

## Risk attitudes and mitigation among gold miners and others in the Suriname rainforest

Marieke Heemskerk

### Abstract

*This article analyzes the question: do attitudes towards risk influence participation in small-scale gold mining, a hazardous activity that generates uncertain income? This question is examined by measuring and comparing the risk attitudes of gold miners and non-mining community members in the rainforest of Suriname, South America. The author presents a multivariate model to predict the duration of work in mining areas as a function of risk tolerance, age, education, and household demographics.*

*The results suggest that a greater tolerance to risk increases the duration of a person's mining career. However, attitudes explain only a fraction of the variation in occupational choices. Qualitative data suggest that these choices are primarily shaped by local barriers to human capital development and by national economic volatility. Given their marginal position in society and the multitude of mining risk mitigation strategies, it is questionable whether gold mining exposes Suriname forest peoples to greater risks than other subsistence alternatives. The author argues that sensitivity to local historical and cultural conditions would improve the efficiency of policies aimed at developing a more sustainable mining industry. By zooming in on the daily lives of miners, anthropology can complement macro-scale analyses and contribute to policy interventions in the small-scale mining sector.*

*Keywords:* Risk-attitude scale; Small-scale gold mining; Amazon; Suriname.

### 1. Introduction. Why do people become small-scale miners?

This article examines the question: do attitudes towards risk explain why some people are more likely than others to become small-scale gold miners? This query relates to the larger question of why people engage in subsistence activities that provide little economic security and present severe health hazards. Among the many high-risk jobs that poor people in developing countries pursue, small-scale mining merits attention because growing numbers of people depend on it for their livelihood. Employing about 13 million workers, small-scale mining may sustain 80 to 100 million people worldwide (ILO, 1999). Small-scale miners extract more than 40 different minerals, including precious, semi-precious, heavy, and industrial minerals, and construction materials (Hilson, 2002). This article looks at the mining of gold, the most popular and lucrative mineral extracted by small-scale producers (Veiga and Hinton, 2002).

While sustaining many poor households in the developing world, small-scale gold mining also presents economic, physical, and environmental risks to miners, their families, and communities near mining areas.<sup>1</sup> Variable income and unreliable contracts make for economic uncertainty, exacerbated by robberies and criminal assaults (Cleary, 1990; MacMillan, 1995). Due to the demanding and unregulated nature of their work, many miners suffer from muscular strains, wounds, and other injuries. The techniques and chemicals that small-scale miners use damage human health and the natural environment. These environmental impacts — including deforestation, mercury pollution, and the development of drug-resistant malaria — plague old mine-sites well after mining activities have ceased (Peterson and Heemskerk, 2001; Veiga and Hinton, 2002). Inadequate public regulation and services, such as police protection and medical care, perpetuate the chaos and insecurity of small-scale gold mining areas in many regions of the developing world.

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<sup>1</sup> See the February 2002 special issue on "Mining, People and the Environment" of *Natural Resources Forum*, 26(1), and the March 2003 special issue on "Environmental Management in the Small-Scale Mining Industry" of the *Journal of Cleaner Production*, 11(2).

Despite concern among policy makers about the social and ecological disruption produced by gold rushes, what causes people to participate or not remains poorly understood. Researchers have explained gold mining as a livelihood of last resort for poor, unemployed, and poorly educated people (Cleary, 1990; MacMillan, 1995; Schmink and Wood, 1992). Yet it is less clear why people living under comparable political and socio-economic conditions make markedly different decisions about mining. In this article, I investigate whether attitudes influence these decisions. MacMillan (1995: 73) reports that small farmers see mining as 'an adventure' and a 'welcome break from the monotony of agricultural work.' Naughton (1993) finds that gold miners boast about their toughness, and others report that miners have exaggerated expectations of striking it rich (MacMillan, 1995; Naughton, 1993; Slater, 1994). If risk taking characterizes gold mining, one might infer that gold miners are inherently more tolerant of risks than their non-mining community neighbours.

I test this inference in the small South American country of Suriname. I measured the risk attitudes of forest peoples who were either small-scale gold miners or engaged in other jobs. A multivariate model is used to predict the duration of working in the mining area as a function of risk tolerance, age, education, and household demographics. The results suggest that increased tolerance to risk increases the duration of mining careers, though attitudes only explain a small fraction of the variation in occupational choices. The discussion section places this finding within a broader context of subsistence risk and risk mitigation among Suriname's forest peoples. The present article complements macro-level, structural analyses of the small-scale mining industry<sup>1</sup> by documenting how miners confront risk at a personal level (see also Cleary, 1990; Godoy, 1990; Heemskerk, 2002). The micro-level, socio-cultural dimensions of small-scale mining deserve attention because they mediate the success of policy efforts aimed at formalizing and legalizing the small-scale mining sector. Formalization through licensing, registration, and law enforcement is a first step towards producing a more sustainable artisanal and small-scale mining environment.

## 2. Study area

### 2.1. Suriname

Suriname is located north of Brazil, between Guyana and French Guiana (Figure 1). The majority of its population (est. 441,356) lives along the coast, primarily in the capital city of Paramaribo (ABS, 2002). The forested interior houses several Amerindian and Maroon ethnic groups that claim different forest territories. These groups operate largely independently from the nation State in political, legal, religious, and socio-cultural matters. The country's gold deposits are part of the Guiana Shield, a geological

greenstone formation that covers 415,000 km<sup>2</sup> of Venezuela, the Guyanas, and Brazil (Veiga, 1997a).

