



# Livelihood Decision Making and Environmental Degradation: Small-Scale Gold Mining in the Suriname Amazon

MARIEKE HEEMSKERK

Department of Rural Sociology  
University of Wisconsin  
Madison, Wisconsin, USA

*This study examines why mining booms occur and why some people participate in them while others, living in comparable conditions, do not. Ethnographic data were collected among the Ndjuka Maroons, forest peoples in the Suriname Amazon. The occupational justifications of 41 gold miners and 34 nonminers generated a decision-tree model with a 95.5% prediction rate. The results suggest that decisions about mining are rational given the present economic conditions of both Ndjuka households and of Suriname as a whole. The author argues that environmental awareness campaigns and stricter law enforcement are not likely to encourage more sustainable resource use in Suriname, and probably not in other parts of the Amazon rainforest. Rather, more effective conservation policy would be to promote people-centered development in rural regions through improved public education and health care, while stabilizing national economies.*

**Keywords** Amazon conservation, ethnographic decision-tree modeling, Maroons, rationality, small-scale gold mining, Suriname

Small-scale gold mining has gained global importance both as a source of subsistence for the poor and as a cause of environmental degradation (Barry 1996; Cleary 1990; United Nations 1996). The term *small-scale gold mining* refers here to all formal and informal, manual and mechanized mining that uses rudimentary processes to extract gold from secondary and primary ore bodies. Since the 1970s gold rush in Brazil, the

Received 30 November 2000; accepted 30 May 2001.

Marieke Heemskerk is a postdoctoral researcher in the social-aquatic systems graduate training program at the University of Wisconsin in Madison. Fieldwork in Suriname was part of her doctorate in anthropology at the University of Florida. She acknowledges financial support from the National Science Foundation—Division of Social, Behavioral and Economic Research (Doctoral Dissertation Improvement grant 9726292), as well as funding from the University of Florida's Center for Latin American Studies, the Institute of Tropical Conservation and Development, and the Center for Latin American Studies. The author is grateful to the Ndjuka Maroons for their hospitality and participation in the research. Special gratitude is reserved for the people from Drietabbetje and Mooitaki, and the gold miners at Sella Creek, without whose support and cooperation this study would not have been possible. The advice and insights of other people in Suriname, including Ms. Van der Kooye, are also greatly appreciated. Many people provided insightful comments on earlier versions of this article, including three anonymous reviewers.

Address correspondence to Dr. Marieke Heemskerk, Department of Rural Sociology, 350 Agricultural Hall, 1450 Linden Drive, University of Wisconsin, Madison, WI 53706, USA. E-mail: mheemskerk@facstaff.wisc.edu

larger Amazon region has experienced an unprecedented and globally unequaled increase in gold mining (Cleary 1990; MacMillan 1995; Schmink and Wood 1992). Over 4 million men and women in the Amazon are estimated to live off gold mining and the surrounding service economy (Sponsel 1997). Almost all these people are independent, small-scale entrepreneurs rather than employees of transnational corporations.

Governments of Amazon countries often welcome small-scale gold mining because it provides a source of income for their poorest populations and, if it can be controlled, tax revenues. However, small-scale gold mining is also associated with violent crime, armed conflict, forest degradation, mercury contamination, and the prevalence of malaria and sexually transmitted diseases (Akagi et al. 1995; Cleary 1990; Guimarães et al. 1994; Faas et al. 1999; Greer 1993; Forte 2000; MacMillan 1995). Despite public and scientific concern about these social and ecological impacts, scientists still do not fully understand why specific gold rushes occur when and where they do. Measures to reduce the negative effects of small-scale gold mining will only be effective if they address the reasons motivating people's massive participation in today's informal mining industry.

The purpose of this article is to improve understanding of why mining booms happen, and what motivates people to participate or not. More specifically, I analyze the driving forces of gold mining in the Suriname portion of the Amazon rainforest, where mining has boomed since the mid 1980s. Existing research provides two main explanations that are not mutually exclusive. One theory is that small-scale gold mining is a last resort for poor, landless, unemployed, and poorly educated people, who hope through mining "to escape complete social marginalization" (Veiga 1997a, 1; see also Cleary 1990; Heemskerck 2001; MacMillan 1995; Naughton 1993; Schmink and Wood 1992). If poverty is at the roots of gold mining, then public policy that promotes economic security and alternative employment opportunities for the poor may ease the pressure on the environment (Greer 1993; United Nations 1996).

Another explanation is that people enter gold mining because they do not "appraise *garimpo* [gold mining] incomes or the health risks of mining in a realist fashion" (MacMillan 1995, 74). Researchers have documented that both novices and many experienced miners exaggerate their chances of striking it rich, and appear either unaware of, or oblivious to, the environmental and health hazards of mining (Barry 1996; Rawana 2000). These researchers emphasize that either recklessness, a lack of realism, or an undefined "gold fever" (De Vletter and Hakstege 1998) produce rushes to mining areas.

If misinformation increases the attraction of gold mining, then education campaigns that reveal its true costs and benefits might motivate people to take up other professions, or else to adopt less damaging exploitation technologies (Rawana 2000; Veiga 1997a). A World Bank roundtable on artisanal gold mining recently recommended that "education and the communication of information [are] the keys in making . . . miners, governments, and the local communities aware of the situation [of environmental destructiveness] and encouraging them to improve it" (Barry 1996, 7). The assumption that educating people will motivate them to use natural resources more sustainably has been voiced in contexts other than gold mining,<sup>1</sup> but is seldom tested in field research. Indeed, in my own work with academic ecologists I often notice confidence in education as a vehicle for changing environmental awareness and behavior.

While recognizing that information campaigns might improve environmental attitudes in some circumstances, I expect that they will not eliminate the problems that surround the global small-scale gold mining industry. In this article I argue that

in Suriname, and potentially elsewhere, decisions to enter small-scale gold mining are the outcome of informed and rational choices that are shaped by marginality. I define as *marginal* people who are socially, economically, and politically disadvantaged in society at large. I consider an occupational choice rational if a person chooses among available job options the one that yields the highest socioeconomic payoff and incorporates the fewest perceived risks. Possibly the best way to test if decisions to enter mining are rational is to ask gold miners themselves to justify their occupational choice, which is what I did. While social scientists before me have studied gold miners (Cleary 1990; MacMillan 1995; Rodrigues 1994), my approach is novel in comparing gold miners with nonminers in the same population. This controlled approach reveals why people living in a similar socioeconomic and natural environment behave differently.

