to introduce retorts for mercury recovery at one site having failed as a result of miner’s scepticism and feelings of being cheated by the miller. Wagner’s (2003) focus group discussions with Mwanza Women Miners Association (MWAWOMA) members revealed problems with theft, lack of security at mine sites and underlying distrust. Bamber’s (2005) field observations support the concern that distrust acts

as a major obstacle to both increased process efficiency and the requisite cooperative behaviours.

Distrust in the ASM context occurs in relationships between miners, in interactions between miners and millers; and between 'miners and millers' and others. GMP research concluded that distrust among these groups be examined and understood in greater detail in terms of cause, significance, effects and possible methods to establish or rebuild trust.

Inadequate and/or ineffective leadership was also considered significant in the promotion of improved organization. Cooperative behaviour may be promoted by a greater understanding of the nature of leadership within each mining area and identification of potential leaders in the creation of a trusting work culture. Leadership is essential to a successfully functioning group and any efforts to create trust between distrusting parties can be facilitated by effective leadership.

It was also suggested that attempts to change organization within ASM be aware of incentives and motives of individuals involved. Some individuals may obtain what they perceive as sufficient benefits from the existing structure. There may be unarticulated social benefits from the existing structures and processes that provide adequate reason to resist change. A better understanding of the inherent social, cultural and personal value of present systems, tasks and roles was recommended.

In addition to a better understanding of trust, distrust, needs and incentives, understanding local values was also emphasized. Local values, the attitudes, normative frameworks, symbolism, and belief systems of a particular group or community determine how people interact and behave. Oduol's discussion of adaptive responses to modern technology by Kitui farmers in Kenya, emphasizes the importance of viewing economically ineffective and "backward" production practices as a "rational response to local conditions, and a logical adaptation to

perceived risks based on practical experience”(Oduol, 1991). The role of local values and traditional knowledge in the adoption of innovations, and an understanding of a community’s cultural orientation prior to intervention is required (Malhotra, 2001). Additional research should consider local values and their place in both existing and proposed alternative systems. As highlighted by Hinton et al (2003), the role of cultural beliefs and traditions, and their relevance to the nature of ASM, has been neglected in past research. Investigation and understanding of the socio-cultural context is integral to successful intervention.

A shift from individual units of production to an integrated system calls for the relinquishment of self-governed, self-regulated individual operations. The conditions under which miners will cooperate, collaborate and trust in an ASM context was deemed an essential precursor to organizational change.

This chapter has considered the work of the GMP in defining organizational challenges facing ASM communities and possible methods to address them. Emerging from the GMP work to date is strong evidence for the potential future use of a cooperative organizational structure to improve efficiencies. Developing cooperation and trust between miners on a more fundamental basis was considered of primary importance. The next chapter examines trust and cooperation in greater detail, with a view to showing the essential role these concepts have to play in establishing a foundation from which to improve ASM conditions through organization.

## **4 Understanding Trust and Cooperative Behaviours**

Trusting each other is the fundamental ingredient in any endeavour, be it in mining or any other activity for the mutual benefit of all and more specifically in reducing abject poverty in rural areas such as an ASM mining community like Rwamagasa (A.Tesha, Ministry of Mines and Minerals, Tanzania. 2006)

It is agreed upon by experts in ASM that improved organization of miners is key to any attempt to improve working conditions, productivity and address social, environmental and health impacts of ASM. Although other barriers to improved organization have been identified, addressing the absence of cooperative behaviours and lack of trust is paramount prior to the introduction of organizational alternatives. Understanding trust and cooperation, and how these exist in the Tanzanian ASM context is the first step.

### **4.1 Defining trust**

#### **4.1.1 Trust and Economic Interactions**

As Wicks et al (1999) note, there is a significant amount of literature on trust as an integral role in economic life (e.g. Gambetta, 1988, Smith, Carroll, & Ashford, 1995, Rousseau, Sitkin, Burt & Camerer, 1998, Misztal, 1996). Research defines trust as an essential component of efficient market exchanges (Arrow, 1974; Smith, 1981), and as key to fostering cooperation (Mayer, Davis, & Schoorman, 1995; Smith et al., 1995).

Trust can be understood as “a productive, economic asset...that appreciates in value through use” (Wilson & Kennedy, 1999:190) and as “an attitude that allows for decision makers to be vulnerable to harm in the interest of a perceived benefit” (Michalos, 1990). Trust derives from “mutual confidence that parties to an economic transaction will not exploit one another when one or both of the parties are vulnerable to opportunism” (Sabel, 1993). It requires from the

individual, a confidence, acceptance and belief in the honesty, integrity and reliability of another person's actions, words and intentions. Morrow et al (1999) distinguish between three types of trust: cognitive, affective and general. Objective by nature and resulting from a rational process, cognitive trust contrasts the subjectivity of affective trust which relies on mood, emotion and feelings to determine trustworthiness. General trust is understood as a broad evaluation one has for a person or collectivity. In addition to being the basis for relationships, trust can be considered essential to business interactions from basic systems of trade to more sophisticated corporate structures. Greenspan (1999) goes as far as placing trust "at the root of any economic system based on mutually beneficial exchange".

Lewiski and Benedict Bunker (1995:142) referring to Shapiro, Sheppard and Cheraskin's (1992) three types of trust in the formation of a business relationship: deterrence-based trust, knowledge-based trust, and identification-based trust. Deterrence-based trust can be understood in terms of ensuring consistency of behaviour (doing what one says) by threatening punishment. Knowledge-based trust comes from behavioural predictability – the possession of sufficient knowledge of the other to be able to predict choice of actions. Full internalization of the other person's intentions and desires is known as identification-based trust. "At this level, trust exists because each party effectively understands, agrees with, empathizes with and endorses what the other wants and can act for the other (Lewiski and Benedict Bunker, 1995:143)".

Wicks et al (1999) consider trust "a conditional good", pointing out that from both a moral and strategic perspective, either over-investing or under-investing in trust is undesirable. They suggest that misallocation of resources and unnecessary risk-taking may result from over-investing while under-investing can result in missed opportunities to develop organizational capabilities, and derive benefits from collaboration. As Wick et al (1999:102) note, underinvestment "bypasses opportunities for more efficient and mutually beneficial exchange and creates

significant added risks (e.g. opportunism) and costs (e.g. monitoring), while draining human interaction of a morally desirable trait. One can understand this perspective on trust in terms of ASM in Tanzania. Results from focus group discussions, interviews (Wagner, 2003; Scoble, 2006), and a literature review reveal that currently miners “under-invest”, missing opportunities to have more efficient production and mutually benefits from working in groups.

There exists a variety of perspectives on trust and the role it plays in social processes such as cooperation, coordination and performance. Worchel (1979) categorized perspectives into three groups: personality theorists, sociologists and economists, and social psychologists. “Personality theorists focus on individual personality differences in the readiness to trust and on the specific developmental and social contextual factors shaping this readiness”. From this perspective, trust is understood as a “belief, expectancy or feeling” (Lewicki & Benedict Bunker, 1995:135). Work by Rotter (1971) falls into this category as trust is considered “a generalized response derived from the reinforcement history of previous social interactions”. Worchel’s second group, sociologists and economists, view trust as an institutional phenomenon. Theorists like Neu (1991) discussed trust in two forms: personal trust (in people) and institutional trust (in organized systems). Lewicki & Benedict Bunker (1995:137) note that “in this view, personal trust develops to meet an individual’s need to reduce uncertainty in regularized social interactions; in short, people will buy from, sell to, and work with those whom they trust”.

As Lewicki and Benedict Bunker (1995:137) point out, the third group – social psychologists – look at “the transactions between individuals that create or destroy trust at the interpersonal or group levels”. In this case, trust is defined as an expectation that the other will behave in a certain manner – either pro-socially or not.

#### **4.1.2 Trust and Risk**

Trust can also be considered in terms of rational prediction, a calculative, risk-oriented approach to assessing outcomes (Wicks et al, 1999) – as “the mutual confidence that no party to an exchange will exploit another’s vulnerabilities (Barney & Hansen, 1994:176). It can be understood in the context of cooperation, as in the prisoner’s dilemma game (Lewis & Weigert, 1985), and as it is conceptualized in experimental economics (Wicks et al, 1999). It can also be understood in terms of risk mitigation in the way it safeguards against uncertainty in economic interactions such as freeloading, opportunism or cheating.

Focusing on interdependence (mutual dependencies between two parties), it is possible to conclude that in situations where risk exists for both parties, trust is important and feasible – serving as a type of coping device, the need for trust becoming increasingly important, as the amount of risk increases alongside it. Referring to work by resource dependence theorists, Pfeffer & Salancik (1978), Wicks et al (1999) suggest that interdependence offers both a conceptual link to trust and it highlights the importance of trust as a means to manage stakeholder interdependencies.

Trust can be examined in terms of orientation to risk (Bazerman, 1994). Lewiski and Benedict Bunker (1995:149) note that “in assessing the costs of cheating, and the associated probabilities, an actor’s perceptions are shaped by risk biases that predispose either party toward being exploited (we are naïve and risk seeking, trusting those who do not deserve to be trusted) or toward being suspicious (we are cautious and risk averse, not trusting those who deserve to be trusted)”. This risk aversion can prevent potentially valuable relationships from forming – it will be examined later in relation to fieldwork experiments with women miners.

Luhmann (1988:95) differentiates between familiarity and trust, by defining the former as “an unavoidable fact of life” and trust as “solution for specific problems of risk”. He considers familiarity as important in enabling a context within which trust can develop. Trust, according to Luhmann, is only necessary in the event that a negative outcome would cause an individual to regret their action.

Luhmann (1979) understood trust as a mechanism through which the uncertainty and complexity of future action could be managed and social action made possible (Weber & Carter, 2003). He locates trust within an interactional context stating that “trust occurs within a framework of interaction which is influenced by both personality and social system, and cannot be exclusively associated with either (Luhmann, 1979:6).

#### ***4.1.3 Trust: Affect, Character and Needs***

To fully appreciate the complexity of trust, Wicks et al (1999:100) point to affect, or emotion (Weiss & Cropanzano, 1996), referring to the emotional bond created between people “enabling them to move beyond rational prediction to take a ‘leap of faith’ that trust will be honoured (Lewis & Weigert, 1985)”. Additionally, they emphasize the moral component of the affective element that allows trust to occur. It is referred to it as “a belief in the moral character or ‘goodwill’ of the trustee in the trusting relationship (Wicks et al., 1999:100). Citing work by Jones (1995) they consider this emotional investment as that which safeguards against opportunism or higher agency or transaction costs to prevent it.

Mayer et al (1995) suggested that the decision to trust is determined by the trustworthiness of the trustee. Three criteria determine “trustworthiness”: ability (competence to perform task), benevolence (goodwill toward trustor) and integrity. Wicks et al (1999:111) note that “agents who are more likely to be trusted will shun opportunism and act with dependency, fairness and respect and will keep their promises – all factors that limit the range of strategic thinking and

emphasize the complex mixture of rationally predictive and affect-based belief in moral character elements necessary to create trust”.

Gambetta (1988:217) provides the following definition of trust:

“Trust, (or, symmetrically, distrust) is a particular level of the subjective probability with which an agent assesses that another agent or group of agents will perform a particular action, both before he can monitor such an action (or independently of his capacity ever to be able to monitor it) and in a context in which it affects his own action. When we say we trust someone or that someone is trustworthy, we implicitly mean that the probability that he will perform an action that is beneficial or at least not detrimental to us is high enough for us to consider engaging in some form of cooperation with him”.

Seligman (1997:43) defines trust as a “belief in the goodwill of the other, given the opaqueness of other's intentions and calculations”. Trust is dynamic and continuous so that as relationships unfold “individuals continually update their information base and their decision to trust (Wicks et al, 1999:101). It is this dynamic nature that enables individuals to create or rebuild trusting relationships based on a series of contextually appropriate actions that reinforce decisions to trust and trustworthiness. An example of such actions within an ASM context could be a series of shifts whereby a group of workers pool the fruits of their labour (ore they have collected during a shift) without incidence of freeloading, hoarding or deception. It can also manifest in small groups of artisanal miners making safe after completing their shift, honestly communicating production information and adhering to collectively defined rules.

Griesinger (1990:481) “in an exchange, stakeholders value resources that correspond to their purposes, fulfill their needs, or enable them to progress toward their goals. Value is added when the actions or resources generated by one party to an exchange contribute to the needs or objectives of another party”.

#### **4.1.4 Trust and Context**

Trust “is socially embedded (Granovetter, 1985), existing in context, and is shaped by dynamics specific to particular social settings” (Wicks et al, 1999:101). Within the context of ASM in Tanzania, trust would manifest differently dependent on the specific activities, individuals involved and relationships of parties. For artisanal and small-scale miners and their communities, poverty and food insecurity perhaps serve as forces that intensify the need for cooperation and trust, as survival can depend on the actions of others, but they may also create pressure in terms of sustaining trust, hence making it highly vulnerable even to minor violations.

Upon consideration of all the above conceptualizations of trust the following definition of optimal trust provides a useful summary of the type of trust most desirable for successful cooperation in organizational structures in ASM:

“Optimal trust exists when one creates and maintains prudent economic relationships biased by a willingness to trust. That is, agents need to have stable and ongoing commitments to trust so that they share affect-based belief in moral character sufficient to make a leap of faith, but they should also exercise care in determining whom to trust, to what extent, and in what capacity. Optimal trust is an embedded construct, suggesting that it is determined in context and shaped by a variety of factors, such as the trustworthiness of the agent, local and broader social norms regarding trust, and other features of the relevant social structure(s) (Wicks et al, 1999:103)”.

#### **4.2 Cooperation**

Williams (1988:7) suggests that “two agents cooperate when they engage in a joint venture for the outcome of which the actions of each are necessary and where a necessary action by at least one of them is not under the immediate control of the other”. This definition can be generalized to groups of more than

two. He further adds to this by defining different 'motives to cooperate':  
"cooperation is a symmetrical relation: if X cooperates with Y, Y cooperates with X. 'Depends on', however, is a non-symmetrical relation: if x depends on Y – in the sense that his getting what he wants of the venture depends on Y doing his part – it may or may not be the case that Y depends on X (Williams, 1988:7). If we focus on cooperation, attempting to determine what is required for continued practices of cooperation, Williams(1988) suggests that a motivation to enter into dependent positions is a prerequisite, requiring assurance that the other(s) will not defect. This assurance that others will not defect can be understood as trust.