Gold mining has historically been part of the economy of Suriname (Bubberman, 1977). Yet the number of people involved, the amount of gold extracted, and the social and ecological impacts of mining have increased dramatically since the Amazon gold rush spread from Brazil into the Suriname interior by the early 1980s (Heemskerk, 2001). National annual gold production increased from about 30 kg/yr in 1985 to an estimated 10,000–12,000 kg/yr in 1998 (Peterson and Heemskerk, 2001). Almost all gold is extracted by 10,000 to 20,000 small-scale gold miners, three quarters of whom are Brazilian migrants, called *garimpeiros* (Veiga, 1997a). Maroons, forest peoples of African descent, make up the remaining quarter of Suriname's small-scale gold mining population. This latter ethnic group is the focus of this article.

### 2.2. Maroon gold miners in the Suriname rainforest

Suriname's approximately 80,000 Maroons (Price and Price, 2003) traditionally live off subsistence-level horticulture, hunting, and gathering, in addition to migratory wage labour. In the early days, Maroon men sporadically mined for gold when emergency cash was needed (Healy, 1996). Since the 1980s, gold mining has become a critical source of income for Maroon households (Heemskerk, 2001).

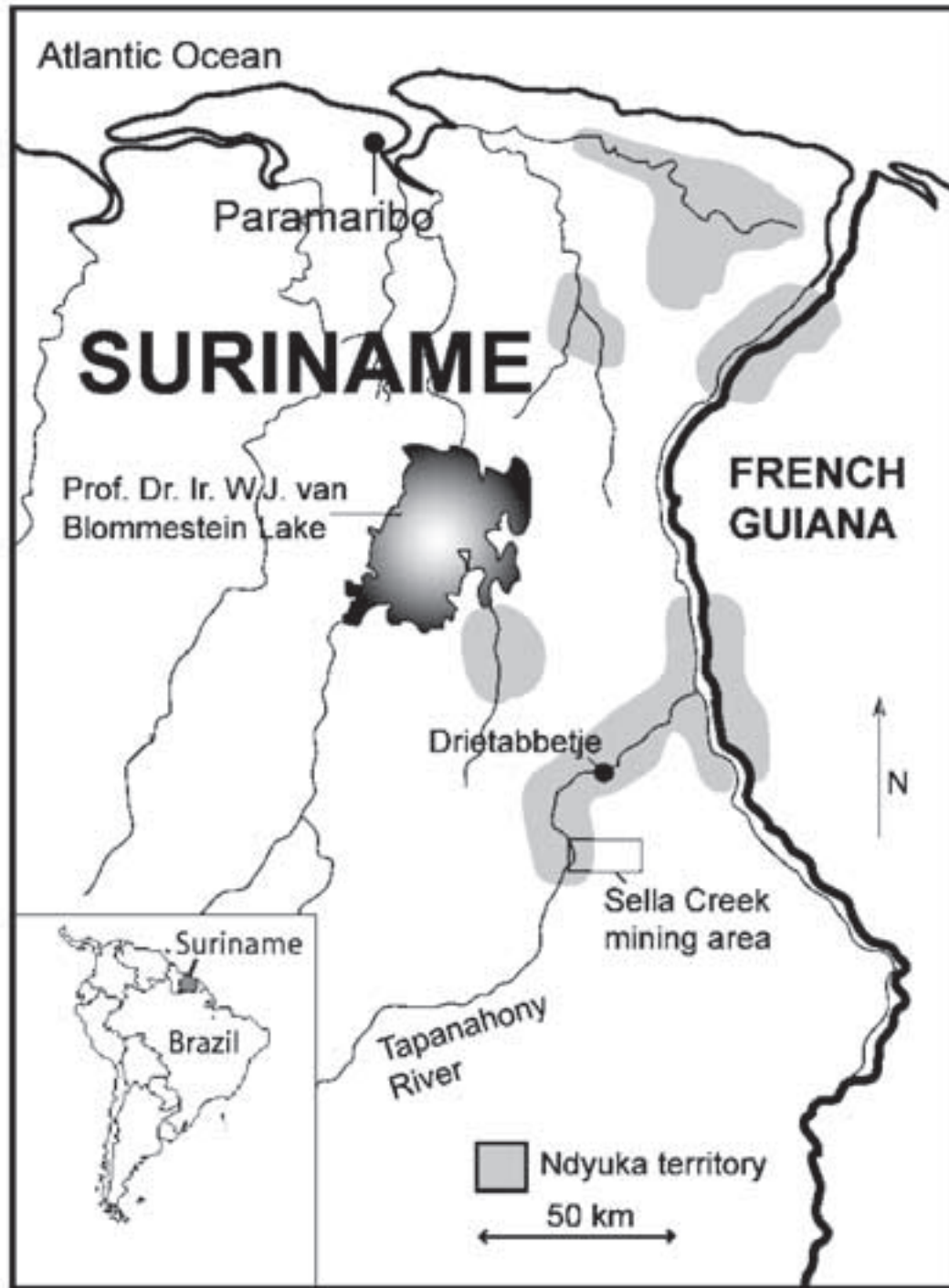
Modern-day Maroon gold miners use hydraulic equipment. After clearing a piece of forest, miners apply water under high pressure to remove the top soil and gold bearing layers of sand and gravel (Plates 1 and 2). Soil contents are pumped through a sluice box, which captures gold and other heavier particles. Mine tailings flow into the nearby forest or into an abandoned mining pit (Plate 3). Using hydraulic methods, miners work in teams that consist of a mine operator, an overseer, five to six pit workers, and a cook. In addition, teams hire temporary or full-time carpenters, boatmen, mechanics, carriers, handymen, and tractor and all-terrain vehicle drivers. Profits vary between and within teams over time, depending on skills, and a great deal on luck. At the study site, the monthly gold production of surveyed operations that worked without bulldozers or backhoe excavators ranged from 275 to 2,750 g, averaging just over 1 kg of gold per machine ( $N = 10$ , mean = 1129; SD = 794).<sup>2</sup> The monthly recovery rate was higher for operations that used heavier equipment.