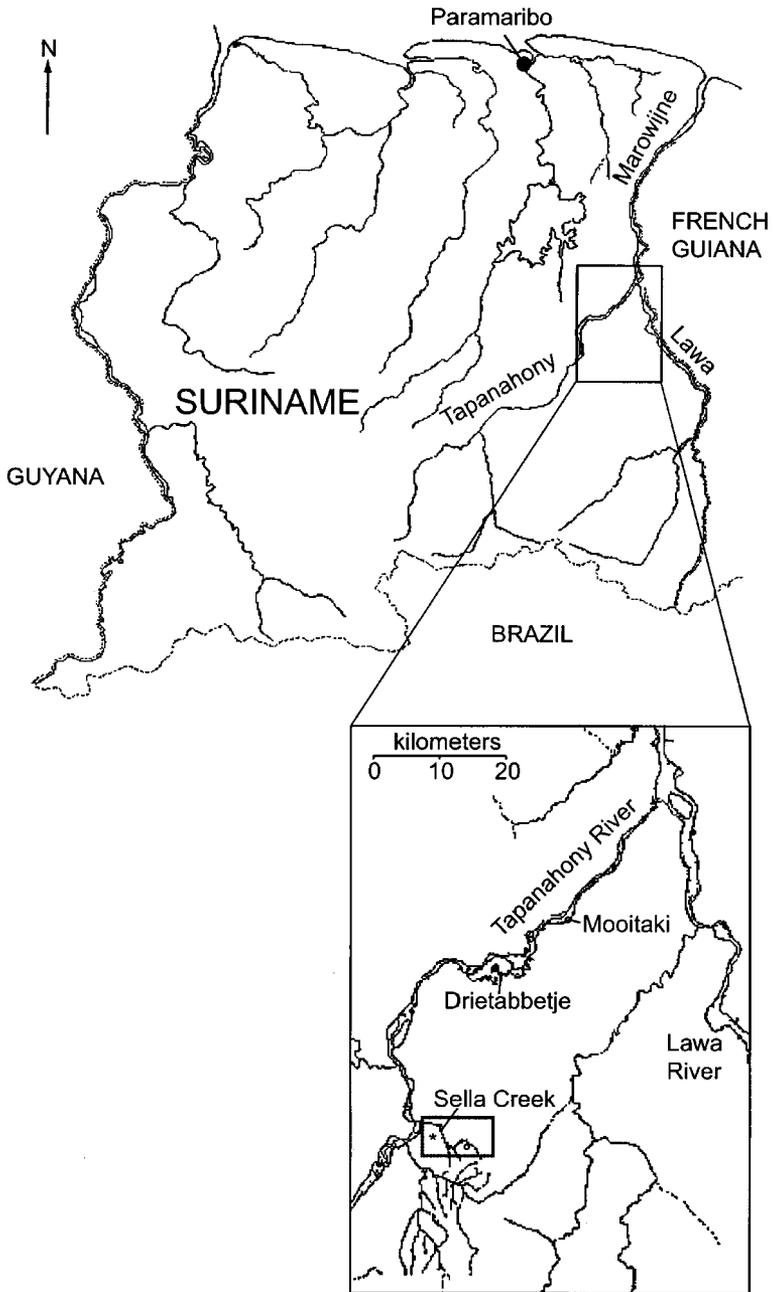
In the following sections I explain why Suriname is a prime location to analyze why people enter gold mining, and provide background information on the Suriname gold rush. Next I justify the methods and present and discuss the results. The article concludes with lessons for conservation in Suriname that, I expect, can be extrapolated to larger areas of the Amazon rainforest.

## The Case of Suriname

Suriname is located in South America, north of Brazil between Guyana and French Guiana (Figure 1). Suriname has a land area of 163,820 km<sup>2</sup>, about the size of the state of Georgia, and a population of 409,000 (Algemeen Bureau Statistiek 1997). Most Surinamers live in the narrow coastal region, in and around the capital city of Paramaribo. Only Amerindians (est. 10,000 people) and Maroons (est. 50,000 people) live in the rainforest that covers 80% of the country. The Maroons are descendants of escaped African slaves, who established independent communities in the forest. Today, six culturally distinct Maroon groups live in Suriname. These groups have maintained a large degree of political, socioeconomic, and territorial sovereignty within the nation-state. This study focuses on the Ndjuka Maroons, one of the largest Maroon groups in Suriname, with an estimated 24,000 members (Price and Price 1999, 19). They live in both eastern Suriname and French Guiana, primarily along the Lawa, Marowijne, and Tapanahony rivers (Figure 1). Most Suriname gold miners are of Maroon descent, and the Ndjuka are more actively involved than members of other Maroon groups (Heemskerk 2000a).

Resource use and labor in Ndjuka society are organized around gender (Heemskerk 2000a; 2000b; Thoden van Velzen and Van Wetering 1991). Men construct houses, boats, and other household items, and provide game, money, and city products. Men usually leave their homes for prolonged periods of time to earn cash income. Today, earning cash typically means gold mining. Ndjuka women care for their offspring, tend to domestic tasks, and grow food for the family. Though women make most decisions about household and agricultural management, they depend on men for essential services, such as cutting and burning farm grounds, and for assets including oil, cloth, and kitchen utensils. Only about 5% of Ndjuka miners are women (Heemskerk 2000b).

Suriname presents an excellent case to study the causes of small-scale gold mining in the Amazon. Most mining research focuses on Brazil, where studying a suitable control group of nonminers is difficult because gold miners originate from diverse urban and rural places that are often far from mining areas. In contrast, Suriname gold miners are almost exclusively Maroons who work near their home communities.