Good (1988:33) understands cooperation as "a central manifestation" of trust. For cooperation to occur, individuals require a certain degree of trust to be able to invest in a joint endeavour during which defection is possible.

"Trust as a precondition of cooperation can be subjected to demands of differing intensities: it may be needed to varying degrees, depending on the force of the mechanism that govern our cooperative decisions in general and on the social arrangements in which those decisions are made (Gambetta, 1988:220).

Griesinger (1990:489) proposes that "cooperation and trust increase more significantly when reciprocated in kind (with a closely related particularistic resource) than when reciprocated with a less similar resources.

Moreover, cooperation and trust will decrease and negative opportunism will increase if resources that are desired and expected in an exchange relationship are withheld". Examples of this can be seen in ASM in Tanzania with millers exploiting miners and miners distrusting in return. Challenges to getting miners to work together involve overcoming past damage caused by breaches of trust, where theft, dishonesty and advantage-taking have created a culture of distrust.

According to Vanderslice (1995:175) "a significant body of research has demonstrated the beneficial effect of cooperation on productivity, morale,

motivation and effectiveness". Citing Deutsch (1949:20), she defines a cooperative situation as "one in which the goals of the participants are so linked that any participant can gain his goal if, and only if, the others with whom he is linked can attain their goals. Cooperative behaviour, then involves coordination of efforts" (Vanderslice, 1995:176).

Vanderslice (1995) points out that Deutsch's theory of cooperation is based on the notion that goal interdependence creates a cooperative situation. Deutsch (1949) considers substitutability (the degree to which one person's actions can substitute for the other), inducibility (degree of influence one person has over the other) and positive carthexis (a positive attitude towards the other person) as components of promotive interdependence, enabling cooperation and long-term relationships (Lewicki and Benedict Bunker (1995).

#### **4.3 Cooperation and Trust-building**

"Cooperation frequently makes some demand on the level of trust, particularly on mutual trust. If distrust is complete, cooperation will fail among free agents. Furthermore, if trust exists only unilaterally cooperation may also fail, and if it is blind it may constitute rather an incentive to deception (Gambetta, 1988:219)".

Shapiro et al (1992) propose four activities that build trust. The first is commonalty in name (collective identity). This may take the form of mergers or mission statements, it reminds those involved of the collective intentions. In the case of ASM it may be a name for a group of workers, or a joint venture. Colocation is another way to build trust as it ensures contact is maintained. It can take the form of sharing a linking vehicle such as a tool or production schedule.

In ASM this may occur through equipment sharing and a work flow pattern. The creation of joint products and goals is another means of strengthening identification with others. In ASM this may take the form of a production goal. The

final means by which trust can be developed is through having shared values, beliefs and concerns. Shared values and concerns in an ASM context may relate to economics, health, safety, and environment. A group may share concerns regarding the importance of using protective gears.

Attempts to build trust among distrusting parties involves the identification of a shared goal. Establishing a link between trusting behaviour, enhanced quality of life and increased economic wellbeing is crucial. The key shared goal in ASM is the production of gold. Unless this is to be an individual effort, as we have seen, trust and co-operation are required to maximize that shared goal: co-operation to increase the quantity of gold produced, and trust that it will be sold and the profits divided equitably. A second example of a shared goal could be safety in the pit – one worker relies on the previous worker to have made safe after working, providing a safe workplace for the next worker.

The following ASM-specific model demonstrates the significance of trust and cooperation for organization of miners and hence, improvements to problems encountered in the ASM sector. The following factors were considered:

- Reported and observed lack of trust and cooperative behaviours between those involved in ASM;
- Reports of 'lack of trust' impeding the introduction of improved technology and organizational change;
- Trust as a primary determinant of cooperation; and
- Trust and cooperation as essential for organization of miners into cooperatives, trust groups or basic work groups.

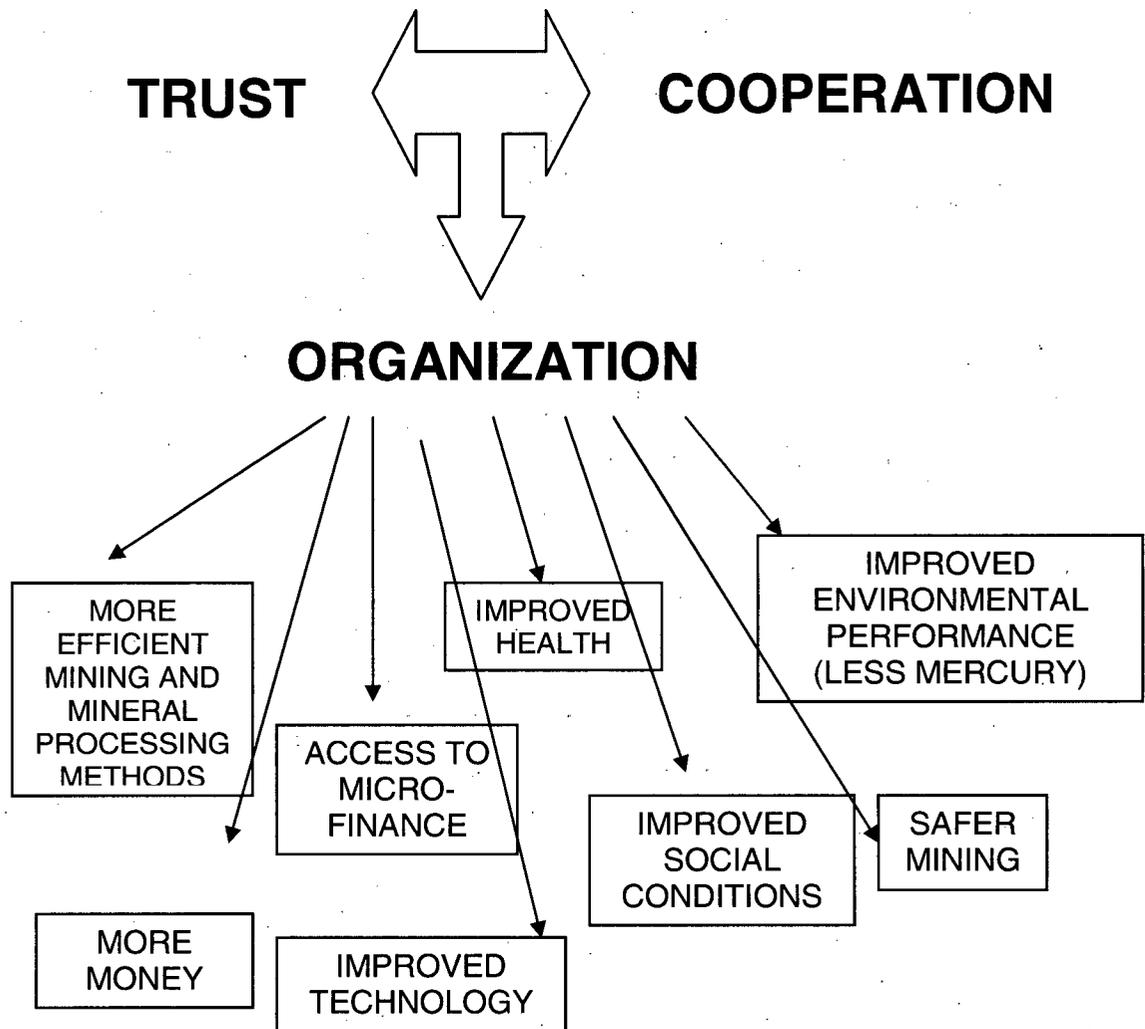


Figure 4.1: Required Components for improvements in ASM

Having obtained an overall understanding of trust and cooperation, and having determined that they are essential for organization in ASM, understanding these components within a Tanzanian ASM context is required. To better understand how cooperation and trust function in this environment, we turn to economic games for insight and method.

## **5 Economic Games**

This chapter provides a brief overview of economic games. Conclusions and ideas related to cooperation and trust from experts in experimental economics are considered and four particular games adapted for research with a Tanzanian ASM subgroup are described. This chapter provides background information from which the reader can understand the intent of adapting economic games for the dual purposes of improved understanding of trust and cooperation in ASM groups and as an educational tool in the promotion of cooperation in groups of miners.

### **5.1 Economic Games**

Economic games, used in experimental economics (the use of experimental techniques to assess predictions of economic behaviour), come from Game Theory – “a mathematical language for describing interactions and their likely outcomes. Economic games consist of two different enterprises: 1) using games as a language or taxonomy to parse the social world; and 2) deriving precise predictions about how players will play in a game by assuming that players maximize expected utility (personal valuation) or consequences, plan ahead and form beliefs about other players’ likely actions (Camerer and Fehr, 2004:58)”.

Game theory works on the premise that individuals behave rationally. It is believed that although people are not always rational, they choose actions that provide them with the highest payoff when choices are simple and situations are straightforward (Glance and Huberman, 1994).

Games represent real-life situations where economic interactions require decision making, beliefs and actions that benefit either the individual, the group or both agents.

### **5.1.1 Games and cooperation**

Gambetta (1988:216) notes that “game theory has provided us with a better understanding of why cooperation may not be forthcoming even when it would benefit most of those involved. As Binmore and Dasgupta put it in their survey on the subject; ‘it is a major and fundamental error to take it for granted that because a certain cooperative behaviour will benefit every individual in a group, rational individuals will adopt this behaviour’ (1986:24). Irrespective of individual rationality and motivation, cooperation may still fail to take place”.

This will be exemplified in the application of economic games with a group of reef pickers<sup>7</sup> at Blue Reef Mine (see chapter 6) and can be generalized to artisanal miners in other contexts. It has been assumed, albeit by well-intentioned efforts to improve ASM in terms of productivity and safety, that because cooperation in the form of working together towards a shared production goal, is beneficial, people will adopt cooperative behaviour. The situation with artisanal miners throughout Tanzania, and the GMP participating countries proves otherwise.

It is also possible to understand a social dilemma in the context of games. “A social dilemma involves a group of people attempting to provide themselves with a common good in the absence of central authority (Glance and Huberman, 1994:77). In situations of this nature, all members of the group benefit from the equitable division of the common good, so an individual is faced with a choice between contributing to the common good or free-riding on the sacrifices of others. The common good increases by a fixed amount with each individual who decides to cooperate. The individual who cooperates receives back a small portion of the added value but this return is reduced by free riding - benefiting without contributing. Working together in mining groups functions according to the same rules – if everyone participates and cooperates, everyone benefits. If individuals choose not to cooperate benefit is reduced, the potential for inequity

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<sup>7</sup> “Reef Picker” is a local term used to refer to people who sort rocks in the waste rock dump at Blue Reef Small-Scale Gold Mine.

increases and production tends to suffer as trust deteriorates from defection. Cooperation has costs to the individual and the return must outweigh those costs in order for cooperation to continue.

Glance and Huberman (1994:78) note that “when an individual realizes that the costs of cooperating exceed her share of the added benefit, she will rationally choose to defect and become a free-rider. Because every individual faces the same choice, all the members of a group will defect. Thus, the individually rational strategy of weighing costs against benefits has an inferior outcome: no common good is produced, and all members of the group are less well off than they could be”. In game situations that are repeated, and not one-shot situations (in the single round Prisoner’s Dilemma<sup>8</sup>, the optimal strategy is to defect), decision making requires careful consideration of the consequences of defection or cooperation. Choices are affected by expectations – by plans, beliefs, objectives and perceptions.

Nowak, Robert & Sigmund’s (1995) examination of repeated versions of the Prisoner’s Dilemma found that when individuals anticipate future interactions they are forced to consider what affect their defection will have on the future action of the other player – it may encourage defection. The strategy in repeated games like this is influenced by actions occurring in previous rounds.

Lewicki & Benedict Bunker (1995:133) note that “observation of the relationship development process between subjects in simple experimental research game paradigms shows that cooperative behaviour can be developed over a long series of predictable moves by the parties. But this cooperation can be rapidly destroyed if one party decides to defect – and can be even more destructive if

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<sup>8</sup> In the prisoner dilemma, a judge has two prisoners that are accused of a crime. Each is told that if one confesses but the other does not, the confessor will serve one year while the other will serve 10 years. If both confess they will each get five years. If neither confess they will both serve three years. It is considered a non-zero-sum game in which two players can cooperate with each other or defect (betray one another). Since defection is more beneficial to the individual than cooperation, rational player should choose not to cooperate.

the defection occurs after the parties have made some explicit agreement to coordinate their moves (Deutsch, 1958; Deutsch and Krauss, 1962)”

Glance and Huberman's (1994) mathematical theory of social dilemmas found that cooperation was sustained only in group of a specific size, and that the size was determined by the duration the individual expected to be a group member. They also found that the quantity of information available to group members was significant and that there could be occurrences of sudden and unexpected general cooperation and defection.

Experimental research of the 1980s and 1990s reveals that a significant percentage of people in developed countries care about both their own payoffs and the payoffs of others (Camerer and Fehr, 2004). These experiments have mostly involved college students but the results suggest that people may be less self-interested<sup>9</sup> than researchers previously assumed. “The willingness to reduce or increase payoff of relevant reference actors exists even though people reap neither present nor future material rewards from reducing or increasing payoffs for others.

This indicates that, in addition to self-interested behaviour, people sometimes behave as if they have altruistic preferences and preferences for equality and reciprocity<sup>10</sup> (Camerer and Fehr, 2004:55)”. Camerer and Fehr (2004:56) distinguish reciprocity from altruism, understanding the former as “behaviour conditioned on the previous actions of another actor” and the latter as “unconditional kindness”. They add that social life and social norms are greatly affected by social preferences, such as reciprocity, inequality aversion and altruism, citing food sharing as an example. The lack of formal mechanisms for

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<sup>9</sup> Self-interested, as defined by Camerer & Fehr (2004:55) refers to “people who do not care about the outcomes to others”.

<sup>10</sup> Reciprocity, according to Camerer & Fehr (2004:55) “means that people are willing to reward friendly actions and punish hostile action although the reward or punishment causes a net reduction in the material payoff of those who reward or punish”.

governing the sharing of food results from preferences such as inequality aversion or reciprocity. People willingly punish those who do not share – hence there is not need to create formal means of enforcing the social norm.