## 3. Methods

### 3.1. Defining small-scale mining

The term small-scale gold mining has been used interchangeably with artisanal mining, wildcat mining, informal-sector

<sup>2</sup> In 1999, when the data were collected, 1 g of gold was worth US\$ 9.



**Figure 1.** Study area. The map shows the location of Suriname, Ndyuka territory, and the Sella Creek small-scale gold mining area. Drietabbetje is the main Ndyuka village and residency of the tribal chief. Adapted from Heemskerk (2003).

mining, and — in Brazil — *garimpagem*. The practice has been defined in various ways. For the purpose of this article, I characterize small-scale gold mining by:

- Informality; a large degree of independence from social, legal, and economic regulations implemented by the national Government; and

- A labour force that is not formally trained in mining and uses rudimentary techniques for prospecting, extracting, and processing of ore.

Small-scale mining includes both manual mining and mining that makes use of pumps, backhoe excavators, and other mechanized equipment.



**Plate 1.** Small-scale mining pit. Two miners are operating power hoses to remove the soil (front and back-center). One miner stands next to the suction hose (left-center) to make sure that stones and branches do not enter and clog the hose. The two other miners remove waste materials from the pit. Hydraulic work at this site had started about one week before the picture was taken.

### 3.2. Sample

Ethnographic and survey data were collected during ongoing anthropological fieldwork (1996 and 2003) among the Ndyuka Maroons. The Ndyuka are one of the largest Maroon groups in Suriname and participate most actively in gold mining. In 1998–99, 219 Ndyuka responded to a socio-economic survey, which included an attitude scale. Survey respondents worked either in forest villages along the Tapanahony River or at a nearby mining site at the Sella Creek (Figure 1). The Sella Creek is a tributary of the Tapanahony River and is accessible only by canoe. In the rainy season, boats can enter the creek. In the dry season, miners walk for several hours from the boat landing at the creek mouth to their camps.

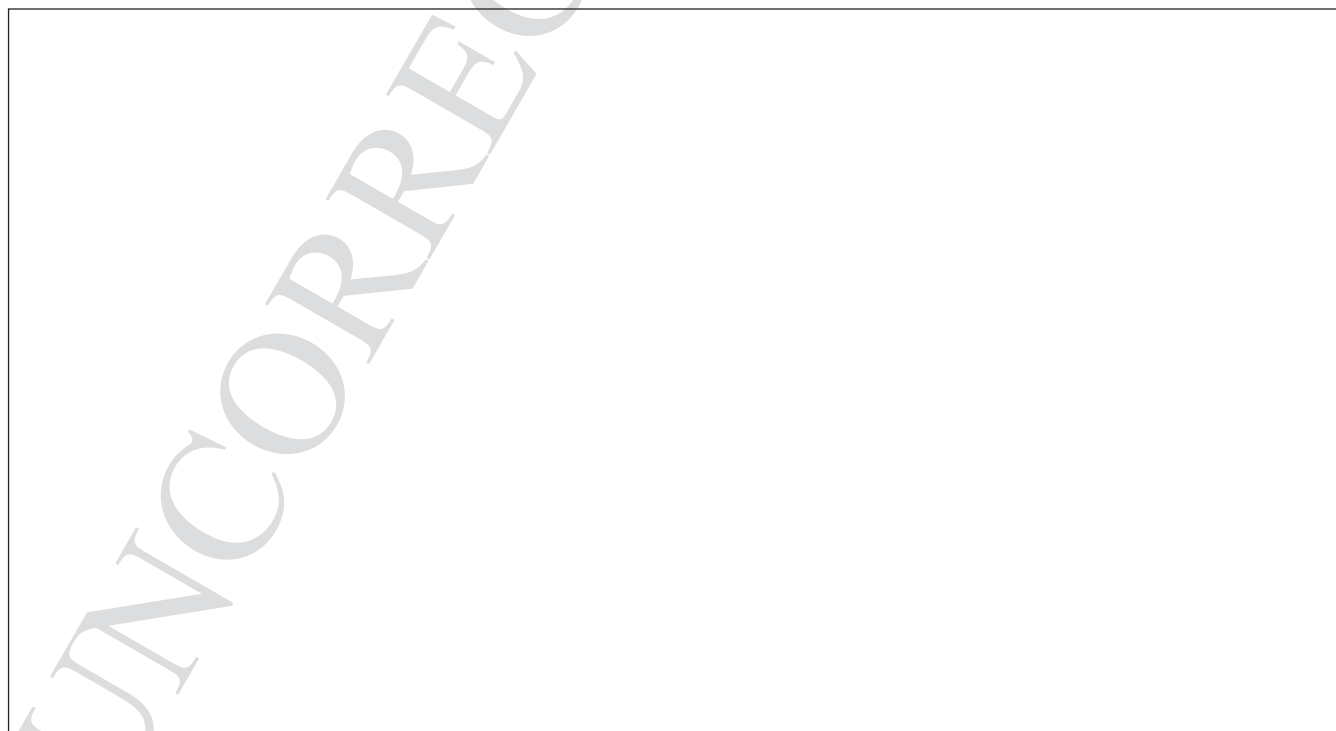
Because Ndyuka men and women confront different responsibilities and risks, and because few Ndyuka women work in the mining areas, the attitude analysis only includes men ( $N = 120$ ), either gold miners ( $N = 86$ ) or non-miners ( $N = 34$ ). For the purposes of this article, I define a gold miner as anyone who works in the mining industry or

its service economy. The definition includes not only operators and pit workers, but also merchants, cooks, and others working in the mining camps. I use this broad definition because all people in the mining area, regardless of their profession, are exposed to malaria and violent crime, the absence of medical care, labour uncertainty, and income variability. I selected a control group of non-mining Ndyuka from the same communities where the miners lived. Non-mining men worked for the Government, in the informal sector, or in the subsistence economy.