**FIGURE 1** Study area.

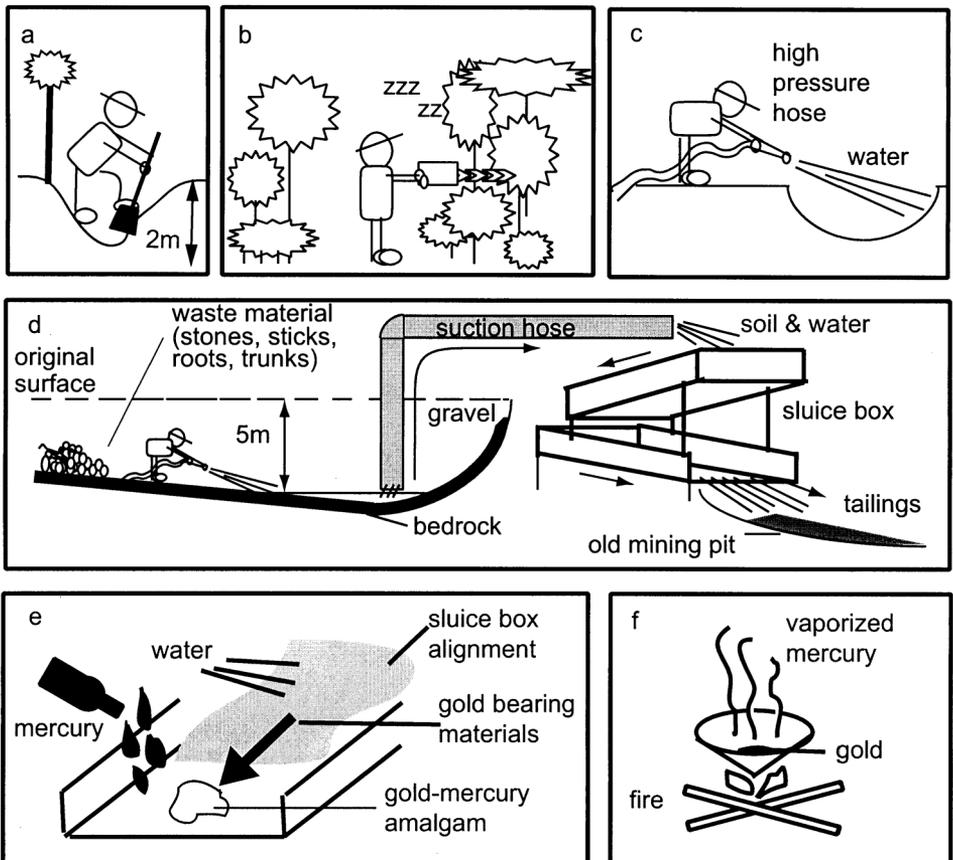
Consequently, I could interview miners and nonminers with comparable ethnic, cultural, and socioeconomic backgrounds. Moreover, Suriname is unique in the Amazon for its low population density and large continuous surface of minimally impacted tropical forest (Mittermeier et al. 1990; World Resources Institute 1998). The virtual absence of cattle ranchers, loggers, landless farmers, and governmental settlement schemes in Suriname helps separate the forces that are driving small-scale

gold mining from those driving other land-use changes. Finally, Ndjuka miners have vested interests in conserving the forest that is the home and source of subsistence for their families. The limited anthropogenic pressure combined with local interests in forest preservation offers a viable opportunity for biological conservation.

### Background: The Suriname Gold Rush

Today's small-scale gold mining industry exceeds all earlier mining activity in Suriname in terms of technological advancement, gold production, and the number of people involved. It is estimated that somewhere between 10,000 and 20,000 small-scale gold miners work in Suriname (De Kom et al. 1998; Veiga 1997b). Only about a quarter of them may be from Suriname. The remaining three quarters are Brazilian migrants, called *garimpeiros* (Veiga 1997b). Unlike indigenous peoples in many Amazon countries who have been victims of invasions by gold miners, Maroons control virtually all gold-bearing territories and mining activity in Suriname. Because Maroons also control travel to and from most mining areas, outsiders depend on Maroons to reach and work in Suriname gold mining.

Almost all small-scale gold miners use hydraulic equipment and apply mercury to separate gold from the soil (Figure 2). Most scientific and media attention has



**FIGURE 2** Hydraulic mining methods. A simpler version of this figure appears in Peterson and Heemskerk (2001).

concentrated on the spillage of mercury in rivers and streams, which may severely affect the physical and neurological health of fish-consuming Maroons in communities near mining areas (De Kom et al. 1998; Van der Kooye 1997). Further documented social and environmental costs related to the Suriname gold rush include violent conflict (Healy 1996; Van der Kooye 1997), the epidemic spread of malaria and sexually transmitted diseases (Antonius-Smits et al. 1999), and a degraded forest ecosystem (Peterson and Heemskerk 2001). Figure 2 helps understand why these impacts occur.

Recent national developments have stimulated the growth of the small-scale mining industry (Heemskerk 2000a). Economic depression and political violence have characterized Suriname since its independence from the Netherlands in 1975 (Bakker et al. 1998). In 1986, ethnic and economic tensions erupted in a civil war between the country's contemporary military government and Maroon insurgents. The civil war destabilized the economy, which has not recovered since the parties signed a peace treaty in 1992. The real cost of food items increased 10-fold between 1990 and 1997 (Algemeen Bureau Statistiek 1997), and inflation reached 586%/yr in 1994 (Brauman and Shah 1999). Unemployment rates that had remained under 5% of the economically active population throughout the 1970s reached over 20% by the late 1980s. People in Suriname who have seen their wages depreciating or else lost their jobs have massively turned to the informal economy. Many of them work multiple jobs to keep their heads above water.

## **Methods**

I use ethnographic decision-tree modeling (Gladwin 1989) to analyze and predict the occupational choices of Ndjuka individuals. Decision trees model the cognitive processes of people who choose between different alternatives, here "mining" or "not mining." Gladwin (1989) explains and discusses the method in detail, and here I only briefly go over its steps. I first asked Ndjuka gold miners and nonminers either "Why did you become a gold miner?" or "Why do you not participate in gold mining?" Thus, rather than testing preconceived ideas about the reasons for mining, I asked an open-ended question that allowed interviewees to elaborate freely on their decisions. When new interviewees no longer added new reasons, I grouped similar reasons under umbrella criteria and used these criteria to construct a preliminary model (not shown).

Like a flow chart, a decision tree contains a set of if-then rules that guide the decision maker from choice alternatives at the top of the tree to a predicted outcome, either mining or not mining. I tested the preliminary model with Ndjuka who had not been part of the first sample, using a questionnaire that followed the model's if-then rules. Based on the responses, I modified the model by adding and deleting segments and rerouting tree paths. When new cases did not require more changes, I tested the model on a test sample of not previously interviewed Ndjuka. The composite decision tree model is acceptable when it predicts at least 85 to 90% of the test cases (Gladwin 1989, 16).

Other than purely descriptive ethnography, the decision-tree model allows for forecasting. This predictive element makes it a useful tool for policymakers, resource managers, and extension agents who want to identify the most effective areas for intervention. An advantage over multivariate analysis is that ethnography does not require the quantification of variables, such as income and wealth, that are often difficult to capture in a rainforest setting. Moreover, the method allowed me to

analyze the insiders' perspective. This perspective is valuable because predictions about people's responses to policy changes are probably more accurate when they take into account how these people themselves perceive their options in society.

### **Data Collection**

Field data were collected from June 1998 to May 1999. Research efforts concentrated on Ndjuka villages and mining activity along the Tapanahony River (Figure 1). In addition, I conducted interviews with a smaller group of urban Ndjuka in Paramaribo. The Sella Creek mining area was the main mining site of the field work. The Sella Creek is a small tributary of the Tapanahony River, situated in Ndjuka territory. No roads extend deep into the Suriname interior, and people travel to and from Maroon villages and mining areas by boat. A few selected places can be reached by plane, unless the airstrips flood during the rainy season.