Wicks et al (1999) refer to Messick's (1994) version of a prisoner's dilemma computer simulation partnered unconditional cooperators (saints), unconditional defectors (rogues) and conditional cooperators who cooperate only with cooperators (pragmatists) he found the latter to be the most effective strategy. This demonstrates that "a bias toward trust, shaped by prudence offers an appropriate balance for economic relationships". They add that "research on enactment and trust in economic relationships also reinforces the idea that a bias toward trust is beneficial" and that "skeptical or indifferent behavioural attitudes can undermine potential for developing trusting relationships" (Wicks et al, 1999:104). This is an interesting perspective when considered in terms of ASM. It raises the question as to whether there exists a bias toward trust, shaped by prudence, in artisanal and small-scale miners. How individuals engaged in ASM play economic games may shed some light on the nature of trust and cooperation, and on possible steps to address issues of distrust and lack of cooperative behaviours.

In Axelrod's (1984) tournament of various strategies in a repeated play prisoner's dilemma, the winning strategy was "tit for tat". This signified an opening play of cooperation with subsequent plays that copied the previous behaviour of the other player. The strategy included punishment for opportunism and forgiveness accompanied by a return to cooperation. In terms of strategic efficiency, this approach was greater than approaches that were "fundamentally uncooperative (e.g. defection) or universally cooperative (Wicks et al, 1999:103)". When Axelrod altered the game slightly, preventing the identification of the opponent's last move, the strategy became 'tit for two tats' – two defections resulted in retaliation. This strategy demonstrates the inclination towards trusting with a desire to punish uncooperative behaviour and encourage trust in partners (Wicks

et al, 1999). If punishment for uncooperative behaviour is found among miners it might suggest an inclination towards trust and a cooperative mentality that could factor into strategies for improving organization.

Good (1998) referring to work by Pruitt and Kimmel (1976) on the Prisoner's Dilemma Game, draws attention to the importance of participant perspective on the duration of the interaction, albeit short-term or long-term. Behaviour was found to be more cooperative among those who believed the interaction with the other participant would continue after the game. This is also an important consideration for how miners might play economic games given the dependence on others in non-mining contexts within mining communities.

Good (1998:36) also notes that "the greater the amount of communication there is between the players in a wide variety of games, the greater the likelihood of there being a mutually beneficial outcome". With communication and duration of interaction as important considerations, Good (1998:37) suggests that cooperation and trust can develop in situations where "the long term interests of the participants are stressed, where only a small initial or additional rewards are at stake, where there is no potential for threat and great potential for successful communication in that the ambiguity of the situation is reduced, and where the participants are in free and easy contact".

Reputation is also examined as a factor influencing outcomes in games. Dasgupta (1988) and Good (1988) stress the importance of establishing a favourable reputation as an economic agent and the role of reputation in decision making around trust. Dasgupta (1998:70) goes as far as to say that "people invest resources for the purpose of building a reputation for honesty". As Dasgupta (1988:50) emphasized in his discussion of trust as central to all transactions, "the threat of punishment for errant behaviour must be credible, else the threat is no threat". Reputational risk might account for decisions to

cooperate in communities where mutual assistance and interdependence are commonplace.

Andreoni and Samuelson's (2006) discussed designing interactions for optimal economic efficiency through encouraging cooperation, based on evidence from economic experiments (Prisoner's Dilemma) that suggests people "have tastes for cooperation, that at times, override economic incentives to the contrary" (Andreoni & Samuelson, 2006:1). It is this proclivity towards cooperation that may shed light on how to construct and promote the most efficient organizational design for groups within ASM. Enhancing the organization of groups of artisanal and small-scale miners requires an understanding of the group's current levels of cooperation, levels of trust and mistrust, and inclination towards cooperation.

## **5.2 Games Selected**

The following section provides an overview of four economic games that were adapted for use in an ASM context. These games provide an opportunity to understand the nature of trust and cooperation as it currently exists in ASM, as well as explore the potential to use economic games as a tool in the promotion of cooperation and trust in these contexts.

### **5.2.1 *The Ultimatum Game (UG)***

In this game a participant ("proposer") is requested to divide a sum of money with another participant ("responder"). If the "responder" accepts the amount offered, each player receives a portion of the money – the "responder" keeps the amount offered and the "proposer" retains the amount minus the offer. If the "responder" rejects the offer, both players receive nothing. "The ultimatum game elicits the responder's propensity to hoard or share and the responder's propensity to accept or punish." (Marlowe, 2004:168)

Standard Economic Theory suggests that since something is better than nothing, "responders" should accept any offer greater than zero. "Proposers" should,

accordingly offer the smallest non-zero sum. Camerer (2003) points out that the modal offer in complex societies is well above this amount – it is usually 50%. This is understood as being irrational until one considers that “responders” tend to reject small offers (one in two offers of 20% is rejected) (Marlowe, 2004). It is assumed that potential for punishment (rejection of offer) should result in higher offers in the Ultimatum Game than in the Dictator Game. “The rational offer would be zero in the dictator game, as there is no possibility of rejection, and 10% in the Ultimatum Game, it is rational to offer enough to avoid rejection – with an acceptable degree of risk.” (Marlowe, 2004:170)

### **5.2.2 The Dictator Game (DG)**

The Dictator Game is played the same way as the Ultimatum Game except that the responder does not have the option to reject an offer. While the Ultimatum Game reveals how people behave when there are potential costs, the Dictator Game “reveals how willing people are to share without such costs, thus revealing more about internalized norms of fairness.” (Marlow, 2004:168) By removing the fear of punishment, a greater understanding of an individual’s generosity and sense of fairness is obtained.

### **5.2.3 Public Goods Game (PGG)**

In the Public Goods Game, players simultaneously decide about their contribution to a common pot. They anonymously contribute 0-100% from an endowment. The total contributions are doubled and divided by the total number of players. Players benefit most if they contribute nothing but contributions from all players benefit everyone. For example, if four players contribute 100% of a \$100 endowment, each person receives \$200. If they each contribute nothing, each player receives the same as the original endowment. This game is similar to real life situations such as team compensation, cooperative production in simple societies, and overuse of common resources like water. Players are expected to reciprocate anticipated cooperation (Camerer & Fehr, 2004).

### **5.2.4 Grab game**

The grab game (Harvey, 1998) consists of placing 5 candies (or other “easy to grab” object of value) in a bowl. Participants gather around the bowl. They are instructed to get as many as they can by taking them out of the bowl. Any candy touched by one participant cannot be taken by another, and any touched candy must be taken. The game begins with 5 candies in the bowl and the amount doubles every 10 seconds. If, at any time, the number of candies drops below 5, the game immediately ends.

Harvey (1998:215) notes that “generally participants will immediately grab for the [candies]” and that “sometimes the group will wait, but inevitably someone will make a move to get a handful of [candy] from the bowl, which causes the others to grab for the [candies] and ends the activity”.

This game illustrates how cooperation results in greater benefits to the individual and to the group. By waiting for the amount of candies to increase, and avoiding grabbing, the quantity in the bowl increases significantly and with cooperative behaviour, all participants can obtain a better payoff. In terms of pursuing one’s own self interest, an individual can maximize his/her own gain by defecting later in the game; when the amount has increased, however, group cooperation is required to allow the number of candies to augment. The greatest good to the greatest number of people is only possible with cooperation.

“In the Grab Game, defection by individual players reduces the reward earned not only by others but by the persons grabbing, since players give up opportunities of receiving higher payouts in the future by grabbing early (Harvey, 1998:219)”.

### **5.3 Experimental Economics in Small-Scale Societies**

#### ***5.3.1 Overview of research in economic experiments***

Roth et al (1991) conducted one of the first cross-cultural comparisons in the Ultimatum Game (UG). Minor differences were found in “the distribution of offers and acceptances between student populations in Pittsburgh, Tokyo, Ljubljana and Jerusalem, each of these samples were university populations living in industrialized nations with a long history of market economies (Gurven, 2004:7)”. Experimental data indicates that people behave similarly in the UG in different places throughout the world. “In studies from places as different as Ljubljana, Pittsburgh, Tokyo (Roth et al., 1991), Yogyakarta (Cameron, 1999), Tucson (Hoffman et al., 1994) and Los Angeles, proposers make similar mean offers (40-50 percent the total) and responders frequently reject low, “inequitable” offers (Henrich, 2000:974)”.

Gurven (2004) cites work by Henrich (2000) among the Machiguenga of Peru, where the UG offers were low and there were few rejections. Henrich also found low contributions in the Public Goods Game (PGG). Further research among South American forager-horticulturalists, the Tsimane, Ache and Achuar, revealed no rejections in the UG, with many offers being below 50%.

Gurven (2004:7) notes that “the extent to which cooperation is essential for daily subsistence or welfare determines cross-cultural variation in contributions to the common pot in the PGG (Henrich et al., in press; Gurven, in press)”.

### **5.4 Summary of Results of Economic Experiments by Heinrich et al**

The most dramatic cross-cultural bargaining experiments in small-scale societies resulted from an interdisciplinary collaboration between eleven anthropologists and several economists (Henrich et al, 2001, 2002). The locations of the small-scale societies studied are shown in Figure 9. This work came out of research done by Henrich (2000) involving ultimatum experiments with Machinguenga

farmers in Peru. Comparing the Machiguenga offers with those in other subject pools, Henrich observed that the Machiguenga accepted almost all offers (except one) and offered significantly less than in all other subject pools (average 26%, mode 15%). He postulated that social and economic isolation of the group resulted in behaviour consistent with the game-theoretic (self-interest) prediction. From this work Henrich hypothesized that culture had a huge effect on the UG outcomes and a cross-cultural comparison of Ultimatum and Public Good games ensued (Camerer, 2003).



**Figure 5.1: Locations of small-scale societies studied by Henrich et al (2005:799)**

#### **5.4.1 Results of Public Good Game**

According to Henrich et al (2004), the mean contribution in student populations is between 40-60% with wide variance, with most contributing nothing or all. Henrich et al (2004:22) found that “typical distributions of Public Goods Game

contributions from university students have a U-shape with the mode at full defection (those who contribute zero) and a secondary mode at full cooperation (those who contribute everything to the group)". The mean for the Machiguenga is 22 percent resulting from a mode at full defection and an absence of cooperative contributions (Henrich et al, 2004). The study also revealed similar mean results to the student populations were found among the Tsimane and Ache (40-60%) but had "distributions with few or no contributions at full free riding and full cooperation (Henrich et al., 2004:22)".

Several conclusions resulted from the PGG in Henrich et al's study. Players contributed 50% of the endowment in one-shot games. There was a progressive decrease in contributions with series of games. The majority chose to offer 0 in final round. Communication between players strongly increased cooperation and individual punishment greatly increased contributions (Camerer & Fehr 2004).

#### ***5.4.2 Results of Ultimatum Game and Dictator Game***

In results of UG from Henrich et al's (2002) study of 15 societies, the mean offers from proposers ranged from 25-57 percent, compared to a mean between 42 and 48 percent with student populations. Among the Kazakh, Quichua, Ache and Tsimane, there were zero rejections. The Ache accepted offers that were generally equitable, however, "47 percent of offers to Tsimane and 57 percent of the offers to Quichua were at or below 30 percent – yet all were accepted (Henrich et al., 2004). There was one rejection among the Machiguenga despite over 75 percent of offers being below 30% of the total.

The Hadza of Tanzania rejected 24 percent of offers, 43 percent of which were for offers of 20 percent or less. Henrich et al (2004) note that in the university student populations (Roth et al., 1991) there are more rejections than average, placing them at the top end of the rejection scale. These student respondents, however, rejected less than the Au, Gnau, Sangu, and Hadza – all of whom rejected a larger number of positive offers.

Dictator Game results yielded offers in contrast to the predictions of self-regarding models and were unlike those of university student populations. “Mean offers among the Orma, Hadza, and Tsimane, respectively, were 31, 20 and 32 percent of the pie. These mean dictator offers are 70, 60 and 86 percent of the corresponding mean Ultimatum Game offers for these groups (Henrich et al., 2004:27). It is also important to note that among these groups there were little to no offers of zero, whereas the modal offer for the student samples is usually zero (Henrich et al, 2004).

Henrich et al (2004:22) concluded that “the selfishness axiom was violated in every society we studied across all three different experimental games [PGG, UG, DG]”. In the UG, the axiom was violated by both players, the proposer alone or the responder. Proposer behaviour, according to the study, was ‘consistent with income maximizing behaviour among only two groups, the Hadza and Sangu Farmers (Henrich et al, 2004:24). Both of these groups are from Tanzania.

Camerer (2003) highlights the following results from Henrich et al’s (2002) study:

- In 10 of the 15 cultures studied, average and modal offers are lower than offers in developed countries;
- Rejection rates tend to be low but vary;
- Offers are consistently above the utility-maximizing offer;
- Many subjects reported offering a lot to avoid causing problems in their village;
- Two cultures, the Ache Headhunters of Paraguay and the Lamelara whalers of Indonesia, offered an average of more than half. “Anthropologists think that these hyperfair offers represent either a norm of over-sharing because game caught in hunt cannot be consumed privately, or a potlatch or competitive gift-giving. Accepting an unusually generous gift incurs an obligation to repay even more. Hyperfair offers are often rejected, consistent with the competitive

gift-giving interpretation (Camerer, 2003:72)". Camerer (2003) adds that offers of this nature indicate that "self-interest is typically violated in these games [and that] offers and rejections are a language with nuance and cultural variations" (Camerer, 2003:72).