I sampled purposively to capture the experiences of people who differed in age, wealth, and other characteristics. Random sampling was not possible because Maroon men continuously travel between mining areas, their home villages, and the capital city, where they sell gold and buy city products. Table 1 summarizes the sample characteristics for miners and non-miners separately. Gold miners were on average younger than non-miners, but the groups did not differ in family composition or educational indicators (years of formal education completed, literacy, language skills). Some non-miners had prior mining experience, but



**Plate 2.** Miners use hydraulic power to remove the soil. The power of the water makes the miner lean forward on the hose.



**Plate 3.** Mining tailings flow into adjacent forest and an abandoned mining pit. Note the fallen trees in the old mining pit behind the sluice box.

**Table 1. Socio-demographic characteristics of the complete sample, and of miners and non-miners separately**

Variable <sup>1</sup>	Sample	Miners	Non-miners
<i>N</i>	120	86	34
Age, mean (SD)*	33.9 (12.3)	31.2 (9.2)	40.1 (16.1)
Number of children, mean (SD)	3.5 (4.0)	3.3 (3.9)	4.0 (4.2)
Ratio children to workers in the household, mean (SD)	2.0 (2.2)	1.9 (2.2)	2.1 (2.1)
Number of years formal education completed, mean (SD)	5.7 (3.8)	5.9 (3.3)	5.0 (5.0)
% Literate	69	70	65
% Dutch speaking (national language)	66	69	57
Number of years mining experience, mean (SD) *	8.7 (8.4)	10.8 (8.1)	3.3 (6.4)
Risk tolerance score, 0 = most risk averse, 1 = most risk tolerant; mean (SD)	0.90 (0.17)	0.90 (0.16)	0.89 (0.20)

*Notes:*

<sup>1</sup> Significant tests are either 2-tailed *t*-tests or Chi-squared tests (for percentages) for the difference between miners and non-miners.

\* Indicates that the difference between miners and non-miners is significant at the 0.001 level.

**Table 2.<sup>1</sup> Results of the principal component analysis for scale items measuring risk-tolerant versus risk-averse attitudes**

Risk attitude: Risk-tolerant versus risk-averse	Item mean	Factor loading 1	Factor loading 2
% of variance explained		51.00	20
Eigenvalue		3.07	1.19
When I encounter a snake I will kill it	0.65	0.79	-0.45
I am not afraid when I walk alone in the forest	0.67	0.81	0.29
I don't mind going outside at night	0.98	0.09	0.83
I walk on my own to other fields and camps	0.69	0.84	0.23
I don't run away when I see a snake	0.69	0.87	-0.33
I am not afraid when I pass the rapids by boat	0.58	0.57	0.25

*Note:*

<sup>1</sup> Item values are based on a Likert-like scale ranging from 0 to 1; scores approaching 1 indicate a more risk-tolerant attitude, while scores approaching 0 indicate risk avoidance. Several statements are displayed reversed from the way they were originally presented to respondents for reasons of consistency in the Table. Cronbach's alpha = 0.80.

on average they spent less time in the mining area than Ndyuka who were mining at the time of the interview.

### 3.3. Risk-attitude scale

The survey included a three-point risk-attitude scale with 10 statements about activities unrelated to mining that were familiar to the Ndyuka and perceived as hazards. I assumed that general avoidance of daily life hazards translated into risk aversion. A typical statement was: 'I am afraid to cross the rapids by canoe.' Respondents could 'agree,' 'disagree,' or be 'neutral/not know.' I used the responses of 63 test observations to test the scale for validity and reliability (Bryman and Cramer, 1997). These test observations are not considered in the present analysis. I corrected the scale by deleting, adding, and reformulating statements based on my impression of how well the statements measured risk-tolerant versus risk-avoiding attitudes (Heemskerk, 2000). The adjusted scale was tested again for internal reliability using Cronbach's alpha procedure and factor analysis (Bryman and Cramer, 1997)

Individual interviewees received a risk-attitude score based on their responses to six statements that made up the

final scale (Table 2). I calculated these scores as follows. I assigned a numeric value to each of the possible answers for every question (risk taking = 1, risk averse = 0, neutral = 0.5). I divided the sum of answer scores by the number of questions (6), to obtain a ratio between 0 and 1. The ratio expresses whether someone tends to take (score close to 1) or avoid (score close to zero) risk.

### 3.4. Regression analysis

I used a multivariate model to predict the duration of a person's participation in mining as a function of risk attitudes. The dependent variable is the number of years that a person has been mining for gold. The logic is that the longer an individual mines, the greater the risks to his health. The time measure differs from a measure of present involvement in mining in that it includes people who are no longer mining today. This approach decreases the bias that would result from the most successful miners leaving the mining industry. Moreover, it accounts for people taking a pause between years of mining. I include the dependent variable as the log of the number of years spent in mining.

**Table 3. Regression results for the Tobit model predicting the duration of mining<sup>1</sup>**

Predictors	Definition	B	t(p)
Risk tolerance	Likert scale of risk tolerance, ranging from most risk averse (RT = 0) to most risk tolerant (RT = 1)	1.45	2.40 (0.018)
Dependency ratio	Ratio of dependents versus able-bodied adults in the household	0.11	2.11 (0.037)
Age	Age of the person	-0.03	-2.42 (-0.046)
Education	Number of years of formal education completed	-0.04	-1.42 (0.158)
Constant		1.41	2.09 (0.039)

*Note:*  
<sup>1</sup> The dependent variable, log (years in mining), is the natural logarithm of the total number of years a person has spent working in the mining area regardless of current performance in a mining-related job.