The Sella Creek mining area does not have an airstrip, is relatively far from the coast, and is situated upstream from several large rapids. From Paramaribo, traveling to Sella Creek takes about 4 days by motorboat, and 1 day if one takes a plane to the nearest airstrip. From the creek mouth, miners walk for several hours to reach their camps. The Sella Creek's difficult access has prevented the introduction of heavy equipment such as backhoe excavators and bulldozers. An estimated 60 to 70 gold mining camps occupied the area, housing a shifting population of about 700 people. These people were primarily of Ndjuka Maroon descent. All *garimpeiros* in the study area worked for Maroon machine owners, who hired Brazilians for their advanced mining skills and experience. The relatively large local segment of the mining population increased social control and hence the safety of this mining area.

Field methods relevant to this study include structured interviews, ethnographic interviews, oral histories, and participant observation. I used structured questions to solicit the motivations for either participating in mining or not. Through qualitative interviews and oral histories I gained a better understanding of the context in which people make occupational choices over time. Like David Cleary (1990), I found the gold mining area an excellent research setting from the ethnographic point of view. The mining area offers little entertainment and if nothing else, conversations with a foreigner were at least a distraction. In fact, most Ndjuka miners seemed pleased with the interest in their lives. While male miners might either exaggerate or diminish their hardships in conversations with a female outsider, a year of observations in the area enabled me to validate and contextualize their stories. All informant names are pseudonyms.

### **Sample and Analysis**

I sampled purposively to capture the heterogeneity in the Ndjuka population in sex, age, occupation, education, and other characteristics. A random sample was not desirable because the selected method required me to cover the socioeconomic and demographic spectrum in the mining and nonmining Ndjuka populations (Gladwin 1989, 27). I worked with two separate samples: a preliminary sample and a test sample. The preliminary sample included 41 gold miners and 34 nonminers, of whom 50 were men and 25 were women. The test sample consisted of 16 men and 6 women, of whom 13 were miners and 9 were nonminers (Table 1).

For the purposes of this study, a gold miner was defined as anyone in the mining area who was part of the mining industry or the surrounding service economy. This definition included not only pit workers, but also merchants, cooks, and other people

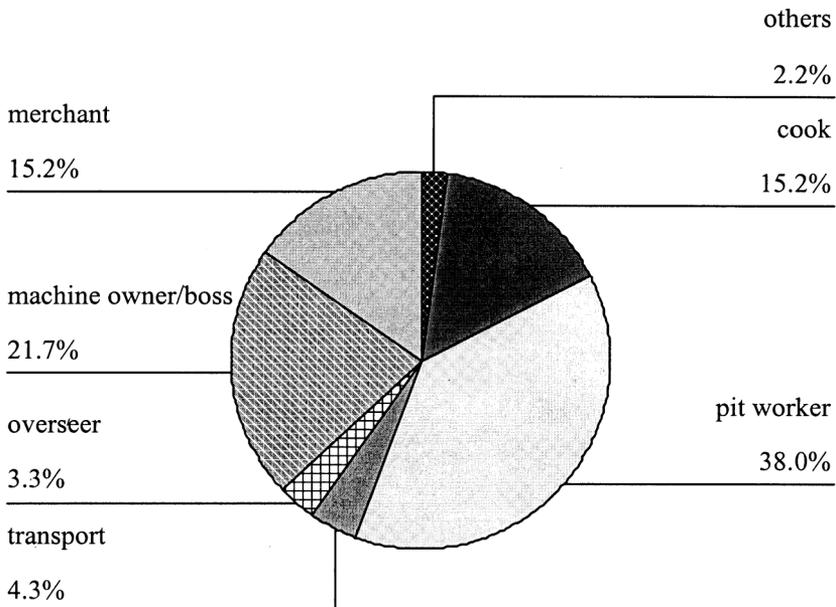
**TABLE 1** Summary Statistics for the Sample Populations, Preliminary and Test Samples

Sample and characteristic	Sample	Men			Women		
		All	Miners	Others	All	Miners	Others
<b>Preliminary</b>							
<i>n</i>	75	50	35	15	25	6	19
Age (years)	33.3 (16–79)	34.4 (16–79)	30.1 (16–48)	44.5 (25–79)	31.8 (18–58)	26.3 (19–39)	33.5 (18–58)
$\bar{X}$ (range)							
Education (years)	4.4 (0–15)	5.3 (0–15)	6.1 (0–15)	3.6 (0–9)	2.4 (0–8)	4.3 (0–8)	1.8 (0–7)
$\bar{X}$ (range)							
Literate (%)	53%	65%	71%	50%	28%	50%	21%
Urban <sup>a</sup> (%)	32%	36%	51%	0%	24%	33%	21%
<b>Test</b>							
<i>n</i>	22	16	12	4	6	1	5
Age (years)	30 (17–52)	30 (21–52)	29 (21–52)	33 (28–35)	32 (17–50)	36	32 (17–50)
$\bar{X}$ (range)							
Education (years)	7.8 (0–17)	8.1 (0–17)	6.7 (0–9)	13.5 (10–17)	6.2 (0–11)	11	5.2 (0–11)
$\bar{X}$ (range)							
Literate (%)	77%	81%	75%	100%	67%	Yes	60%
Urban <sup>a</sup> (%)	73%	75%	83%	50%	67%	Yes	60%

<sup>a</sup> Urban refers to residency in the capital Paramaribo versus residency in the forest or in the coastal villages.

in and around mining camps. It excluded people who invested financially in mining equipment but were not physically present in the mining area. A broad definition of gold miners was preferred because people in the mining area often perform different jobs simultaneously or in sequence. Moreover, all people in the mining area share risks such as malaria, violence, and crime. Therefore, the main livelihood decision for many Ndjuka is whether or not to work in the mining area, rather than what job they might have in a mining location. Figure 3 shows the proportional representation of gold miners in both samples in different mining occupations. Pit workers make up a majority of miners, and they are all men. The second largest group is composed of merchants, and this group includes most women. Women also ran mining operations, cooked, grew vegetables, and did other jobs.