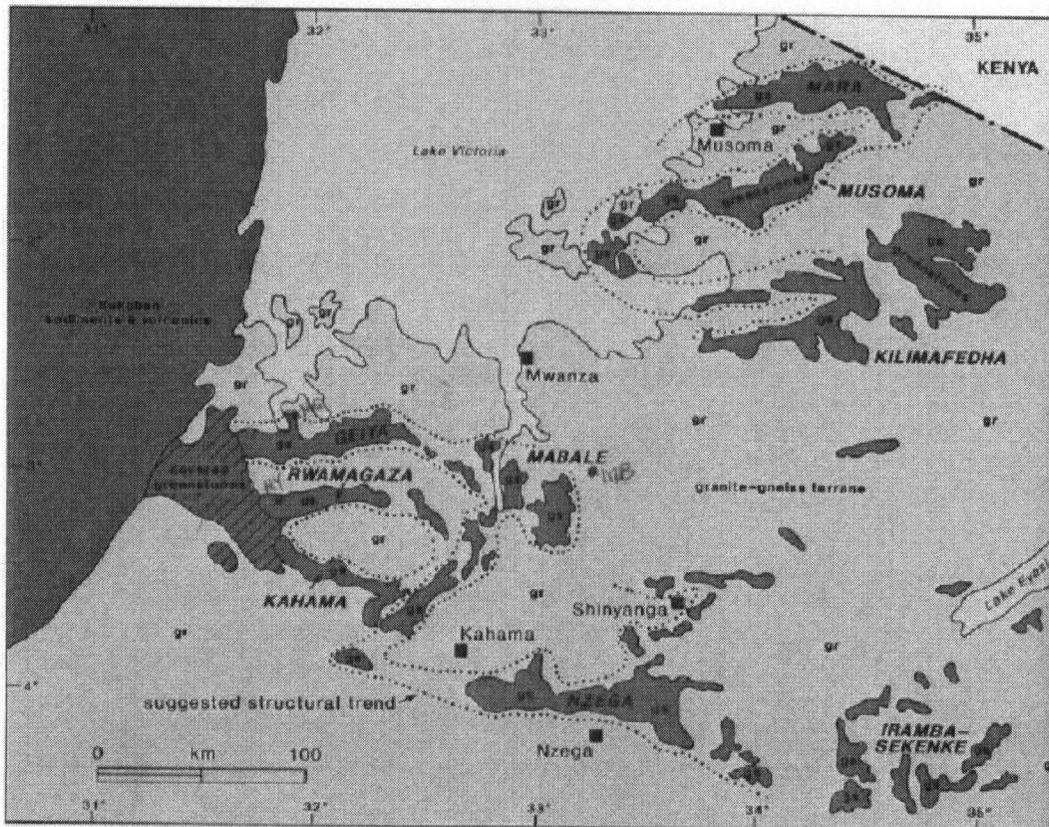
This chapter has illustrated how results from economic games can provide an insight into cooperation in varying cultural contexts. It has also demonstrated how cooperative behaviour can be influenced by fear of punishment, perception of others as free-riders or cooperators, reciprocity, norms of fairness, reputational risk and communication. Economic games are a useful tool in understanding orientation towards cooperation. The following chapter uses economic games in the context of artisanal and small-scale mining in Tanzania to obtain a greater understanding of the nature of cooperation and trust in this environment.

## 6 Background to Field Studies in Rwamagasa, Tanzania

This chapter provides an overview of the context within which economic games were conducted in Rwamagasa, Tanzania. It begins with an overall description of ASM in Rwamagasa, Geita District, followed by a more specific examination of the mining context at Blue Reef Small-Scale Gold Mine where the sample population is found. Information is also given to paint a picture of the work conducted by the subgroup of workers at the mine, demonstrating current work inefficiencies with a model for improved efficiency and organization.

### 6.1 Description of Rwamagasa, Geita District

The following map is of Rwamagasa, Geita District. Located to the south of Lake Victoria and southwest of Mwanza Town, it is one of several areas of small-scale gold mining success in the district.



**Figure 6.1 - Map of Rwamagasa, Geita District**

(Mwaipopo et al, 2004: 35)

In Tanzania, the most significant ASM sites are in the Lake Victoria Goldfields, in particular the Geita, Rwamagasa, Kahama, Musoma-Mara, Nzega and Kilimafedha belts, which produce more than 95% of the country's gold (Hinton & Veiga, 2004). Impacts to the environment and on human health are the most intense in these areas, especially in Geita which accounts for the largest number of miners and is comprised of four major ASM centres, Nyarugusu, Nyakagwe, Mgusu and Rwamagasa (Wagner, 2003).

Rwamagasa village is located in the heart of the Rwamagasa belt where "gold mineralisation occurs in quartz veins as well as secondary enrichment in rubble at the base of laterites overlying subsurface greenstone rocks (Hinton & Veiga, 2004:3).

Wagner (2003), reports that in 2002 the population of Rwamagasa was estimated at 26,990 (13,879 males, 13,111 females). She notes that most people tend to rely on ASM in conjunction with livestock, farming and fishing, with the majority relying solely on ASM (54%). Wagner's 2003 sociological report of the area found that 14% conduct mining in conjunction with farming and small business enterprises, 9% practice farming alone, 7% buy gold and other minerals and 5% operate bars, hotels and guest houses. It is important to note that "the difficulty in estimating the number of people engaged in small-scale mining arises from its informal nature in many locations, lack of official data, the transient and seasonal nature of its activities, and problems of definition (Jennings, 2003:153). Determining the exact number of miners in the Rwamagasa area is close to impossible.

According to a sociological survey of the area 64% of residents earned below TSh 50,000 per month (US\$48.40/mo), with 24% earning between TSh 51,000 and 100,000 (US\$44-88) and 3% making more than TSh 200,000 per month (US\$176) (Wagner, 2003). Wagner (2003) notes a country-wide trend towards

spending more than the income earned by a primary occupation. This, she suggests, accounts, to some extent, for the significant number of people participating in more than one economic activity.

In terms of education, Rwamagasa has a teacher: pupil ratio of 1:98. This is almost double the national standard. The significant number of drop-outs is attributed to the need to work, as many are forced to assist their families in order to survive. Wagner (2003) reports that 72% of 250 people surveyed had primary education, 11% had secondary and 27% were illiterate.

Wagner (2003) observed that health services in the area are inadequate, that there are no social welfare services, and a severe shortage of access to drinking water (120 out of 163 villages have drinkable water). The absence of a health officer in Rwamagasa is also of concern as sanitation and health issues are numerous. Out of a total of 848 households, only 625 have pit latrines.

### **6.1.1 ASM in Rwamagasa**

“The residents of Rwamagasa are primarily involved in mining activities. Gold extraction is a labour intensive activity, drawing on all members of the community, including young children who are involved in the processing of gold” (Wagner, 2003:7).

ASM is a family tradition for 78% of residents involved in the sub-sector, while 21% cite economic hardship as the driving force behind their participation (Wagner, 2003). Mutagwaba (2006:5) notes that in Rwamagasa “there is a mixture of small groups of successful small-scale miners and larger groups of disorganized artisanal miners”. While young men mostly work in larger mining sites, women, children and older people are found working in small sites (GMP Environmental and Health Assessment report, 2006). Intensive small-scale gold mining began in Rwamagasa in the 1980's.

Women in Rwamagasa region mostly engage in food vending, selling vegetables at the market, bar work and, to a lesser extent, mining. Wagner (2003) notes a clear-cut division of labour whereby women are responsible for food preparation, child care and household duties. "The traditional image of a woman as a mother and housewife underlie a clear-cut division of labour between men and women. Women perform the bulk of the household work (Wagner, 2003:15)".

Women are overburdened as a result of the family labour system and involvement in additional activities to supplement family income. As in most ASM communities, women's involvement tends to be restricted to more laborious, manual tasks such as transportation, crushing and grinding and amalgamation (Hinton & al, 2006). Women at Blue Reef Mine, Rwamagasa, exemplified involvement in ASM that is physically taxing, dangerous, requiring low skill level, repetitious and disproportionately rewarding in terms of effort for economic gain.

Wagner's 2003 household surveys revealed that 40% of respondents spend 12 hours/day processing gold, and 25% spend 24 hours in pits. There is limited involvement in mining associations, with 36% members of the mining association (MWAREMA). Wagner attributes low membership to the following: lack of awareness of the association's existence; a perceived lack of benefits; the fact that miners must be legally registered as artisanal miners; lack of education, and the belief that work is temporary and membership is unnecessary.

Small-scale mining enterprises in Rwamagasa are characterized as "family affairs" (Tessa, 2000). Bare hands are often used when handling mercury which raises concern over the impact of ASM on human health in this community. Of Wagner's (2003) survey respondents, 20% expressed serious concern over the impacts of mercury on community health – a concern exacerbated by the fact that there are no designated play areas for children who are at high risk for exposure to mercury in many locations near their homes.

Wagner (2003) found that 56% of respondents in her study in Rwamagasa cite lack of equipment and proper tools as their main challenge. They note that this occupational health and safety issue results in injuries and general malaise. Lack of working capital and unreliable market for gold was the second largest concern (16%). Currently 65% sell their gold to 'Makota' (businessmen) or to Kadeo's Blue Reef Small-Scale Gold Mining Company. Additional concerns include a high tax rate of 37% for mining, problems of theft, distrust of others, and lack of security in mining areas.

Most artisanal miners in Rwamagasa do not own claims. As a result, 30% of the ore is given to the claim holder. Gold processing, according to Wagner, occurs on compounds. Mine pits are located between 0.75 km – 3km from residences (Wagner, 2003).

Decision-making in Rwamagasa is predominantly made by the male head of household. In some cases, men and women make joint decisions related to ASM however women's role in the sub-sector might be greatly improved if they were given more decision-making power. Wagner (2003:20) suggests that "there are many disadvantages associated with allowing men to make decisions for the women. When men make decisions, the women are denied the opportunity to build their confidence in the decision-making process. In addition, the women are denied the opportunity to advocate for her interests, and when they are the ones actually doing the work, it might discourage them from improving the enterprise".

## 6.2 Blue Reef Small-Scale Gold Mine



Figure 6.2 - Blue Reef Gold Mine, Rwamagasa. (Source: Bamber, 2005)

Blue Reef Gold Mine is an organized small scale gold mine with mechanized mining and processing. The Blue Reef Mine is a model for artisanal and small-scale miners who have aspirations to operate in a more organized and productive manner. Operations adhere to the Ministry of Energy and Mines 'Code of Practice', with provision of production and sales records to appropriate authorities, and the use of suitable technologies such as retort systems, amalgamation tanks and amalgamation ponds (Kinabo.2003a).

Blue Reef Mine is owned by Mr. Christopher Kadeo, a former artisanal miner. The claim lies in the same geological formation as the old Buck Reef gold mine. Bamber (2005:19) notes that "the blue reef ore is a brittle, shear-hosted mafic greenstone reef, overlain by felsic oxides typically 2-3m thick, striking E-W, and dipping at maybe 40°". There are three operating shafts along strike at a depth of about 40-50m. These have steel headframes and electric winches that hoist ore to the surface. The mining method at Blue Reef Mine is drill and blast resue mining, where ore and waste are blasted separately, sorted at the face and the

ore hauled to surface (Bamber, 2005). Waste rock is hauled separately to the surface where women villagers (reef pickers) are allowed to sort through it and keep anything of value.

Bamber (2005:20) reported that “the typical process at the mine comprised hand crushing to -2” using 2lb hammers, grinding (210kg for 45 minutes with steel balls in the local mill), sluicing, and panning, and amalgamation of the concentrate; the tails are then sold to the villagers for approximately TSh 100/kg for processing at the independent milling and sluicing centers in the village”. Bamber notes that workers at the mine are provided a bonus in ore. This bonus is for their own processing which can be done at one of the independent grinding and sluicing centres or at the toll facility near the mine.

SEAMIC (2006) reports that the current production rate averages 2 tons per week. Low production capacity can be attributed to labour intensive work. “The average gold content of ore to be sourced from the underground mines is very variable and ranges from 3.48 g/t to more than 100 g/t. The rate of mining and manual hoisting of ore from the underground pits ranges from an average of 2 tons per week to a maximum of 7 tons per week, incorporating all other associated underground works such as water pumping, development works, roof timbering supports etc (SEAMIC, 2006:12)”.

SEAMIC estimates that the introduction of modern mining equipment and hoisting systems would raise production of ore to somewhere between 15 tons and 45 tons per shaft per week. They also noted that the mine has accumulated about 300,000 tonnes of tailings as a result of inefficient gold recovery. The tailings are currently located on site near the amalgamation pond. It was suggested that “gold recovery can be improved to 96% by the use of cyanide leaching of the tailings from the gravitational concentration processes.” (SEAMIC, 2006:15)

In addition to the shift boss, hoist operator and surface ore handle, there are 12 men working per shaft per shift. Blue Reef Mine has a total workforce of about 163 – this figure does not include unpaid workers, such as reef pickers (approximately 400 women) (Kadeo, Interview. 2006).

It is within the context of Blue Reef Mine that a group of approximately 400 women 'pick reef'. The women are permitted a 30-minute period to pick through the waste rock at the mine and to fill sacks that they then transport to the village for processing. This situation arose from the mine owner's desire to positively contribute to the community.<sup>11</sup>

### **6.3 Reef Picking at Blue Reef Mine**

“Before we crush the rocks into smaller pieces to feed into the ball mill we use our hands so you can get injured...and for dust...there is no protective gear and we get rocks in our eyes.” (Reef picker, 2006)

Reef picking is a laborious, strenuous and tedious activity with a small economic return that in no way equates to the amount of effort invested. It is conducted only by women who are not considered miners or workers at the mine despite their participation in mining activities. The permission for them to work at Blue Reef Mine is considered a form of charity. Little consideration is given to organization or health and safety precautions by the mine operator. Reef picking involves visual sorting of “valuable” pieces of rock in the waste rock dump.

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<sup>11</sup> Further to his assessment of Blue Reef Mine, Bamber visited a milling centre, typical of those in Geita District, by the river west of Rwamagasa village. He noted that the mills operate below the recommended ball charge and below the critical speed. Exposure to intense noise during grinding was also observed. Mills are operated dry, are unlined so there is no fluid in the mill to create a cushioning effect. “The result is a harsh dry crashing sound near the mill which was estimated at easily over 96dB, and without hearing protection is guaranteed to impair the hearing of the operators, even over short periods of exposure (Bamber, 2005:20).



Figure 6.3 - Women reef picking at Blue Reef Mine.

(Source: Bamber, 2005)

Reef picking at Blue Reef Gold Mine involves a group of women being scheduled for a specific day and time slot for work. The women work at home during the morning (sunrise to noon). During this time they attend to other duties in and around the home. At noon they are given 30 minutes to reef pick. They collect the reef and carry it home in a sack. After transporting the rock to their homes they perform a visual analysis whereby they discard the “bad ones” and keep the “good ones”. They break the rock manually. If they do not have enough to fill the 50kg bag for processing, it is stockpiled in the home until the desired amount is reached. The 50kg bag is then taken for grinding in ball mills. Rules surrounding reef picking and related to the mine in general are as follows: follow safety procedures at all times, and work only within the scheduled time period.