Model summary

*N* = 116; 15 left-censored observations at log(years in mining) ≤ 0, 101 uncensored observations

$\chi^2(\text{Prob} > \chi^2) = 13.06 (0.011)$

Log likelihood = -166.43753

Pseudo *R*<sup>2</sup> = 0.0378

Within the group of non-miners (*N* = 34), 15 individuals had never worked in a mining area. To correct the model's functional form for the disproportionate number of zero values in the dependent variable, I use a left-censored Tobit regression rather than the more common Ordinary Least Squares regression. The Tobit model controls for age, education, and a ratio of dependents to workers in the household. This ratio is a measure of household economic needs versus income earning potential. Variable definitions and regression results appear in Table 3. The coefficients in Table 3 represent the percentage change in the time spent in mining due to one unit change in the explanatory variable, when all other explanatory variables are held constant.

#### 4. Results

After deleting the items that produced the most error, I obtained a reliable risk-attitude scale with six items (Cronbach's alpha = 0.80; Table 2). The two most important factors explain 51% and 20% of the variation in responses, suggesting that the scale captures two main dimensions of risk attitudes. The most important factor measures people's response to natural elements beyond their control, such as snakes, the uncultivated forest, and rapids. The question that scored high on the second loading factor, "I don't mind going outside at night," probably captures fear of supernatural forces, which are more active during night-time. I did not identify adequate questions to test attitudes towards economic risk. For example, the statement "I like to gamble for money" was omitted because few participants had ever gambled. Hence a limitation of the scale is that it only tests attitudes towards (super) natural hazards and not towards economic risk.

The results suggest that while risk attitudes do not differentiate current miners from non-miners (Table 1; one-tailed *t*-test, *t* = -0.30, n.s.), they do affect the length of mining careers. Individuals who score higher on the

risk-tolerance scale are predicted to spend more years working in gold mining areas (Table 3;  $\beta = 1.45$ , *t* = 2.40, *p* < 0.05). Its abstract nature makes it difficult to interpret the social effect of an attitudinal change. Yet, one can distill that a 10% higher score on the risk-attitude scale corresponds to a person working a 15% longer time in mining.

Of the control variables, age and the ratio of dependents to workers in the household are statistically significant predictors of the duration of a person's mining career. Each year of increase in age is predicted to decrease the number of years spent in mining by 2.5% (Table 3;  $\beta = -0.025$ , *t* = -2.40, *p* < 0.05). This finding is counter intuitive, as having lived more years, older men could have been mining longer. The fact that age negatively relates to the amount of time a person has spent in mining suggests that young Ndyuka today are more likely to become gold miners than young Ndyuka of the past. The multivariate results further suggest that the presence of more dependents (i.e. children and elderly) and fewer adult workers in the household increases the duration of mining involvement. People from households with twice as many dependents as workers are estimated to mine 11% more years than people with equal numbers of dependents and workers (Table 3;  $\beta = -0.11$ , *t* = 2.11, *p* < 0.05).

Having completed more years of formal education is suggested to decrease the propensity for working in mining, but the coefficient is statistically not significant. It is possible that a larger sample would generate a more significant effect. Such a finding would be consistent with the expectation that higher educational attainment decreases the propensity to participate in mining (Heemskerk, 2002; Schmink and Wood, 1992). The overall predictive power of the model is weak, suggesting that factors other than attitudes, age, education, and the economic dependency ratio motivate people to become gold miners (*R*<sup>2</sup> = 0.0378). The fact that many other combinations of explanatory variables did not generate stronger statistical results can also mean that the complex and diverse considerations underlying the decision to enter mining are not readily captured in a linear model.

## 5. Discussion. Confronting risk in and outside of mining areas

People who mine for consecutive years are suggested to be the relatively more risk-tolerant in Ndyuka society. Two observations explain this finding. First, local socio-economic conditions motivate a majority of Ndyuka men to enter mining at some point, but those who are more easily discouraged quit sooner. Disappointing earnings, physical injury, and traumatizing events, such as the death of a family member, are the most frequently mentioned reasons for leaving the mining area (Heemskerk, 2002). Others, presumably those with a higher tolerance for risk, continue to work in the mining area even after meeting adversity. Second, longer stays in the mining area increase risk, as a person's overall health status deteriorates with cumulative years of poor diet, strenuous work, unsanitary conditions, and malaria episodes. More risk-averse men reduce exposure to health risks by working for fewer years in total, and by taking longer breaks between mining years.

Yet, risk attitudes explain only a fraction of the variation in occupational choices. Understanding people's multi-faceted motivations to spend years of their lives in mining camps requires an evaluation of mining risks *vis-à-vis* risks in other jobs available to the Ndyuka. Many fatal and disabling accidents occur in small-scale mines throughout the world, but these accidents are typically under-reported or not reported at all. Furthermore, due to limited access to health care and widespread self-medication in small-scale mining areas, there are few reliable statistics on the incidence and spread of malaria, HIV/AIDS, mercury contamination, and substance abuse among mining populations.

Suriname is no exception. There are no national statistics on the frequency of accidents, death, illness, and other calamities in small-scale gold mines, nor on the economic volatility of gold miners. For example, no systematic HIV-testing takes place in Suriname mining areas and surrounding Maroon communities. Hence, virtually nothing is known about HIV-prevalence, populations at risk, and the relation between mining-related sexual behaviour and recent AIDS deaths in the interior of Suriname. The following impressions of hazards and uncertainties in and around Suriname gold-mining areas are based on anthropological observations and interviews.