Summary statistics for the samples appear in Table 1. The average age of the preliminary sample was 33 years and ranged from 16 to 79. People in the test sample averaged 30 years of age, ranging from 17 to 52. On average, men in the complete sample (preliminary and test samples) had received more years of formal education than women ( $\bar{X} = 6.1$  years vs.  $\bar{X} = 3.1$  years;  $t = -3.79$ ,  $p < .001$ ). Men were also more often literate than women (70% vs. 39%;  $\chi^2 = 3.62$ ,  $p < .1$ ), but both groups compared poorly to national literacy rates of 94% and 89% for men and women, respectively (Algemeen Bureau Statistiek 1997). People in the test sample had attended formal schools for more years than people in the preliminary sample ( $\bar{X} = 7.8$  years vs.  $\bar{X} = 4.4$  years;  $t = 3.38$ ,  $p < .005$ ) and were more often literate (77% vs. 53%;  $\chi^2 = 3.62$ ,  $p < .1$ ). The difference is probably due to a larger proportion of the test sample compared to the preliminary sample coming from urban areas (73% vs. 32%;  $\chi^2 = 11.64$ ,  $p = 0.005$ ). These differences are not likely to influence the test results because the test sample included representative members of all relevant population subgroups.

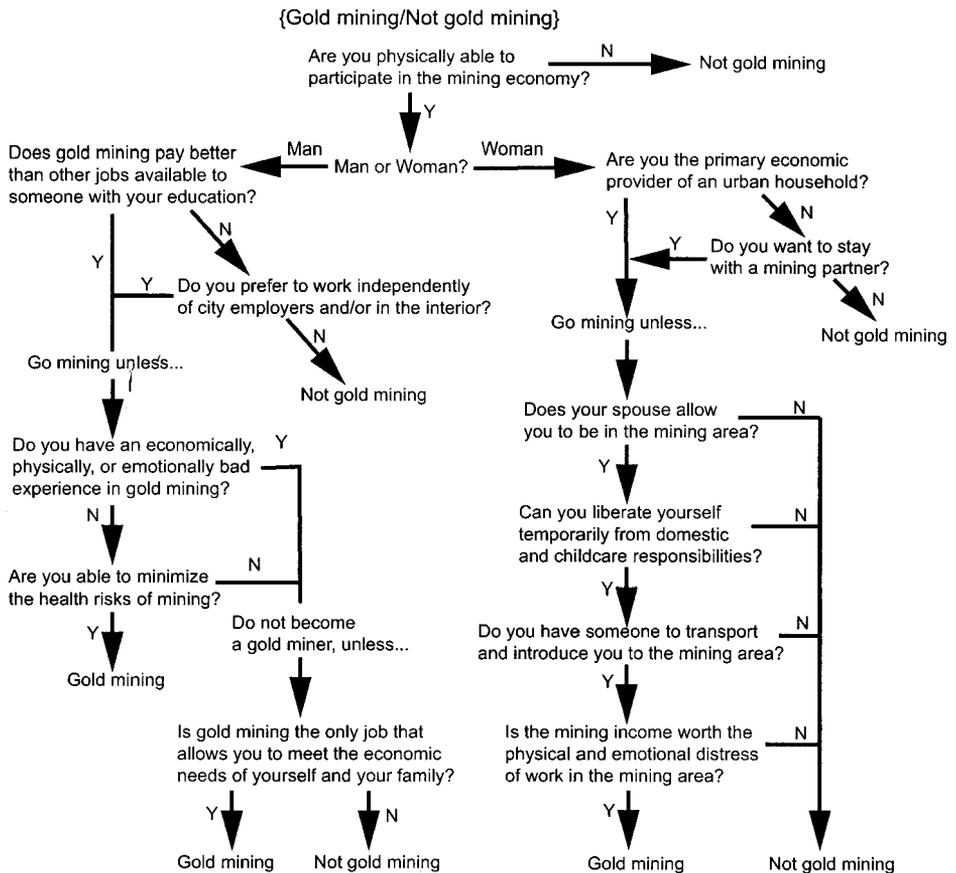


**FIGURE 3** Self-reported occupations of gold miners in the preliminary and test samples, allowing people to report more than one activity.

Because the preliminary sample did not include observations for urban male nonminers, the preliminary model did not represent well the decisions of that specific group. By including more urban nonminers in the test sample, I increased the chances that their choices were accurately predicted. The test sample only contained one female miner because I met no more mining women who were not previously interviewed. As Gladwin (1989, 53) advises in such circumstances, I relied on ethnographic interviews with women who had mining experience but were not mining at the time of the interview ( $n = 29$ ). I tested how well the model represented their decisions to mine or not. The model's robustness to this procedure suggests that it accurately predicts the decisions of women as well as those of men.

**Results**

The composite ethnographic decision-tree model appears in Figure 4. The model has a prediction success of 95.5%; that is, only 1 out of 22 people in the test sample did not follow the model (for the raw data, see Heemskerck 2000a). The percentage points in this section refer to the proportion of people in the preliminary sample who named a certain reason for mining ( $n = 41$ ) or not mining ( $n = 34$ ). Because the test sample was small, it would be useful to retest the model with a larger sample in the future.



**FIGURE 4** Ethnographic decision-tree model.

Economic reasons dominate the motivations to mine. The main reported reasons to become a gold miner are poverty (39%) and the lack of other work that pays sufficiently to sustain a family (24%). Other miners had immediate needs such as new clothes (20%). The average miner in both samples had completed more years of formal education than the average non-miner ( $\bar{X} = 6.1$  years vs.  $\bar{X} = 3.9$  years;  $t = -2.80$ ,  $p < .01$ ). Nevertheless, several miners (7%) perceived education as a barrier to better employment. Negative criteria dominate the motivations to become a miner, but some miners viewed their job as a challenge (7%) and appreciated their freedom and independence (29%). The appreciation of independence usually related to an unpleasant work experience under a city employer, where Maroons had felt bossed around or discriminated against. The most important reason for not entering gold mining was physical inability from illness or old age (26%).

An immediate observation is that men and women consider different options and constraints in decisions about mining; the decision tree separates in male and female branches that are structurally different (Figure 4). Men have many reasons to become miners. They are only held back by physical constraints, or because of negative economic, physical, or emotional experiences during prior involvement (15%). Economic misfortune could be work in an operation that did not find gold, financial investment in a mining operation that went bankrupt, or failure to collect outstanding debts. Discouraging physical experiences ranged from back injuries to malaria. The mining-related death of a family member or criminal assaults motivated others to avoid the mining area.

In contrast to men, women have many reasons to stay at home, including the objections of husbands, a lack of transport, and domestic responsibilities. Women came to the mining area either to join a mining husband or to work for themselves. Independent female miners mentioned reasons similar to their male colleagues: They needed to earn household income. A crucial difference between female and male breadwinners was that all mining women were single mothers, while male miners usually had spouses. Women with either a husband or another source of income said that gold mining was incompatible with their household and child-care responsibilities (Heemskerk 2000b). Female miners typically shared that opinion, but economic need and the absence of a male provider forced them into mining. Men did not usually express enthusiasm for gold mining either, but male duties and the lack of viable alternatives left few men with any other choice.