An average working day for the women is more than 12 hours long. Mornings are spent attending to their homes and the remaining time is devoted to farming and

domestic activities. Agricultural activities occur on small parcels of land and are for subsistence.

### **6.3.1 Reef Picking and Risks to Health**

Reef picking is an arduous and laborious activity during which women do not wear protective gear and expose themselves to a high risk of hand, finger and eye injuries. During a focus group discussion with reef pickers they reported that injury is an accepted consequence of the activity. The following comment was made:

“Before we crush the rocks into smaller pieces to feed in the ball mill we use our hands so you can get injured...and from dust...there is no protective gear and we get rocks in our eyes”

Other information obtained from a focus group discussion with women reef pickers revealed that 10 of the 12 women reported having missed a scheduled time to reef pick due to an injury sustained at the mine. Injuries to hands, fingers, backs, eyes, and overall physical wellbeing were cited. Hazards were identified at the collection stage of work. These involve injuries to hands and fingers, tripping, and other falls associated with the scramble to pick reef. Other risks occur during transportation of heavy sacks of rock. Women reported fatigue and physical strain from carrying 10-50kg bags from the mine to the village. Falls and injury occur with muscle fatigue and as a result of the uneven, challenging terrain between the mine site and their homes.

There is a significant financial loss that can result from missing one of these opportunities to subsidize their income. The dependency of the reef pickers on supplemental income raises concerns around occupational health and safety issues. Lack of protective gear not only jeopardizes the women's health, it has potentially devastating impacts on their family's wellbeing and the women's ability

to survive. Injuries occurring at the mine site may also impact the women's ability to work within the home and at their primary source of income, farming.

All of the women consider their work strenuous and with significant risk of minor injury. When asked if they considered reef picking to be hazardous, they all said no, seeing the risk as minimal in comparison to the risk of working underground. (11 answered "not dangerous", 1 answered "not very dangerous"). When asked about the likelihood of suffering an injury from reef picking activities, given the choice of "not likely", "likely", "very likely", "definite 100%" and "I don't know", all women chose "definite 100%". All reported having already suffered an injury, witnessing someone else get injured or working with an injured person. One woman said "it is expected. It is not too bad".

The group mentioned how some risk is currently mitigated to a certain degree by assigning women to the specific work groups. Without the existing groupings they believed that the work would be "extremely dangerous".

The group was also asked if alternative means of supplementing their income existed. They stated that the livelihood of the village depended on the mine and that they had no other options. Without the reef picking they would not have enough money to survive, with this dependency increasing during times of drought. This dependency can also be considered significant in terms of tolerating risk and perceiving risks to be less significant. It appears that these women are more likely to expose themselves to hazards due to desperation - when survival is at stake.

The risks for the reef pickers can be minimized with changes to the organizational structure of the groups, the use of protective gears and with improvements in working conditions that would accompany improved organization. By forming organized, cooperating groups, the women would

experience increased profit and wellbeing, which in turns leads to access to finance, acquisition of technology and improved occupational health and safety.

#### 6.4 Organization of Reef Pickers

“One group is up to 100 people. It is a struggle for survival, a scramble” (Reef picker, 2006).

Reef pickers are assigned to five different groups based on age and physical condition. There can be more than 100 women in a group at any given time with some inter-group movement due to changes in physical condition. There were no formal lists of group membership at the mine at the time of the fieldwork (May 2006).

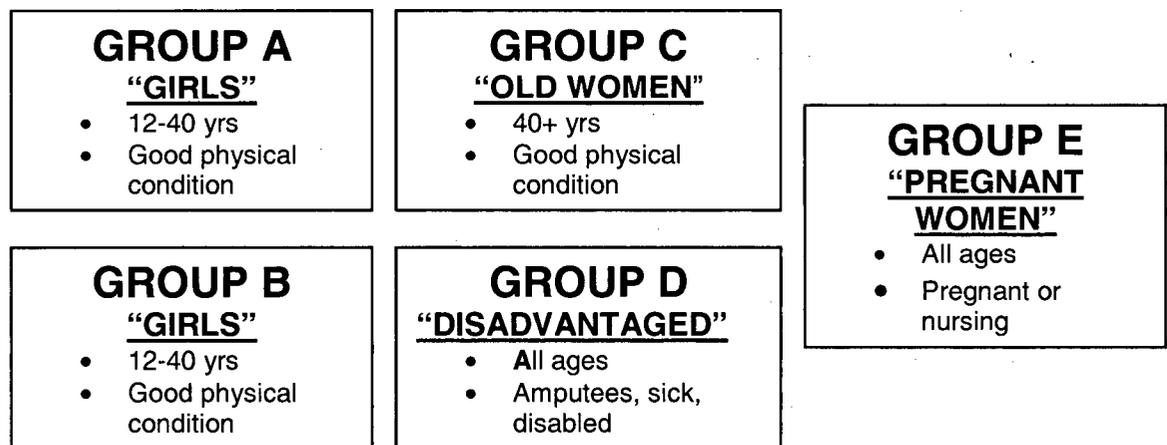


Figure 6.4: Reef Picking Groups

Groups were initially formed in response to problems occurring as a result of unfair competition between women of differing physical capabilities. At first, groupings were random, and pregnant women, elderly or those with disabilities were either injured or were unable to successfully participate. The nature of reef picking behaviour can be understood as highly competitive, opportunistic, aggressive, and selfish. Given the short amount of time to pick, women are compelled to act in a frenzied state, attempting to maximize individual gain.

Necessity and desperation are driving forces. As a result there is no time available, and no desire, to consider assisting others, for sharing or cooperation.

The current division of women into groupings was described by one reef picker as a way to “make the opportunity equal, make it fair” and to “avoid fights”.

The groups constitute organization in a basic form – women are grouped according to similarities and capabilities, however, there is little organization in terms of work. The current work structure enables a group of workers to work individualistically. With both behavioural and organizational changes, workers with shared goals could work together as a team, increasing the benefit to the individual and to the group.

#### ***6.4.1 Current schedule for reef picking activities***

The women reef pickers at Blue Reef Small-Scale Gold Mine, Rwamagasa, divide their time between the following activities:

- I. Household Duties:
- II. Primary Economic Activity:
- III. Child care
- IV. Reef Picking at Blue Reef Mine & related activities
  - Picking reef
  - Transportation of rock to the village
  - Sorting the reef
  - Crushing of rock with hand hammer
  - Grinding or milling
  - Sluicing
  - Amalgamation of the gold concentrate
  - Burning amalgam
  - Selling the gold
- V. Rest

Current reef picking at Blue Reef Mine and its related activities are individualistic, labour intensive, stressful, and expose the women to certain occupational health and safety risks. Although the women are assigned a group for the picking of waste rock, and would benefit from working together, their work does not entail cooperation or collaboration.

The following table includes estimates for time allocated to reef picking and related activities (women are charged for grinding, sluicing, and amalgamation services), and the subsequent output of each for women interviewed in Rwamagasa (Tessa, 2006). A reef picker currently performs each activity individually and must find time to conduct all of the activities below in addition to the other responsibilities listed above.

Table 6.1 - Current Reef Picking Activities

<b>Activity</b>	<b>Estimated Time Allocated to Activity</b>	<b>Output or Amount of Product</b>
Picking reef	30 minutes	10kg of unsorted waste rock*
Transportation of unsorted waste rock to village	20 minutes	
Sorting of waste rock	15 minutes	8kg of sorted gold reef
Crushing with hammer	20 minutes	8 kg of crushed gold reef
Grinding or milling – ball mills	45 minutes	8kg of powder
Sluicing	20 minutes	1.5 kg of concentrate
Amalgamation of the gold concentrate	10 minutes	Amalgam 5 grams
Burning the amalgam	10 minutes	Gold dore 0.5 grams
Selling the gold	5 minutes	Tanzanian shillings or \$

\*This is based on the assumption that a single reef picker can pick a maximum of 10kg of highly mineralized reef ore. Reef=waste rock with residual gold (Tessa, 2006).

Tessa (2006) notes that processing such small amounts of ore results in high losses and most ball mills require a minimum quantity of ore (e.g. 50kg). This

means that the women are required to stockpile their crushed reef ore until they obtain the minimum amount required. Another option would be to combine one's crushed ore with that of another reef picker. Activities after crushing require specialized skills for which the women are required to pay. It was not possible to determine the exact charge for these services as the women interviewed did not want to disclose weekly, monthly or yearly earnings, estimated earnings or costs for services at the processing centre (estimates suggest the women are charged approximately \$4/ 50kg sack). The mine owner, Mr. Kadeo, estimates that the women make an average of TSh 2000/week (US\$1.54) from reef picking.

Fear of Kadeo, Blue Reef Mine's owner, withdrawing the privilege of reef picking if waste rock is known to be more profitable than expected, may account for unwillingness to disclose earnings. The importance of maintaining secrecy around individual wealth can also be explained by the dynamics of the relationships between these women. Inequitable profit, streaks of luck (successful picking) and an imbalance between effort (input) and gain (output) can cause jealousy and strained relationships among the women.

Women considered success in reef picking as the result of two variables: luck and hard work. Some may believe that luck can be increased with the aid of charms, however, it is considered impermanent and unpredictable. The focus group discussion revealed that hard work was highly valued as a controllable and predictable variable. Reluctance to work together was attributed to the belief that some women could not be trusted to contribute consistent hard work, and also to the individual's perception that they worked harder than the others. This fear of 'free riding' is discussed in greater detail in terms of cooperation and results of economic games (Chapter 7).

#### ***6.4.2 Improved Organizational Structure for Reef Picking***

An improved organizational arrangement for the reef picking and related activities requires trust. The organizational model below assumes trust has been built and

mechanisms are in place to reinforce cooperative behaviours, such as increased opportunities, rules, leadership, training and punishment for defection/rule violation.

The following model is for work groups of 10 women. Reef pickers at Blue Reef Mine are currently divided into large groups that are not designed to ensure optimal productivity or profit. Organized sub-groups can exist within the larger groups. Women would be responsible for selecting their own members from the larger grouping.

After the sub-group has picked the reef for the allotted time, one woman can be chosen to accompany a donkey-drawn cart to the village with 10 x 10kg of unsorted gold reef. During this time, the other women are free to perform farming, household or child care activities. A time can be agreed upon for the women to meet again to sort and crush. One member of the group can then be selected to supervise the milling, giving them time to perform other duties. All women can be present for the remaining activities until a time when enough trust exists for one person to handle the sale of the gold.

Tesha (2006) notes that this organizational model results in: an increased amount of amalgam due to minimized losses; increased output; less time in the process; more time for other duties; and twice the amount of gold that they would obtain from working alone.

Table 6.2 - Improved Organization for Reef Picking

<b>Activity</b>	<b>Estimated Time Allocated to Activity</b>	<b>Output or Amount of Product</b>
Picking reef	30 minutes (all women)	10 x 10kg of unsorted waste rock *
Transportation of unsorted gold reef to village	20 minutes (1 woman)	Donkey and cart to take 100kg of unsorted waste rock to village – accompanied by one of the women
Sorting of reef	15 minutes (all women)	10 x 8kg of sorted waste rock
Crushing with hammer	20 minutes (all women)	10 x 8 kg of crushed rock
Grinding or milling – ball mills	45 minutes (1 woman supervising)	10 x 8kg of powder
Sluicing	20 minutes (all women present)	10 x 2kg of concentrate
Amalgamation of the gold concentrate	10 minutes (all women present)	Amalgam 10 x 10 grams
Burning the amalgam	10 minutes (all women present)	Gold dore 10 x 1 grams
Selling the gold	5 minutes (all women present)	Tanzanian shillings or \$

(Source: Tesha, 2006)

With the above model contingent on trust and cooperation among groups of reef pickers, a greater understanding of the nature of trust, willingness to adopt the model for improved organization, inclination towards cooperation and means to enhance trust are required.

For the women reef pickers, cooperation in the form of pooling resources and forming a more efficient work team would require abandoning the current individualistic and highly unproductive work arrangement. Cooperative behaviour is far from unfamiliar for these women, all of whom derive their primary income from farming. They reside in a community with high levels of cooperation, governed by the social norms of sharing, charity, assisting those in need, and reciprocating.

Women who participated in a focus group discussion all cited examples of cooperating in their primary economic activity and in other interactions in the community. They were also familiar with the notion of working in an organized group in order to improve productivity. Their reef picking activities, however, exemplify high levels of uncooperativeness, competitiveness, unproductiveness and distrust. This distrust and lack of cooperation, however, exist only within the context of the mining activity. Within the community there is a history of positive interpersonal exchange evident in the community's collaborative efforts during drought and periods of agricultural difficulty, and in the friendships and relationships referred to by the women. Cooperation is required between Blue Reef Mine and the community, and between villagers for other economic activities such as farming and trade.

For the women reef pickers, as would be the case for artisanal and small-scale miners engaged in two or multiple economic activities, interdependence necessitates cooperation. Respondents from the focus group discussion expressed not only the need for and expectation of cooperation in agricultural activities, but also the importance of cooperation for overall community wellbeing.

This social norm is evident in the interdependent and highly reciprocal relationship between Kadeo, owner of Blue Reef Mine and the surrounding community. The community assists in the successful operation of the mine through provision of workers and support services, reciprocating the much-valued employment opportunities and charitable donations of Kadeo with protection from banditry, and punishment for those who jeopardize the status of this well-balanced and mutually beneficial relationship. Tesha (2006: pers. comm..) explained that Kadeo depends on the community for protection – without which he could not operate. He is a target – a man with a lot of money and therefore, a lot to steal. He travels with armed body guards, and does not disclose the location of where he stays. Kadeo realizes the importance of the

community in the operation of his business and, most importantly, to his personal safety.

The community, Tesha adds, “cannot exist without the mine. If the mine is gone the community is gone. They depend on this mine to exist”. This interdependent relationship is governed by what appears to be simple, clearly understood rules, the violation of which result in consequences that exceed the legal realm. The impact of violation of these rules can jeopardize the livelihood of the entire community, and possibly threaten its existence. Thieves face potential ostracism, reputational risk and legal ramifications, while bandits are deterred by a unified, and highly invested, community.