### 5.1. Economic risks

All people working in the mining area share a great deal of risk, but some mining professions are more risky than others. In economic terms, the owners of mining equipment and camps are most at risk. These mine operators usually borrow money to set up a hydraulic unit, which costs approximately US\$ 20,000. In addition, they are responsible for all operating costs. In 1998–1999, Sella Creek operators spent on average 600 g of gold (~ US\$ 5,400) each month to keep their operations going ( $N = 21$ ,  $SD = 421$ ).

Prospecting occurred haphazardly and net earnings varied widely, ranging from a low of 14 g to over 1 kg/month reported by the most successful operators ( $N = 21$ , mean = 344 g/month,  $SD = 364$ ). Some operators find barely enough gold to cover extraction and subsistence expenses. Others go bankrupt or temporarily close their mine to work for neighbouring operators until they have earned enough money to re-stock fuel and supplies.

Economic risk is also high for independent entrepreneurs who are paid on credit, such as merchants, sex workers, and the drivers of tractors and all-terrain vehicles. A traveling salesman said: "It is difficult to find money. . . . If people need to pay you 100 g, you perhaps receive 50 or 60 g. It can take one or two years [before they pay]." A carpenter who built camp structures and sluice boxes experienced similar problems, as he complained that: ". . . you cannot trust people in the forest to pay you back." By contrast, most cooks earn a fixed fee, with 60 g/month being the most common wage observed in Sella Creek mining camps.

The mine operator supplies food, shelter, fuel, and equipment in exchange for the main share of ore recovery. In Sella Creek, this share is usually 70%. The operator's skills and luck determine the wages of pit workers, who divide the remainder of the variable gold production. In a team with six pit labourers, this translates to 5% per labourer. Pit labourers reported gold earnings ranging from 13 to 150 g/month in the month prior to being interviewed, averaging 43 g per month, the equivalent of approximately US\$ 387 in 1999 ( $N = 32$ ,  $SD = 27$ ). A large share of pit-workers (39%) had earned between 20 and 40 g/month in the month prior to the interview, and over a quarter (27%) had earned less than that. Three miners had earned more than 160 g/month on barges elsewhere. Because pit workers do not invest financially in the operation, their economic risk is relatively low. They are unlikely to return home indebted, unless gold earnings are so disappointing that they fail to pay off credit debts to local merchants.

Mining incomes are uncertain and variable, but it is questionable if formal employment provides more economic security to Suriname forest peoples. Some Ndyuka prefer public jobs, because such jobs offer health insurance and social benefits. Others though, are skeptical about relying on the government, because salaries do not cover basic needs and benefits payments are unreliable. Elderly men work as miners because their old-age pensions are insufficient to support their families. Too fragile for the heavy pit-work, they clear forest, build camp structures, and perform other light manual labour. A female camp-boss (39) explains:

I pay for school with the gold mining income. I want my children to complete their education, and then they can go somewhere else. In the early days you received child benefits, now you have to try everything you can.

Some miners commented that mining is economically less risky than relying on wage labour, since a mining boss provides food and shelter. Moreover, a family in the forest can live in a self-constructed house, collect rain water to drink, hunt for bush meat, catch fish, and plant vegetables and staple crops. Meanwhile, monetary devaluation has caused formal wages in Suriname guilders to become insufficient to cover the costs of rent, food, transportation, electricity, and other services in the city.

### 5.2. Health and environmental risks

Like economic risks, mining-related health and other risks vary with the type of occupation. Operators are a preferred target of criminals, and pit workers sustain a disproportionate number of injuries from accidents with machinery. More than others, sex workers are exposed to sexual molestation and sexually transmitted diseases.

All mine workers share exposure to poor sanitation, lack of clean water, malnutrition, malaria and other tropical diseases. Medical assistance is often far away, and even when they are available and affordable, medicines are taken haphazardly. For example, at least four different anti-malaria drugs are taken when miners fall ill with headaches, feverish trembling, and pain in the joints. These symptoms, however, can also be signs of other tropical diseases (e.g. dengue fever, yellow fever), mercury pollution, alcoholism, or a combination of the above. The drugs, which originate from Suriname, French Guiana, Brazil, China, and the Netherlands, are purchased on the black market. This unregulated consumption has stimulated the development of drug-resistance in malaria parasites.

Scientific research and media reporting on the Amazon gold rush have paid a great deal of attention to mercury pollution. Small-scale gold miners use mercury, which amalgamates with gold, to separate gold particles from the soil. This process and its implications for gold miners, communities around mining areas, and the river ecosystem have been documented for Suriname (De Kom et al., 1998; Mol et al., 2001) and other Amazon countries (Veiga, 1997b; Veiga and Hinton, 2002). In addition, river silting and gasoline spillage interfere with the foraging and mating behaviour of fish, amphibians, and aquatic mammals, including the endangered giant river otter (*Pteronura brasiliensis*). Maroon villagers living downstream of mining activity have complained that the meat of freshly caught fish is now mushy and falls apart within an hour. When the fish is cooked, yellow-brown foam is left on the bottom of the pot.

Finally, Ndyuka ancestral and earth spirits both present risks and protect against them. Though outsiders, including *garimpeiros*, may not believe in them, to Ndyuka miners, supernatural control over luck and misfortune is a daily-life reality. For example in 1998, three Ndyuka miners were lost and never found again despite organized searches by other gold miners. The young men were believed to have

been caught by the ‘bush-cow’ — a hairy creature with sharp tusks, according to those who claim to have seen it. Two years later, the same mystical animal was blamed for the disappearance of a Maroon woman from the mining area. Extraction of the earth’s richness (i.e. gold), without paying appropriate dues to the earth deities, allegedly had caused this creature to turn against the mining community. In other instances, occult forces are generated within Ndyuka society itself. For example, jealous Ndyuka with witchcraft powers can hurt successful miners by casting harmful spells upon them.