## Discussion

Decisions about gold mining appear more rational than some people imagine them to be. Not a single miner had overrated expectations of mining incomes, nor did they deny mining risks. Instead, both men and women responded to, and were restricted by, domestic responsibilities.

Ndjuka society expects men to supply household cash, yet many cash-generating jobs that Ndjuka men preformed previously are no longer available to them. Ndjuka men said that before the gold rush, they were guides and laborers in geological expeditions, extractive industries, and public projects ranging from malaria eradication to dam building in Suriname's interior (Heemskerk 2000a; see also Lamur 1965; Thoden van Velzen and Van Wetering 1991). Others performed unskilled labor or were informal entrepreneurs in Paramaribo and French Guiana. The political and economic instability of the past two decades has eliminated most public jobs in the forest, as well as many jobs in the bauxite and timber industries and in construction.

During the civil war of 1986–1992, military activity destroyed much of the social, economic, and educational infrastructure in Eastern Suriname, where most Ndjuka live (Polimé and Thoden Van Velzen 1992). Many Ndjuka children could not attend school during these years, and few youngsters went back to school after the war was over, as many had become adults and had family responsibilities (E. Chary, Headmaster Drietabbeje, personal communication 1998). The educational system never fully recovered. Currently, schools on Ndjuka territory suffer from a chronic shortage of motivated teachers and frequent illness among students and educators. Cultural and language barriers between children who primarily speak Ndjuka, and teachers who do not, further inhibit learning. The consequently low educational performance limits competitiveness in the formal labor market. The war also magnified urban disdain for Maroons (Price 1995). Almost a decade after the war has ended, I commonly heard Surinamers of other ethnic groups express negative stereotypes about Maroons. Because people other than Maroons control access to urban jobs, Ndjuka have difficulties obtaining formal employment and, as shown in the model, prefer to work independently of urban employers.

Male miners expressed a dedication to their families in spite of their limited job opportunities. Alex (25, pit worker) explained that only mining allows a man to fulfill his duties:

In the city you cannot make it. You maybe work for 60,000 Sfl per month [ $\sim$ 60 US\$ in January 1999]. One bag of rice costs 5,000 Sfl, how are you going to make it? A man perhaps works three jobs to be able to survive. So you have to work in gold mining.

In this fragment, Alex alludes to the rising costs of living in Paramaribo and the decreasing purchasing power of formal wages. Ndjuka interviewees typically estimated that they would earn the equivalent of about 60 US\$ per month in formal employment, such as construction and other types of manual labor (January 1999 exchange rates). Due to severe inflation, these wages were depreciating on a daily basis.

My field data show that average earnings from gold mining are high in comparison to formal wages. Pit workers in the sample earned between 13 and 150 g gold/month, averaging 43 g gold/month ( $n = 32$ ,  $SD = 27$ ). With 1 g gold equaling about 9 US\$ in 1998–1999, the average pit worker's wage was just short of 400 US\$/month. The median earnings of carriers (60 g gold/month), cooks (60 g gold/month), and merchants (10 g gold/month) in the Sella Creek mining area also exceeded wages for alternative formal labor in Paramaribo.

### ***Confronting Mining Risks***

In addition to being more profitable, a rationally chosen occupation should also contain fewer risks than job alternatives. Many Maroon miners lamented their participation in small-scale gold mining. The work is emotionally and physically demanding, and those involved are separated from their families for months at a time. The typical workdays I observed involved 12 hours of heavy labor in pools of dirty water, while being exposed to the burning sun and disease-carrying mosquitoes. Prolonged periods of poor nutrition, overwork, and frequent infections with malaria, coupled with the absence of medical assistance, will have lasting consequences for the health and life expectancies of gold miners. These observations

suggest that gold miners experience more health risks than nonminers. Moreover, rudimentary exploration and exploitation methods increase the amount of financial risk associated with gold production.

Despite variable incomes and health hazards, I argue that the relative risks of gold mining are not as great as they initially appear. In gold miners' eyes, wage labor provided less economic security. In mining, explained Erwin (25, pit worker) "you do not lose your money. When you come, you only need to take your clothes with you. The boss has all costs [for food and shelter]." Such arrangements make mining labor regimes economically safer than jobs in the city, where living expenses are high and rising. In theory, formal employment offers a stable wage, health insurance, and pensions. In practice, stable wages in Suriname guilders are insufficient to sustain a family, and it is common for pensions to not be paid at all.

I did not find evidence that health risks were misunderstood or disregarded. In fact, miners used intricate schemes to mitigate mining risk. A popular strategy was to return to town after a few months of work, to rest and build up strength. "You know how we struggle," said one pit worker (23): "Your health is always more important. That is why one should not stay for six months." A machine owner (29) added, "Gold mining is a risky job, you cannot do it your whole life long. For a short period of time you can do it, to set up another job." These and similar comments suggested that gold miners perceived their job as a short-term sacrifice to resolve immediate poverty and to eliminate larger, structural problems. Albert (23, pit worker) explained:

[In the city] with 60,000 Sfl you'll have to pay for school, a car to drive to work, money for electricity. The money [in gold mining] softens the suffering. I am able to struggle for one year, two years. Then you can work in town, more relaxed. But if you start working a city job, then you'll work forever to have a good life.

### **Future Goals**

When asked about their future goals, 18% of miners, like Albert, wanted to perform less strenuous work in the city. Another 44% of miners wanted to start an independent business, such as a shop or a taxi, 7% wanted to buy a house, and 7% wanted to go abroad, primarily to the Netherlands.

Miners were thinking not only about their own advancement, but also the future of their children (22%). When miners were asked whether they wanted their children to become gold miners, 86% answered negatively, versus a third (36%) of nonminers. Six percent of miners versus 26% of nonminers wanted their children to enter mining. These data, and the observation that fewer miners (3%) than nonminers (9%) were the parents of mining children, suggest that miners more actively discouraged their children from entering mining.

Better education, miners believed, would enable their children to obtain less strenuous "sitting work," "in an office," and "with a computer." Realizing that few forest schools meet national educational standards, miners asserted that escaping poverty required an urban education. With the current high inflation rates, however, traditional incomes do not cover the expenses of boarding schools and urban life. It remains unclear whether mining incomes do indeed allow households to rise above the minimum needed for bare subsistence, and thereby improve the prospects for future generations. However, other formal and informal jobs available to most Ndjuka provide even fewer opportunities for social advancement.