In terms of cooperation, Kadeo has little concern over the need to enforce rules and regulations on site. He expressed confidence in the willingness of his employees to cooperate, with dependence an obvious factor in willing adherence to the rules (Kadeo. Interview 2006). As Dasgupta (1988:50) emphasized in his discussion of trust as central to all transactions, “the threat of punishment for errant behaviour must be credible, else the threat is no threat”. In the context of Blue Reef Mine and Rwamagasa, the threat is indeed credible.

When interviewed about the frequency of theft at his mine, Mr. Kadeo reported that a verbal reprimand is given for first and second time minor offences. For more serious cases and upon failure of the verbal warnings, theft results in prosecution and a court appearance. Mr. Kadeo emphasized the low rates of theft occurring amongst mine workers and reef pickers and attributed it to: dependency on the work as primary or supplemental income, community protection of the mine and Kadeo’s interests (clear understanding of obligations and reciprocity) and the fear of the community’s reaction.

The uncooperative behaviour of the reef pickers in the context of their 30-minute shift is inconsistent with the high level of cooperation between the mine, the miners and their families, and daily life in the community.

## **7 Data Analysis**

### **7.1 Profile of Reef Pickers Participating in Economic Games and Focus Group Discussion**

Reef pickers were selected as subjects for the economic experiments and focus group discussion for several reasons:

- The nature of reef picking: the work is unsafe, tedious, uncooperative, unproductive and is highly disorganized. It presents a “worst case scenario” for challenges to improving and changing organization in ASM. Improvements in a context as challenging as this would be an indication of the potential positive impact of the GMP initiative. Lessons learned and successes would facilitate work in other ASM groups.
- The reef pickers suffer from many of the social impacts from ASM and are in need of assistance in terms of improved standard of living and increased access to finance and technology. They are an ideal target for efforts designed to enhance women’s participation in ASM.
- Reef picking exists within a larger ASM context and culture but behaviours demonstrated during reef picking are inconsistent with general patterns of behaviour and social norms of sharing and mutual assistance. Cooperative, pro-social behaviour is the norm in the surrounding culture and is essential to their survival both in terms of social relationships and in other economic activities such as agriculture.
- Access to this group was provided by the partnership between the GMP and Blue Reef Mine. It is often difficult to locate and keep track of artisanal miners. The reef pickers were a group willing to participate and take time away from their other responsibilities.
- Reef pickers are a unique group working in an artificial environment. Participants function in the world outside the reef picking according to different rules. They are a particularly interesting sub-group within ASM. It was believed that the economic games would yield interesting results within this sample.

Twelve reef pickers participated in the study. There were representatives from each of the five groups.

Table 7.1 - Participant Profiles for Economic Games Blue Reef Mine, Rwamagasa

<b>Participant</b>	<b>Age</b>	<b># children</b>	<b># in home</b>	<b>earners in home</b>	<b>alternative income</b>	<b>Group</b>
1	30	4	9	1	farming	A (girls)
2	35	4	11	1	farming	A
3	29	4	6	1	farming	A
4	27	3	5	1	farming	A
5	32	5	8	1	farming	B (girls)
6	30	1	10	1	farming	B
7	43	10	7	1	farming	C (old women)
8	53	7	12	1	farming	C
9	32	4	11	1	farming	D
						(disadvantaged)
10	56	10	12	1	farming	D
11	20	3	8	1	farming	E (pregnant)
12	32	4	6	1	farming	E
<b>Average</b>	<b>35</b>	<b>5</b>	<b>9</b>	<b>1</b>		

The average age of the group was 35, with the youngest woman being 20 and the oldest 56. All of the women were involved in farming as their primary economic activity and none had any additional financial support from household members. This was a surprising finding and would have been interesting to explore in more detail. Women claimed to be married yet responded that they were the only person earning in the family. Absentee husbands, impacts of drought on farming and illness can account for this occurrence however, this is pure speculation and additional research is required. The average number of people per household was 9, with women having an average of 5 children. All participants expressed that they rely on reef picking for survival and that the biggest problems they face are hunger and poverty.

## 7.2 Focus Group Discussion

A focus group discussion was held prior to the activities. It had the following objectives:

- Obtain baseline information for the creation of participant profiles;
- Gauge impact of factors such as poverty, desperation and reciprocity on levels of cooperation;
- Determine subjective perceptions of cooperation, pro-social behaviour and current work arrangements;
- Acquire greater understanding of the nature of the work and participatory significance;
- Understand their perception of trust and cooperation in the reef picking environment compared to non-mining activities;
- Assess psychosocial factors of work behaviour; and
- Determine risks, perception of risk, and risk behaviour.

Twelve participants were involved – all of whom volunteered to assist as part of the GMP- Blue Reef Mine collaboration. These activities were undertaken by the researcher as a representative of UNIDO/GMP. English questions were translated into Swahili, by A. Tesha, Ministry of Mines and Minerals in Tanzania. Participants' responses were also translated to English. Women gave video-taped consent to participate in the Focus Group Discussion, and in the subsequent games. This was considered the best solution for this group considering most women had little to no literacy. They were informed that they were not obliged to answer questions and could terminate participation at any time. They were ensured of confidentiality and that comments, answers and results would be anonymous.

Results from the focus group discussion were significant when one compares the results of the experiments (mentality whereby mutual assistance and common good are paramount) with the individualistic, uncooperative and highly competitive behaviour during the reef picking.

The following issues and points were raised:

- The women will pick different sized reef. Some will pick bigger and better ones than others. Picking the best reef is the main objective of each woman.
- They did not believe that equal distribution of picked waste rock is a good idea since some reefs are richer than others.
- Prior to the focus group discussion they had not considered cooperation an option as their needs and interests are different.
- They do not, under any circumstances, assist others while picking.
- They consider their work "individual" but they are "grouped".
- If someone from the group is sick and is unable to reef pick, they do not provide assistance or share rock or earnings.

The Focus Group Discussion was followed by the PGG, UG and DG.

### **7.3 Methods for PGG, UG and DG**

There is a definite protocol for experimental games. "Subjects generally are given thorough instructions, encouraged to ask questions, and are often given a short quiz to be sure they understand how their choices (combined with the choices of others) will determine their money earning (Camerer and Fehr, 2004:59)". In the interest of determining whether behaviour corresponds to or leads to an equilibrium, games are repeated. This also allows for learning as players become more familiar or comfortable with the possible strategies available.<sup>12</sup>

Participants were randomly selected by a manager at Blue Reef Mine. Time constraints and logistics prevented the selection of participants by the experimenter. Blue Reef Mine and the GMP are currently working together to make improvements at the site and this collaboration facilitated the recruitment of participants. According to mine owner, Mr. Kadeo, the manager randomly

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<sup>12</sup> It is worth noting that participants in an experimental game often express angry responses to unfair offers or to the behavior of other participants in the game. See, for example, Xiao and Houser (2005) or Pillutla and Murnighan (1996)

selected women from the five different groups in an effort to best represent the reef pickers.

1000 Tanzanian shillings were used as stakes in the games (USD\$0.77). This decision was based on two factors: it is an amount that is easily divisible into smaller bills; it is enough money to elicit an investment in the game playing (it is worth the time spent participating); and it is equivalent to half the estimated maximum weekly economic gain from reef picking. In order to facilitate division of the sum, pieces of paper representing denominations of 100 Tanzanian shillings were provided. This served as a visual aid for participants. The games were conducted in Swahili, with a translator translating English instructions and questions. Instructions were simple, scripted to ensure consistency and a demonstration was provided. A series of test questions checked for comprehension and attention was paid to ensuring each participant understood the game. An opportunity for participants to ask questions was also provided.

To ensure anonymity in the Ultimatum and Dictator Games, "proposers" and "responders" were not told the identity of their partners. Roles were randomly assigned. To safeguard against contributing to inequity among the women and possibly alerting them to role identity from the discrepancy between individual payoffs, all women received the maximum amount of money they could have obtained from the games at the end of the day. They were not aware during game playing that they would all leave with the maximum amount so that decisions would not be influenced. From an ethical point of view, it was believed that valid results could be obtained while avoiding possible conflict or inequity by providing all participants with equal compensation.

A post-game discussion was held with the women to determine reasons for offers, contributions and rejections, factors in decision making, and the minimums they would accept. This opportunity was also used to discuss the participants' feedback, assess the potential educational value of the games and

determine the effectiveness of the activities in the promotion of cooperation and trust for improved organization.

Games were played in the following sequence: Public Good Game, Ultimatum Game, Dictator Game and Grab Game. Post-game discussions occurred between games. It was believed that the Public Goods Game would show whether participants reciprocated expected cooperation and indicate proclivity toward cooperation. The Ultimatum Game followed, and would indicate whether unfair offers would be punished and if rational players would offer and accept the lowest non-zero sum, and the Dictator Game came next – measuring pure altruism and informing as to whether players would be rational by offering nothing. The Grab Game was last.

It was theorized that the PGG, UG and DG would reveal information about the nature of cooperation and trust among the reef pickers and that the PGG might have lead to some realizations by the participants of the best way to benefit oneself and the group. Since the Grab Game mimicked the reef picking it seemed that the greatest impact would come from this activity and that it was best left until right before the final discussion.

### ***7.3.1 Adaptation of Grab Game***

In attempting to use the Prisoner's Dilemma to teach business ethics, Harvey (1998) points out that ethical or cooperative behaviour produces an outcome that is both individually and collectively superior to unethical, non-cooperative behaviour. He notes that "unethical behaviour, while apparently rewarding to the individual (the unethical person does relatively better than the ethical players), is ultimately self-defeating because of the feedback effect such behaviour has on the individual. Unethical conduct not only harms the group, but it also adversely affects the individual engaged in the questionable activity (Harvey, 1998:219).

Harvey (1998) proposed using the Prisoner's Dilemma in ethics training to assist business students in understanding the ethical consequences of their decisions, especially in situations where self-interest conflicts with moral principles.

He suggests that "the basic insight offered by an examination of the Prisoner's Dilemma is that individual obligations to consider the social welfare of the group require decision-makers to rise above their own narrow self-interests (Harvey, 1998:212)". The Prisoner's Dilemma, he adds, illustrates how participants will use "individually optimal strategies at the expense of outcomes that will benefit the participants collectively".

Harvey (1998) proposed that by adapting the Prisoner's Dilemma to the classroom, an activity he named "the Grab Game", participants would be able to see the consequences of their actions, and the significance of ethics in decisions where individual interests conflict with the group. This activity requires an object of value that was easy to grab – Harvey used paper clips that represented an amount of extra course credit for students. The game illustrates how cooperation, "ethical behaviour" according to Harvey, results in increased individual and collective payoffs. A post game discussion provides an opportunity to review actions and alternatives.

Although Harvey intended the Grab Game for use in ethics training, to promote ethical decision-making, I considered adapting the game for use with artisanal and small-scale miners as a way to demonstrate the benefits of cooperative behaviour – both to the individual and group. The Grab Game, as Harvey suggests, enables an immediate demonstration of the consequences of actions to oneself and others. From an educational perspective, the Grab Game is a tool that can show tangible and measurable benefits that come from choosing cooperation and, ultimately trust, over the pursuit of ones own interest.

This game requires trust in the sense that one believes the others will avoid actions that will adversely affect the participant's chance to profit. The use of this game within an artisanal and small-scale mining context was considered as a means to promote cooperative behaviours in an environment where cooperation and trust were often absent. For this purpose and due to the complexity of the subject, "ethics" and the ethical implications of self-interest were ignored. With the goal of changing the individualistic and disorganized nature of the sub-sector, it was felt that the Grab Game was a simple tool by which a miner could see the immediate advantages of cooperation. It is also simple enough to provide an analogy for mining individualistically or working in a unit. Objects of value, paper clips in the Harvey experiment, provide the added benefit of being able to represent something of greater value. Applied in an ASM context, a coloured bead can represent a gold nugget, diamond or something of significant value that, with such high stakes, will tend to encourage truly self-interested behaviour. The post-game discussion can assist in clarifying the significance of behaviour in the game, but most importantly, it can demonstrate how it is applicable in a miner's work environment.

Research into ASM in Geita District led me to identify a sub-group of persons involved in ASM – reef pickers at Rwamagasa's Blue Reef Mine. This group is an excellent illustration of the social impacts of ASM, the added challenges for women in the sub-sector and the need for improved organization. Most interesting, however, was the fact that this group was perhaps the best example of individualistic, anti-social, unproductive and distrustful behaviour in ASM. Reef picking involves scavenging, self-interest, fighting and uncooperativeness that serve as barriers to improved organization. Organization could improve working conditions, safety, access to finance, earnings and the overall standard of living for all involved. What was not understood prior to conducting the experiments with the reef pickers was the extent to which the Grab Game mimicked reef picking. In terms of education, this mirroring-effect enhanced the effectiveness of

the game as a learning tool. This is discussed in greater detail in the analysis of data to follow.

Adapting the Grab Game to ASM involved the selection of an object of value. The reef pickers live in poverty and therefore, food is of high value. I decided to use candies, a treat that the women were unable to afford but would definitely want to play to win. Using the grab game with other groups in artisanal and small-scale mining might involve the use of a different object of value. It was concluded from the research at Rwamagasa that future experiments involve higher stakes (such as ore) in an effort to step closer toward the implementation of improved organizational arrangements. It would also serve as a measure of the effectiveness of the exercise with alternative objects of value.

## **7.4 Data Analysis**

### ***7.4.1 Results for the Public Goods Game***

For the Public Goods Games, Henrich et al., (2005) used two versions. The “voluntary contributions” (VC) version involves a player making an anonymous contribution to the common pot from an endowment given to them, the pot is increased (by 50% or doubled) and divided equally among contributors. The second version is the “common pool resources” (CPR), in which players withdraw (limited) amounts from a common fund and the remainder is increased (50% or doubled) and divided equally.

Selfish subjects remove as much as possible in the CPR version while contributing the least possible amount in the VC format. For this research the VC format was selected as it was believed that it could reinforce the notion that investing in a collective goal could benefit the individual and the group. It is somewhat analogous to artisanal miners investing their own money in a common fund to purchase equipment that will enhance productivity for the whole group. It is also a game that can elicit ‘free riding’ and be used to illustrate the self-

defeating nature of such behaviour. The PGG was used to determine how reef pickers would behave when their own interests conflict with those of the group.