Does working in the mining area present more physical risk than other occupations available to the rural poor in Suriname? Compared to non-miners, the average miner had experienced more malaria in his or her lifetime (5.5. vs 8.5 incidences of malaria, respectively.  $N = 219$ ,  $t = 3.56$ ,  $p < 0.001$ ). However, malaria seriously endangers the health of non-miners as well. Furthermore, Sella Creek gold miners argued that the mining area experienced less violent crime than the capital city of Paramaribo. An analysis of articles that appeared in the two national newspapers between 1994 and 1998 confirms this claim. Work-related injuries affect gold miners more than criminal activity, but there are no data to compare the number of work-related accidents in mining with that in other professions. Pit workers probably experience more work-related accidents than the average non-miner, but this is not necessarily true for others in the small-scale gold mining industry.

### 5.3. Risk awareness and mitigation strategies

Some people believe that if miners were better informed about mining risks, they would take better protective measures. A World Bank panel on environmental, health and safety issues in small-scale mines, for example, concludes that “education and the communication of information [are] the keys in making . . . miners, governments, and the local communities, aware of the situation and encouraging them to improve it” (Barry, 1996). In my experience, however, few miners miscalculate mining risk and most do take protective measures of various kinds. These measures include adjusting the intensity of the labour regime (e.g. quitting mining for some months to regain strength), selecting a safe work location (e.g. among kin), taking dietary supplements (e.g. taking forest medicines to prevent malaria), respecting dietary restrictions (e.g. not eating taboo animals), and maintaining social networks that will provide assistance in difficult times.

In economic terms, Ndyuka gold miners realize their poor prospects of getting rich, and report expected and actual earnings that match my observations of gold production. Ndyuka miners also understand that the inhalation of mercury vapors and consumption of toxic fish endangers their health and that of their families in the long run. Yet, they reason, not using mercury will jeopardize the immediate economic well-being of their household. Sanabria (1993)

presents a similar argument to explain the participation of Bolivian peasants in coca production, which entails a great deal of environmental and economic risk: “[G]iven an accelerated fall in terms of exchange of traditional highland crops and steadily deteriorating living standards . . . [these] peasants faced a greater threat to their livelihood if they did not aggressively pursue coca cultivation.”

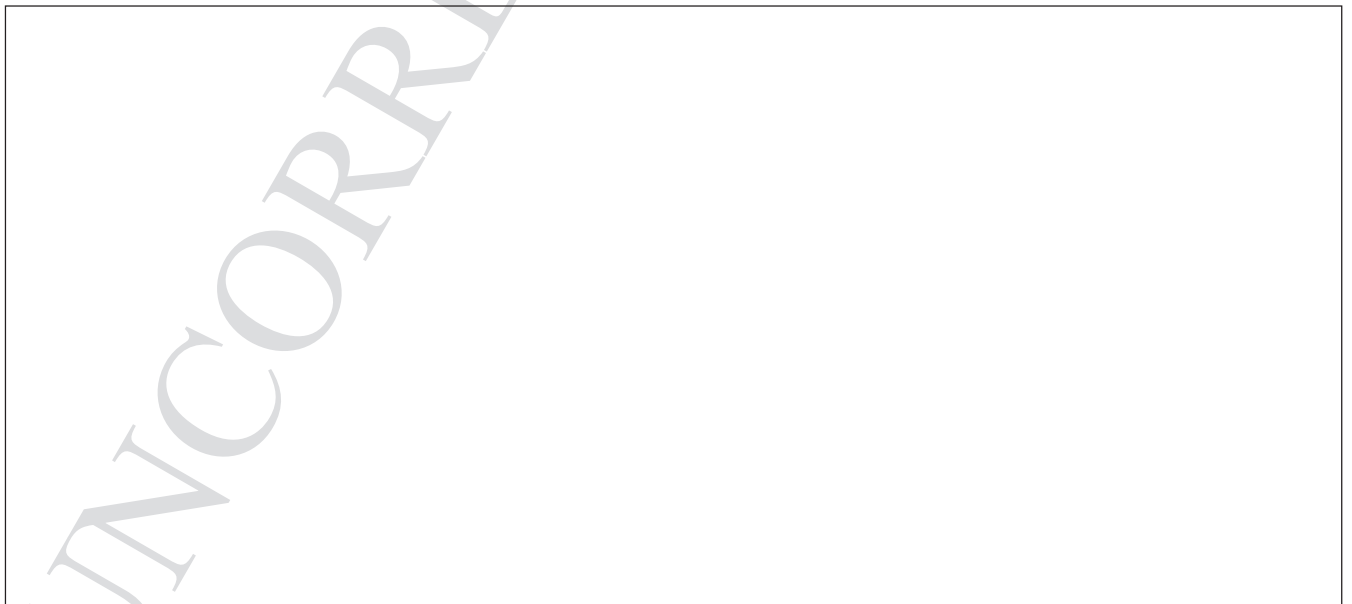
Mercury spillage can be reduced through the use of retorts, closed systems that recycle the mercury. Even though they are relatively cheap and easy to use, retorts have been slow to catch on. Sella Creek miners said they did not want to use retorts, because the burning process takes too long and is too noisy (G. Amelo and M. Oliveira, pers. com. March 17, 2003). For safety reasons, miners do not want others to know when they are burning the gold-mercury amalgam, and noise gives this away. Furthermore, a long history of broken and misleading treaties has shattered Maroon confidence in the good intentions of outsiders. Suspicion of university researchers and politicians leads miners to distrust that the retorts, promoted by these parties, can extract as much gold from the amalgam as does open-air burning. Miners complain that the Government expects them to comply with national regulations concerning taxes, titles, and environmental pollution. However, public preoccupation with the lives of miners in the interior of the country withers when it comes to providing schools, clinics, drinking water, electricity, and other services.