A majority of miners wanted to leave the mining business as soon as the opportunity presented itself. More than a third of interviewed miners (36%) said that they wanted to leave the hardships of mining life within a year. Many others wanted to quit mining either in just a few more years (11%), as soon as they found another job (6%), or once they had earned enough money to start another enterprise (18%). Only a fifth of miners (22%) wanted to mine until they would be too old or weak to do so, and two miners (2.2%) said they would mine until they were tired of it. Even though I expect that many miners may not reach their goals due to structural macroeconomic reasons, they appear to make informed choices that are shaped by their marginal position in Suriname society.

By focusing on the local mining population, I consciously avoided discussing migrant miners and their environmental impact. Garimpeiros have spread over the larger Amazon since the early 1990s, when the Brazilian government began to regulate, limit, and control small-scale mining (MacMillan 1995; Schmink and Wood 1992). Garimpeiros themselves said they had left their home country because they felt that too many gold-containing areas in Brazil were now protected as indigenous reserves, and the few remaining places were exhausted and overpopulated. They were attracted to Suriname by its relative lack of bureaucracy and by exaggerated rumors of its richness. The systematic investigation of the complex, proximate and distant drivers and consequences of migratory movements of gold miners is left for future investigation (but see MacMillan 1995; Martins 2000; Veiga 1997b).

### **Models of the Amazon Gold Rush**

This analysis was informed by the observation that a majority of Ndjuka households in the Suriname Amazon have come to depend on small-scale gold mining for income. The United Nations has expressed the opinion that small-scale mining is an “effective weapon against rural poverty” that is worth promoting (1996, 223). I question this rhetoric, and instead propose that this type of mining will probably not produce long-term economic or ecological sustainability. Rather, small-scale gold mining may perpetuate the cycle of poverty as mercury contamination, the removal of wildlife, the epidemic spread of disease, and the pollution of rivers compromise the livelihood options and health of future generations of Maroons who live near mining areas. Moreover, small-scale gold mining is an unhealthy and disliked job far from home, which many Ndjuka miners would prefer to abandon.

This analysis advances existing models of the Amazon gold rush. In the 1980s, as the media condemned Amazon gold miners (Slater 1994), Hecht and Cockburn (1989, 129) recognized that gold miners were “victims too, of hard times and limited opportunities for Brazil’s small farmers, and of the harsh fight to survive in the cities.” National economic instability coupled with rural poverty characterized both Brazil and Suriname at the onset of their gold rushes in the 1970s and the 1980s, respectively. In both countries, marginal groups in society have found in gold mining not only a relatively lucrative job, but also an occupation that has low barriers to entry in terms of money, education, and work experience. It is noteworthy that in contrast to Brazil, the urban and rural poor from only one ethnic group have taken up mining in Suriname. The historic contempt among coastal populations for the uncultivated forest and its people partly explains this pattern. The Maroons’ traditional control of social and economic resources in the interior, such as transport, further makes work in the forest less familiar and accessible to urban residents.

My results challenge arguments that miners underestimate the real health and economic risks of their profession. I did not find evidence for the “get-rich-quick” mentality that characterizes small-scale miners according to the World Bank (Barry 1996, 3) and popular culture (Slater 1994). Future research on decision making among gold miners and others involved in hazardous, environmentally damaging activities may inform more general conclusions about the rationality of such occupational choices.

Finally, it is unlikely that the same forces motivate gold mining in different times and places (MacMillan 1995). Suriname observers have suggested that gold regions closer to Paramaribo do attract opportunistic miners (Van der Kooye, personal communication 1998). These people, again mostly Maroons, take temporary leave from their jobs in town to supplement to their regular wages. A similar pattern has been observed among peasants in Brazil who find in gold mining what farming cannot offer: a chance for fortune (MacMillan 1995). My data suggest that for miners in the Sella Creek region, gold mining is the primary source of household support, and an undesired activity if other income-generating options are available. Whether my model works well in other gold-mining settings in the Amazon warrants additional investigation.

### **Toward Conservation of Amazon Rainforest**

Given the multiple interrelated reasons to go mining, on which rationales should conservation policies focus? Academic ecology has traditionally placed trust in environmental education as a vehicle for encouraging more sustainable resource use (Lubchenco et al. 1991). Given my results, however, I doubt whether this is the strategy to follow. A significant portion of Amazon small-scale gold mining is driven by structural problems including inflation, unemployment, and the poor quality of public services, including education, in rural areas. Consequently, I do not expect that campaigns aimed at increasing the ecological awareness of miners will reduce participation in gold mining or mining’s environmental impacts. Educational measures might convince dedicated miners to use mercury more wisely (Veiga 1997a; Veiga et al. 1995). However, they will not address the multitude of mining problems, nor the root causes underlying mining.

Alternatively, development organizations have advocated stricter law enforcement as a mechanism to reduce the impacts of small-scale gold mining (Barry 1996; Monsels-Thompson 1998; United Nations 1996; Veiga 1997a). The World Bank, for example, speculates that “if governments take basic steps to regularize their informal mining sectors, they should at least prevent [environmental degradation] from worsening, and in favorable circumstances artisanal miners could begin to make a positive contribution to national wealth” (Barry 1996, 14). While such measures might offer temporary relief, they are not likely to produce lasting results due to the mobility of miners, the difficulty of policing a vast area, and the lack of trained inspectors (Cleary 1990; Veiga et al. 1995). Stricter regulation is also not realistic in Suriname, where the understaffed and poorly equipped Forest Service lacks the capacity to survey the forest, let alone to enforce environmental regulations (Colchester 1995). The Brazilian case illustrates that as long as rural poverty continues, tighter regulation and military control will at best drive miners across international borders, thus exporting but not solving social and environmental problems.

More effective policies to reduce gold mining would encourage people-centered development both in the interior and in Suriname as a whole. Providing an education

to their children is an important motivation for people seeking an income from gold mining. A more sustainable way to reach that goal would be to increase public investment in good elementary and secondary education for forest peoples. Furthermore, endemic disease in the interior impairs the ability of people to develop their communities and provide for their children. Enhancing health care, by suppressing diseases such as malaria and by improving pre- and postnatal care, would greatly improve the quality of life in Suriname's rainforest. At the national level, lowering inflation and stabilizing Suriname's currency would help provide economic security for poor households in Suriname. I expect that only such drastic, but feasible, economic and social changes in Suriname will allow Ndjuka households to invest in a more sustainable future for their families, communities, and country.

It remains to be seen whether policy interventions aimed at improving the quality of life of Maroons will influence the activities of migrant miners in Suriname. It is possible that once Maroons leave the mining industry, they will no longer need the skills of Brazilians and will be less tolerant of the disease and pollution that accompany mining. Because Maroons control the access to many Suriname mining sites and garimpeiros have many places to go, limited cooperation and increased hostility from the local population may discourage migrant miners. At this point in time it is impossible to imagine the indirect effects of locally directed policies. Recommendations for policies directed specifically at Brazilian migrant miners are beyond the aims and scope of this article, and are an intriguing topic for future study.