The Public Goods Game was played with an endowment of TSh 1000 (USD 0.76) and 12 participants. The four rounds yielded the following results:

Table 7.2 - Contributions in the Public Goods Game

Player	Contribution to Common Pot			
	Round 1	Round 2	Round 3	Round 4
1	1000	1000	1000	1000
2	100	100	100	300
3	400	500	500	500
4	400	400	500	500
5	100	200	200	400
6	400	400	400	400
7	100	300	500	600
8	300	500	500	500
9	100	100	100	100
10	100	100	200	300
11	300	300	500	600
12	500	500	500	500
<i>Median</i>	300	350	500	500
<i>Mean</i>	316 (32%)	367 (37%)	417 (42%)	475 (48%)

In the initial round, the mean contribution was 316. Research has found that players contribute an average of 50% of the endowment in one-shot games and the mean in student populations is a contribution between 40-60% (wide variance with most contributing nothing or all) (Camerer & Fehr, 2004). Players 1, 6, 9 and 5 have different levels of risk established at the start of the game. All four players maintain the same level of risk throughout the rounds. This suggests that either the results from the successive rounds validate and reinforce their initial decision so that they avoid change, or that they are not inclined towards changing their strategy (exception is player 1 who cannot increase offer).

The following table shows the mean contributions from Henrich et al's experiments and those from the Rwamagasa sample. The average contribution

from the four rounds was 0.40 with the mean for the initial round being 0.32 – a result lower than all other mean contributions with the exception of the Mapuche and Machiguenga. Interpreting only the contribution in the initial round might indicate the reef pickers were attempting to maximize gain with small contributions to the common pot, hence supporting their belief that their co-workers are inclined towards free-riding. However, as the game was played for a series of four rounds, it is important to examine game behaviour for duration of the series.

Table 7.3 - Mean Contributions in the Public Goods Game

Michigan	0.43
Machiguenga	0.22
Tsimane	0.54
Mapuche	0.34
Huinca	0.58
Ache	0.65
Orma	0.58
Rwamagasa reef pickers	0.40

In the reef picker experiment, the mean contribution increased over the series of games going from 32% in round 1 to 48% in round 4. Camerer and Fehr (2004) note that in repeat rounds, contributions decrease and the majority of participants offer 0 in the final round. The results from the Rwamagasa experiments reveal the opposite – the offers progressively increased or remained consistent throughout the series of games. None of the players contributed zero. They are not a group of selfish players using the optimal strategy of free-riding.

With none of the players contributing nothing and the contributions increasing rather than declining, it might be inferred that the participants are inclined towards cooperation and trust rather than free-riding and selfishness.

Increases in contributions over the series tend also to confirm the usefulness of the PGG as a tool for demonstrating the benefits to the individual and group.

Communication between rounds and a comparison of gains would have assisted in demonstrating the tangible benefits to cooperation and trust.

Macur L. Olson (1950) suggested that smaller groups are more likely to obtain voluntary cooperation than large ones. His experiments also revealed that repeated iterations of a situation would foster cooperative mentality and that communication between group members had a positive affect on cooperation (Glance & Huberman, 1994). In the experiments with the reef pickers, it seems that a cooperative mentality emerged. This was exemplified when opportunities to defect and gain at the expense of others (free-ride) were not taken. This behaviour is contrary to behaviour occurring within the reef picking context. It is also evidence that may discount reef pickers' belief that others are too untrustworthy to cooperate in the high stakes environment of reef picking.

Communication occurred during rounds as players were reminded of the potential benefit if all contribute 100% compared to the gain from significantly smaller contributions. This communication might have had an influence on the decisions to increase or maintain contributions. The small size of the groups might also have an affect, however more research is required to understand the influence of group size and communication among this population.

#### ***7.4.2 Results for the Ultimatum Game and Dictator Game***

The optimal strategy in the UG, according to Marlowe (2004), is to offer 10%. This amount is considered enough to avoid rejection and small enough to provide sufficient gain to oneself. In a total of four rounds, there was only one offer of 10%. The offers from all rounds averaged 45%. There were no rejections, even among the lowest offers of 10 and 20 percent. The decrease in offers may suggest that participants became less cooperative with time and with acceptance of offers. In terms of the UG serving an educational purpose of promoting cooperation, results are not significant enough to judge its effectiveness.

Table 7.4 - UG Offers for Reef Pickers

Player	Offers - all accepted			
	Round 1	Round 2	Round 3	Round 4
1	600	600	500	400
2	500	400	400	400
3	800	500	500	500
4	600	600	500	500
5	500	500	500	500
6	500	500	400	400
7	500	600	500	500
8	400	300	300	300
9	300	300	300	200
10	400	400	400	200
11	800	700	700	700
12	400	200	100	100
<i>median</i>	500	500	450	400
<i>mean</i>	523	469	427	392

Poverty may account for the absence of rejections. Women reported be willing to accept something rather than nothing and hence, proposers would not have feared rejection of low offers. The decrease in offers over the series might suggest that amounts were reduced in an effort to increase individual gain or that absence of punishment enabled selfishness, however, the women claimed to reduce or maintain the amounts of the offers out of a desire to assist the other. They stated that uncertainty in terms of food insecurity and economic instability required them to make provisions for the future. By offering an “acceptable” amount to another, they felt that future assistance would be reciprocated if required. One woman said “I keep some for myself because I need it but I give some to the other because one day I might need assistance”.

**Table 7.5 - Ultimatum Game Results for Small-Scale Societies (Henrich et al. 2005) and Reef Pickers at Rwamagasa**

<b>Group</b>	<b>Mean offer</b>	<b>Rejections</b>
Lamalera	0.57	0
Ache	0.48	0
Shona	0.44	9
Orma	0.44	2
Au	0.43	8
Achuar	0.43	2
Sangu	0.41	6
Hadza	0.33	13
Gnau	0.38	10
Tsimane	0.37	0
Kazakh	0.36	0
Torguud	0.35	1
Mapuche	0.34	2
Quichua	0.25	1
Machinguenga	0.26	1
Reef Pickers	0.45	0

Henrich et al's results revealed that mean offers with students are between 40%-45% with responders rejecting offers of 20% half of the time. They found that there were no rejections with the Ache, Tsimane, Kazakhs, Quichua and in none of societies proposers made offers based on the selfishness axiom (proposers offer smallest positive amount because responders only seeking to maximize only their income). The average offer for reef pickers is similar to some of Henrich's sample, although it is important to note that those were one-shot games.

Results for the dictator game were as follows:

Table 7.6 - Dictator Game Results for Reef Pickers

Player	Offer	
	Round1	Round2
1	500	500
2	400	400
3	300	300
4	400	400
5	800	500
6	300	300
7	300	200
8	300	300
9	400	300
10	400	400
11	600	600
12	400	400
median	400	400
mean	423	385

The results showed an increase of 3% from UG round 4 to DG round 1. This is surprising as the player switches from a game with the possibility for rejection/punishment to one where their offer must be accepted. The anticipated drop in the amount of the offer did not occur.

In the DG, Marlowe (2004) points out that the optimal strategy is to offer nothing. None of the reef pickers in the DG made an offer of zero suggesting that they are not seeking to maximize their own gain at the expense of another.

Comparison to results from Henrich et al's research suggest that the mean offers among the Orma (31%), Hadza (20%) and Tsimane (32%) were slightly lower than those of the reef pickers, however, they were significantly lower than offers made in the UG. The reef pickers offered more in the first round of the DG – an interesting occurrence that cannot be explained with the limited data from this study.

### **7.4.3 Results for the Grab Game**

#### *Description of events*

The women were randomly divided into two groups of five (two women sat out). The rules of the game were explained in Swahili and a demonstration was performed. This was followed by questions to test for comprehension. When it was certain that the women understand the rules of the game, the first group gathered around a table where five candies had been placed in pile in the middle. The other group stood around to observe. The groups (A & B) alternated turns. The first round with group A stopped before it began when one woman made a move to grab the candies before I had said they could begin. As soon as this participant moved toward the candies, the others followed. Three of the participants used their bodies to cover areas of the table in an attempt to shield access to the candy. Another explanation was required to ensure that they understood that the first round would begin after I said "go". With the first round for group B, they waited for me to say "go" but several women grabbed candy at the same time, with two of them trying to pry candy from another's hand. Another short explanation of the "you touch it you keep it" rule was provided.

With Group A, the first round lasted less than a second – with two of the five players obtaining candy. The final round (#8) resulted in the largest gain per person and the longest duration of play. This round immediately followed a short discussion involving an examination of the distribution of candies for the 7 preceding rounds. This highlighted inequity and missed opportunity to benefit from the increase in number of candies. A description of a hypothetical situation where players wait for several periods of 10 seconds was aimed at reinforcing the idea that cooperation brings the greatest benefit to the individual and to the group. The results of round 8 indicate an increase in game duration of 9+ seconds between round 7 and 8. Comparing the first round to the final one shows a shift towards equitable distribution of candies and indicates a steady rise in game length. This might indicate increased familiarity (participation, and observation while group B play) with the game improves strategy, it may

demonstrate enhanced willingness to cooperate over time and with less than satisfactory gains. It is also possible that competitiveness is a force so powerful in this group that it requires considerable effort, and repeat play, to control it. Results for Group B show an increase in both game duration and equitable distribution. In rounds 6 and 7 all of the players had candy – this trend continues after the discussion between rounds 7 and 8. The final round reveals a huge change in strategy with the game duration being about 33 times the length it was in the first round, and doubling from round 7. Again the influence of communication on game play seems to be a factor in behaviour change. In both groups the changes occurring after the discussion, before the final round, suggest that with the explanations and demonstrations to reinforce and promote cooperation, game play changes in terms of duration and equity of winnings. It is strongly believed that the Grab Game can serve as an educational tool to illustrate, by tangible means, the benefit of cooperating in a competitive environment.

Table 7.7 - Results of the Grab Game – Group A

Group A	Number of candies grabbed per player (P#)					Duration of play (seconds)	
	Round	P1	P2	P3	P4		P5
	Round 1	2	0	0	3	0	less than 5
	Round 2	2	0	1	1	2	less than 5
	Round 3	1	1	0	0	3	less than 5
	Round 4	0	5	0	0	0	less than 5
	Round 5	0	1	4	0	0	less than 5
	Round 6	0	0	2	2	1	5-6
	Round 7	1	0	2	5	2	10-11
	Round 8	3	3	5	5	4	20

Table 7.8 - Results of the Grab Game – Group B

Group B	Number of candies grabbed per player (P#)					Duration of play (seconds)
	Round	P1	P2	P3	P4	
Round 1	4	1	0	0	0	less than 5
Round 2	1	1	1	0	2	less than 5
Round 3	2	3	0	0	0	less than 5
Round 4	3	0	0	0	2	less than 5
Round 5	1	1	0	0	3	less than 5
Round 6	2	3	3	3	4	10-11
Round 7	2	4	3	2	4	10-15
Round 8	6	8	8	9	9	30-33

*Results of the Grab Game*

The results from the grab game revealed:

- Progressive increase in game duration for reef pickers.
- Discussion among participants between rounds 7 and 8 led to a significant increase in the game's duration.
- Post-game discussion revealed similarities, noted by participants, in reef-picking mentality and actions. They stated that in both the game and in reef picking: "weak get nothing", "we scramble and fight [for something of value]", "we grab reefs like we grab the candies".
- Following the game, the left over candies (approximately 100) were put in a pile on the table. The women were instructed to do what they wanted with the candies when "go" was said. A division of the candies into equal parts occurred, with a lot of negotiation and consideration of gains from the game series. Trades were made between women with teeth, who wanted gum, and those without who wanted toffee. In this situation, it would have been interesting to examine the significance of competition on fairness and cooperation. There was an emergent leadership influence.

With artisanal and small-scale miners, this version of the Grab Game can be complemented with trust building and team building exercises that mimic mining

activities to reinforce cooperation and collaboration, while emphasizing the benefits to both the individual and the group. The game was used with a group of 30 trainees at a GMP training program in May 2006<sup>13</sup>. The grab game was used as an educational tool to accompany team and trust building activities. The application of the game differed from experiments with the reef pickers as it was intended purely to reinforce the importance of cooperation in groups during an intensive eight-day training program. Groups consisted of 5 members, randomly selected. The first group's game ended in less than a second when someone grabbed everything before I had even started the timer. Group 2 had a game time of less than four seconds – with two of the five players obtaining candy. With the 3<sup>rd</sup> group, players threw themselves at the bowl in an effort to take all of the candies, resulting in one player getting everything and the rest getting nothing. The 4<sup>th</sup> group had a game time of approximately 6 seconds with three of the five players getting candy. When the 5<sup>th</sup> group began playing, one player asked the others to wait and demonstrated a controlled, patient alternative to grabbing. This individual had emerged throughout the training as a “leader” and had already gained the respect of the group. They followed his instructions and the game lasted almost 40 seconds – with individuals taking one candy at a time. The last group, learning from the previous one, had a game time of over a minute. No one took any candies, instead they waited for the incremental increases. When the game was stopped because there were no more candies, the group took the bowl and distributed the amount evenly among themselves. In this context – communication and leadership were shown to influence the outcome of games.

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<sup>13</sup> GMP “Training of the Trainers” took place over an 8 day period in May 2006. It was designed to train individuals to work with transportable demonstration units that will travel to mining areas to educate miners and community members in safe practice, health and environmental concerns around the use of mercury and other GMP awareness campaign components. Trainees were trained in areas that related to technical, health, environmental, trust-building, team-building, leadership and business in ASM. The 30 participants were a diverse group of health care workers, miners, and local leaders.

This game was followed by an activity called “sort and transport”<sup>14</sup> - designed to promote organization, cooperation and leadership. It was believed that by complementing technical and health training programs for miners with training in cooperation, team and trust building and leadership, attempts to improve organization could be greatly facilitated. This theory requires further research and testing.

## **7.5 Conclusions from fieldwork**

Post-game discussions, game result and information from the focus group discussion lead to the following conclusions:

### *Fear of defection or non-cooperative behaviour*

Women expressed a fear of defection, in the form of free riding, “laziness”, hoarding (keeping rocks of value from others), theft, dishonesty and unequal distribution of profit. Surprisingly, game results demonstrated a low frequency of defection or self-interest – raising questions as to whether the fears could be substantiated and whether the main obstacle was perceptual rather than factual.