As for the many other risks, miners make efforts to mitigate their effects or to avoid them altogether. For example, many miners guard their health by mining for only a few months out of the year, or only a few years in a row. Part-timers alternate mining with lower paying but less hazardous jobs, such as construction, informal trade, and

subsistence hunting. Gold mining pays for household expenses that other jobs do not cover, such as boarding school fees. Mining money also allows people to invest in alternative income-generating activities, such as a small shop, a car to run a taxi business in the city, or a chainsaw to work in carpentry.

Another risk mitigation strategy is to work among family on tribal lands. Ndyuka miners, who had worked elsewhere, said that outside Ndyuka territory, they lacked the safety net that kin provides. One can work without problems for several months on the territory of another Maroon group, such as the Aluku. But one day, Aluku miners might come to demand payment, chase you away, or confiscate your gold production or machine. Family provides protection from harassment and crime, as well as food, shelter, emotional support, and even a job when times are tough. Working close to home, miners also can visit their homes more regularly and count on tribal authorities to settle disputes about money, mining rights, and women. Furthermore, due to strong social control, relatively few Sella Creek Ndyuka miners use alcohol or hard drugs. Marijuana is popular, especially among young men with an affinity for reggae music. But few Ndyuka use crack cocaine, which is reportedly common in French Guiana mining areas (J.F. Orru, pers. com. January 2003).

Finally, to appease ancestral and natural spirits, mining camps in Sella Creek typically have a small shrine for offerings to deities (Plate 4). In addition, Sella Creek miners continue to respect traditional taboos. Almost all camps keep one weekly work-free taboo day and miners follow personal and group-based food taboos. These precautions reflect an awareness of the dangers of mining life, and miners’ intentions to mitigate these dangers.



**Plate 4.** Religious shrine in a Maroon mining camp. Offerings of an egg and a bottle of beer have been placed at the shrine to honor supernatural powers, and beg them to protect the miners.

## 6. Conclusions. Towards a more sustainable small-scale mining industry

Zooming in on the daily lives of gold miners helps us understand why a person may decide to go mining in the context of personal skills, household needs, and the larger political economy. In deciding whether or not to participate in mining, the Ndyuka consider mining risks versus the risks of other jobs. Personal risk-tolerance plays into this decision, but its influence is small. The data suggest that characterizations of Suriname's gold mining regions as a 'Wild West,' where only the 'tough and tenacious' survive (De Vletter and Hakstege, 1998), oversimplify reality. The popular term 'gold fever' similarly obscures the weighing of gains and costs by individuals who choose to be, or not to be, a gold miner. Differences between miners and non-miners are too small, variation within these groups too great, and risk-mitigation strategies too widespread to justify stereotyping of gold miners as careless adventurers and outlaws.

In general, miners are well aware of mining risks and employ diverse individual (e.g. mining part-time), social (e.g. mining among family), and religious (e.g. begging gods for protection) strategies to avert these risks. Most miners in the study area see mining as a way to escape poverty in a time when traditional subsistence formulas are disintegrating and alternatives are inaccessible or provide insufficient income. In line with this argument, the regression results show that men from households with more mouths to feed and fewer adult workers spend more years in mining-related jobs. Elsewhere I discuss in more detail the international and national (Heemskerk, 2001), as well as household and personal (Heemskerk, 2002, 2003), conditions that drive small-scale gold mining in Suriname.

Formalization and improved sustainability are two sides of the same coin. Promotion of safer and healthier mining practices is virtually impossible if the target population is undocumented, unlicensed, and profiled as outlaws. Local miners, in turn, are unlikely to comply with national mining laws and policies that are insensitive to their history and present socio-economic and cultural realities. Historic developments have left the Maroons today with little political power, low educational attainment, and high dependency on gold mining. Frustrated with nepotism and complex bureaucratic procedures, Maroon miners forgo seeking formal mining titles and instead work without. In response, the military police has forcefully removed small-scale miners and confiscated machinery in several small-scale mining sites closer to the capital city of Paramaribo. Adapting mining regulations to local conditions and assisting miners in legal and technical matters may be a more effective, and ultimately less costly, way to encourage local compliance with mining laws.

An added benefit of formalization and legalization of the small-scale mining industry is that it reduces opportunities for corruption by law enforcement agents (police, military, tax collectors), whose integrity is at times questionable.

Police and military are said to request (enforce) payment for the "protection" of mining camps. Local people also accused military authorities stationed nearby of solving conflicts in favor of the highest paying party. These problems were not evident at the study site, which is situated deep in the forest and far removed from police and military posts. One can only visit the area by boat, which is expensive, inconvenient, slow, and controlled by Ndyuka miners.

Lastly, reducing hazards in small-scale mines will benefit from eliciting information from miners, in addition to bringing information to them. Under what conditions are local gold miners willing to use retorts and pay taxes? What role do miners see for themselves, the Government, large-scale mining companies, and researchers in the small-scale gold mining industry ten years from now? Qualitative interviews reveal that small-scale miners refuse to use retorts not because they are unaware of mercury pollution, but because retorts are deemed unreliable, unsafe, too slow, and bothersome. Local miners may be more willing to try out retorts if they have a voice in the design, building, and testing of these tools. A more sustainable mining industry requires that small-scale miners play an active role in planning, implementation, and evaluation of small-scale mining methods and policy. Ethnographic research can help in the process of designing such policy by revealing the perceptions and opinions of miners and non-miners living near mining areas.

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