- Women were motivated to cooperate based on several factors: fear of appearing “greedy” (reputational risk); mitigating the risk of future unexpected hardships by subscribing to the notion of “mutual assistance” and “reciprocity”; and because they felt it was the “right thing to do”.

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<sup>14</sup> Group work was conducted in order to develop leadership skills among the trainees, ensure the successful dissemination of information by the learners, and to promote organization among miners. Contact exercises, brain storming sessions and peer learning was instrumental in providing immediate feedback, assessment and evaluation. “Sort & Transport” was one particular activity that required leadership, organization and cooperation for the successful completion of a task. Trainees were required to select a leader, plan the most effective method and delegation of tasks, and maximize the use of all members of the group in completing the work within the allotted time. It mimics basic mining activities that can be greatly improved with enhanced team work, organization and planning.

- The belief and perception of high risk from opportunism was enough to prevent trust, and consequently prevented optimal collective work arrangements. They expressed concerns as to whether others would cooperate but cited no examples of past defection to substantiate this. They founded their expectations of future behavioural outcomes on current uncooperative behaviours observed in the reef picking context. They were, in fact, able to acknowledge the uniqueness of this type of anti-social behaviour and contrast it to pro-social behaviour in other areas of village life but it did not affect their reluctance to trust or cooperate.
- The influence of desperation in relation to risk should not be overlooked in this context. The women demonstrated risk aversion in their reluctance to cooperate. Survival depends on the small earnings from the activity and in this case the cost of trusting outweighed the possible benefits of cooperation. The reef pickers acknowledged the obvious benefits that cooperation could bring them both individually and collectively, however, their actions demonstrate that they are more comfortable with zero to low risk with small gain in individual work, than with higher risk and larger gain that accompanies cooperation. Results of the Public Goods Game, Ultimatum Game and Dictator Game are incompatible with this behaviour. The Grab Game, mimicking the scavenging of reef picking, revealed a shift in behaviour that occurs when externally imposed time constraints, competition, tangible objects of value (TOVs) and physicality (in this case grabbing) are introduced. The same variables exist in the reef picking context although the TOVs have an even higher value as they are essential for survival.
- In terms of the decision making process around to trust or distrust, it seems that within the highly competitive reef picking environment others are treated as opponents. This results in a negative distortion of information about others - an inversion of the tendency to generalize positive illusions to members of the in-group (Bazerman, 2006). In his discussion of positive illusions in

groups and society, Bazerman (2006:72) notes that “people tend to believe that members of their group are more honest, more cooperative, more trustworthy, more diligent and more industrious than members of other groups”. (Brewer, 1986, Kramer, 1994) Equitable division of candies after the game showed very different behaviour as the women were quick to cooperate and consider the benefit to each person in the group rather than themselves.

- The artificial and intensely competitive environment within which the reef picking occurs appears to create an opposite effect on the women’s perception of one another. Although their behaviour in the economic games, highly cooperative behaviour in other economic and social activities, and pro-social responses in the focus group discussion indicate a proclivity toward cooperation, they perceive their fellow reef pickers as opponents, attributing seemingly unsubstantiated negative attributes to one another. This phenomenon can be generalized to the larger ASM sub-sector where desperation and poverty enhance competition over scarce resources and elevate levels of distrust and uncooperativeness. This is compounded by the high risk nature of the activity and the uncertainty surrounding gain. There is no certainty that a day’s work will result in sufficient return, therefore, desperation factors in and individuals place more importance on self-reliance rather than possible advantages of collaboration and cooperation. Good (1988) notes that cooperative behaviour does not necessarily indicate cooperative mentality and vice versa. In a situation where there is little cooperation, individuals may possess a willingness or predisposition towards cooperation. This is perhaps the case with the reef pickers – they may possess a cooperative mentality but exhibit uncooperative behaviour due to situational variables or cues such as the imposed time constraint.
- With little evidence to support the accuracy of perceptions of others as untrustworthy and opportunistic, it is useful to consider the possibility that either reef picking context elicits or promotes socially unacceptable behaviour

or that an inherent competitive drive is activated in the high stress, time constrained scavenging context.

- The Grab Game was by far the most successful activity in terms of demonstrating the benefits of cooperation and trust. It also revealed significant information about the nature of the reef picking, and cooperation and trust within this context. The similarities between the reef picking and grab game are remarkable. The following table provides a summary.

Table 7.9 - Similarities & Difference Between Reef Picking, Grab Game and Other Activities

<b>Reef Picking Activity</b>	<b>Grab Game</b>	<b>Primary Economic Activity (Farming) &amp; Social Interaction</b>
Competition	Competition	Mutual assistance
Individualistic	Individualistic	Collectivistic
Competition requires physical action to acquire object – grabbing	Competition requires physical action to acquire object – grabbing	n/a
Tangible object of value –gold	Tangible object of value – candies	Tangible object of value –crops etc...
Externally imposed time constraint – 30 minutes	Externally imposed time Constraint – duration of game	n/a
Artificial environment	Artificial environment	Natural environment
Elicits actions incompatible with social norms (sharing, assisting other). Anti-social behaviour	May or may not elicit actions incompatible with social norms (sharing, assisting other). Anti-social behaviour	Encourages pro-social behaviour, compatible with social norms.
Desperation and survival as factors	n/a	Desperation and survival as factors

- The grab game is an ideal tool to change undesirable behaviours within the reef picking context as it elicits the undesirable behaviour and immediately demonstrates the consequences. A demonstration of the game showing the optimal strategy to benefit the group and individual can function as an educational tool.

- The Public Goods Game demonstrated that when given the opportunity to free-ride, their fellow reef pickers would rather choose to cooperate. Although they did not contribute 100% to the common pot, they understood how, with complete trust in other players, they could benefit the most. In this context, poverty and desperation logically prevent the women from risking a 100% loss. This risk aversion can be understood in terms of poverty and might be generalized to the larger ASM context. Despite not being in a position to take the risk in the game, it was still proven to be an effective demonstration of how cooperation in terms of pooling resources can maximize individual and group benefits.
- The Dictator Game, with no punishment for zero or selfish offers demonstrated that they would give to others even when there was no chance of rejection. It also showed that others did not choose to act selfishly.
- The Ultimatum Game demonstrated that all offers would be accepted and that in the repeated series, fear of rejection (offering amounts to avoid risk of rejection) was absent. Amounts of offers were determined by keeping enough to prioritize one's own wellbeing but giving an amount to "assist" the other.
- Trust was lacking due to fear that others would be opportunistic, free-ride and horde. Evidence from the Grab Game initially supported the belief that others would be selfish but gradual change in behaviour showed a propensity for change. Behaviour in the other games proved that perceptions around free-riding and opportunistic behaviour could not be validated by game play.

A review of what had been learned from the games took place with the reef pickers. In terms of adapting economic games as an educational tool in the promotion of cooperation and trust for improved organization, the following items can be considered:

- The women acknowledged that they can benefit from working together in the reef picking activities and that this requires cooperation and trust. They acknowledged that reef picking brings out undesirable behaviours that do not provide consistent benefit and therefore, do not outweigh the more consistent benefits of pro-social behaviour. The women made their own connection between the lack of cooperation in the grab game and in the reef picking. They noted how in both contexts they behaved without regard for the welfare of others and were purely motivated by their own self-interest. A willingness to change the organizational structure of their work to involve cooperation was expressed. The women stated that any new organizational structure based on cooperation would be contingent upon effective leadership.
- The women stated that the games and discussion were effective means of demonstrating why they should improve their organization, cooperate and build trust. They suggested that others involved in ASM would derive the same benefits from playing the games. They expressed gratitude for participation in the game activities.

### ***7.5.1 Limitations of the Study***

The limitations of the study were as follows:

- The reef picking groups is a small sample – Henrich et al's research used larger samples.
- Variability of Henrich et al's data makes cross-cultural comparisons challenging. It is useful to determine general similarities and consistencies but more extensive research with the reef picking group is required.
- Research involved limited access to participants: fieldwork involved one site visit to Rwamagasa.
- Translation can often interrupt the natural flow of communication during the execution of games and discussion. Cultural nuances may be overlooked.

- A multitude of variables may influence game results – examination of these was beyond the scope of the research.
- Additional, longitudinal studies are required to test the effectiveness of the games on long term behaviour and organizational change.

Despite the above limitations, fieldwork at Rwamagasa was conducted in accordance to guidelines that ensure rigour, ethical soundness and validity of data. As research conducted as part of the Global Mercury Project, strict adherence to UNIDO protocol and research ethics and procedures was maintained. Participants were involved voluntarily in this research, gave informed consent and are active stakeholders in the on-going GMP activities in Tanzania.

## **8 Conclusions and Recommendations**

The objectives of improved productivity and environmental performance, better health and safety, capacity building and enhanced community well-being guided GMP research in Tanzania. It was determined that improved organization was key to meeting these objectives. This work attempted to improve the currently disorganized, individualistic and highly unproductive organizational structures in ASM in Tanzania. Research was conducted around barriers to improved organization and factors determining current inefficiencies. It was concluded that an optimal approach to improved organization would involve miners working in small groups, with a view to some forming cooperatives or other more sophisticated groups. Research revealed that, in addition to lack of finance, education & training, equipment, business knowledge, leadership and role models, the absence of trust is the main obstacle in the promotion of cooperation, team work and organizational change.

With the focus on encouraging cooperative behaviours and building trust it became obvious that understanding the nature of trust in among the ASM communities was essential. Economic games were considered a valuable research method for this purpose. A group of women at a small-scale gold mine were chosen to participate in an experiment designed to assess the current nature of trust and cooperation and to demonstrate the value of cooperative work behaviours through economic games.

It was suggested that economic games could be adapted to: a) improve understanding of the nature of trust and cooperation in ASM communities and; b) serve as an educational tool to demonstrate the benefits of cooperative behaviours in ASM in terms of increased productivity, safety, access to finance and enhanced worker wellbeing.

Results from fieldwork support this suggestion, demonstrating how the adaptation and application of economic games can provide an insight into the nature of trust and cooperation, and a means by which to promote cooperation among those in the ASM sub-sector.

The main conclusions and contributions from this research are:

- Understanding the nature of cooperation and trust in ASM communities is greatly facilitated through the adaptation and use of economic games such as the PGG, UG and DG. This research concluded that for the group of miners at Rwamagasa, trust and cooperation are currently absent from their work arrangements. The focus group discussion revealed that trust and cooperation exist outside of the reef picking context and game results suggest that this ASM group have a proclivity towards cooperation and trust. The significance of these results is greater understanding of the miners, and the acquisition of data useful for future design of alternative organizational structures. In the larger context of ASM, these results demonstrate that groups working with high levels of individualistic, untrusting and uncooperative behaviour may possess an inclination towards cooperation that can support organizational change.
- Economic games, especially the Grab game, can be adapted to suit particular ASM groups to serve as useful educational tools for the promotion of cooperation and trust. The proof of the Grab Game as an effective tool in promoting cooperation and trust as a means to facilitate organizational improvements was evident in both the progressive increase in duration of games and in the post-game discussion. Given the situational influences at play, it might be useful to consider attributional biases such as fundamental attribution error – ‘the tendency for people to over-emphasize personality-based explanations for behaviours observed in others while under-emphasizing the role and power of situational influences on the same

behaviour<sup>15</sup>". Discussion with the reef pickers suggests that the context within which the reef picking occurs was created, albeit with good intentions, by Mr. Kadeo, with little regard for potential psychosocial repercussions. There are unanticipated consequences from the creation of a foreign environment with conditions of high stress, competition and selfishness.

The 30 minute reef picking context is artificial in the sense that it condones normally prohibited and punishable behaviours, and that it exists as an aberrant, anti-social activity that is ultimately self-defeating in nature. It was contrived to benefit the women but is flawed in design and lack of structure. The current arrangement does not result in optimal productivity nor are the potential benefits to the participants derived. As the activity is permitted as a form of charity, or as "small-scale mining social responsibility", there has been little effort given to improving the conditions under which the women work. There is no direct economic gain for the mine owner and the permission to pick waste is considered enough of an investment in these women's lives.

- The environment in which the women perform the reef picking might evoke reactions and behaviours that are not indicative of general behavioural patterns but rather a response to a hostile and alien situation.
- The repeated series or subsequent to the explanation of "how to increase your personal and collective gain". The result of working cooperatively is a substantially larger future payoff for all members. Alternative, less profitable, strategies occurred among the women who, despite repeated plays, obtained the smallest possible gains with some women getting nothing.

Hyperbolic discounting, "the tendency to have a stronger preference for more immediate payoffs relative to later payoffs<sup>16</sup>", may account for outcomes in the games played with the reef pickers. Rather than wait for the amount of

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<sup>15</sup> Wikipedia definition. source: [http://en.wikipedia.org/wiki/List\\_of\\_cognitive\\_biases](http://en.wikipedia.org/wiki/List_of_cognitive_biases)

<sup>16</sup> Ibid.

candies to increase in the Grab Game, the women opted for an immediate, yet smaller payoff. The optimal strategy in this game is to wait for the amount to progressively increase, to cooperate by waiting for this augmentation prior to grabbing. It would then be most beneficial for the individual to grab the large amount without consideration of others. This was not the strategy advised in the post game discussion and nor was it a strategy chosen by participants during the repeated series or subsequent to the explanation of "how to increase your personal and collective gain". The result of working cooperatively is a substantially larger future payoff for all members. Alternative, less profitable, strategies occurred among the women who, despite repeated plays, obtained the smallest possible gains with some women getting nothing.

Research opportunities derived from this work would involve further examination, in greater depth, of the nature of cooperation in ASM groups throughout the world. Research involving larger and varied samples would provide useful and interesting data to enhance understanding and support efforts to improve conditions within disorganized ASM contexts.

Additional work is also recommended to measure the long-term impact of economic games as an educational tool. A larger cross-cultural, longitudinal study would provide an opportunity to explore these effects of economic games in the promotion of cooperative behaviours.

It is also recommended that the grab game be used with the same sample group with higher stakes. By using ore as the object of value, the similarities between the reef picking and the game could be even more striking. This can also provide an opportunity to demonstrate, compare and contrast individual profit from current work arrangements, to individual and group profits from an improved cooperative arrangement. It can serve as a precursor to the introduction of new work arrangements for the reef picking.

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