## Note

1. The Ecological Society of America (ESA) sustainable biosphere initiative (Lubchenco et al. 1991) and the Aldo Leopold Leadership Program (<http://www.leopold.orst.edu>), which is sponsored by ESA, both are based on the implicit assumption that educating people will change their attitudes and use of natural resources.

## References

- Akagi, H., O. Malm, F. J. P. Branches, Y. Kinjo, Y. Kashima, J. R. D. Guimarães, R. B. Oliveira, K. Harakutchi, W. C. Pfeiffer, Y. Takizawa, and H. Kato. 1995. Human exposure to mercury due to gold mining in the Tapajós River Basin, Amazon, Brazil: Speciation of mercury in human hair, blood, and urine. *Water Air Soil Pollut.* 80:85–94.
- Algemeen Bureau Statistiek. 1997. *Statistical yearbook 1996 of the Republic of Suriname*. Paramaribo, Suriname: Algemeen Bureau voor de Statistiek.
- Antonius-Smits, C. C. F., J. Altenberg, T. Burleson, T. Taitt-Codrington, M. D. van Russel, D. van der Leende, D. Hordijk, and R. F. del Prado. 1999. Gold and commercial sex: Exploring the link between small-scale gold mining and commercial sex in the rainforest of Suriname. In *Sun, sex, and gold. Tourism and sex work in the Caribbean*, ed. K. Kempadoo, 62–85. Lanham, MD: Rowman and Littlefield.
- Bakker, E., L. Dalhuisen, R. Donk, M. Hassankhan, and F. Steegh. 1998. *Geschiedenis van Suriname: van Stam tot Staat [History of Suriname: From tribe to state]*. Zutphen, the Netherlands: Walburg Pers.
- Barry, M. 1996. *Regularizing informal mining. A summary of the proceedings of the International Roundtable on Artisanal Mining*. Washington, DC: World Bank, Industry and Energy Department.
- Brauman, B., and S. Shah. 1999. *Suriname: A case study of high inflation*. Washington, DC: International Monetary Fund, Western Hemisphere Department.
- Cleary, D. 1990. *Anatomy of the Amazon gold rush*. Iowa City: University of Iowa Press.

- Colchester, M. 1995. *Forest politics in Suriname*. The Hague, the Netherlands: International Books and the World Rainforest Movement.
- De Kom, J. F. M., G. B. van der Voet, and F. A. de Wolff. 1998. Mercury exposure of Maroon workers in small-scale gold mining in Suriname. *Environ. Res.* 77(section A):91–97.
- De Vletter, D. R., and A. L. Hakstege. 1998. The search for gold in Suriname. In *The history of earth sciences in Suriname*, ed. T. E. Wong, D. R. DeVletter, L. Krook, J. I. S. Zonneveld and A. J. van Loon, 311–350. Utrecht, the Netherlands: Koninklijke Nederlandse Academie der Wetenschappen and Nederlands Instituut Toegepaste Geowetenschappen TNO.
- Faas, L., A. Rodríguez-Acosta, and G. Echeverría de Pérez. 1999. HIV/STD transmission in gold-mining areas of Bolivar State, Venezuela: Interventions for diagnosis, treatment and prevention. *Rev. Panamericana Salud Publica* 5(1):58–65.
- Forté, J. 2000. Impact of the gold industry on the indigenous peoples of Guiana. *Transition* 27–28(special issue: Guyana's gold industry):71–95.
- Gladwin, C. H. 1989. *Ethnographic decision tree modeling*. Newbury Park, CA: Sage.
- Greer, J. 1993. The price of gold: Environmental costs of the new gold rush. *Ecologist* 23(3):91–96.
- Guimarães, G. de Asis, A. R. Benedito da Silva, and M. S. Dutra, ed. 1994. *Contaminação mercurial: Homem versus Meio Ambiente nos Garimpos de Ouro da Amazônia [Mercury pollution: People versus the environment in the gold mining areas of the Amazon]*. Belém, Brazil: Associação de Universidades Amazônicas.
- Healy, C. 1996. *Natural resources, foreign concessions and land rights: A report on the village of Nieuw Koffiekamp*. Paramaribo, Suriname: Organization of American States, Special Mission to Suriname, Unit for the Promotion of Democracy.
- Hecht, S., and A. Cockburn. 1989. *The fate of the forest. Developers, destroyers, and defenders of the Amazon*. New York: Verso.
- Heemskerck, M. 2000a. *Driving forces of small-scale gold mining among the Ndjuka Maroons: A cross-scale socioeconomic analysis of participation in gold mining in Suriname*. PhD Dissertation, University of Florida, Gainesville.
- Heemskerck, M. 2000b. *Gender and gold mining: The case of the Maroons of Suriname*. Working Paper 269. Ann Arbor, MI: Women and International Development Publications Series. <http://www.isp.msu.edu/WID/papers/abstracts.html>
- Heemskerck, M. 2001. Maroon gold miners and mining risks in the Suriname Amazon. *Cultural Survival Q.* [Special issue: Mining indigenous lands. Can impacts and benefits be reconciled?] 25(1):25–29.
- Lamur, H. E. 1965. De Levensomstandigheden van de in Paramaribo Werkende Aukaner Arbeiders [The living conditions of Aukaner laborers in Paramaribo]. *New West Indien Guide* 44:121–132.
- Lubchenco, J., A. M. Olson, L. B. Brubaker, S. R. Carpenter, M. M. Holland, S. P. Hubbell, S. A. Levin, J. A. MacMahon, P. A. Matson, J. M. Melillo, H. A. Mooney, C. H. Peterson, H. R. Pulliam, L. A. Real, P. J. Regal, and P. G. Risser. 1991. The sustainable biosphere initiative: An ecological research agenda. A report from the Ecological Society of America. *Ecology* 72(2):371–412.
- MacMillan, G. 1995. *At the end of the rainbow? Gold, land and people in the Brazilian Amazon*. New York: Columbia University Press.
- Martins, C. C. 2000. *Os Deslocamentos Como Categoria de Análise. Agricultura e Garimpo na Lógica Camponesa*. Master's thesis, Universidade Federal do Maranhão, São Luís, Brazil.
- Mittermeier, R., S. A. J. Malone, M. J. Plotkin, F. Baal, K. Mohadin, J. MacKnight, M. Werkhoven, and T. B. Werner. 1990. *Conservation action plan for Suriname*. Paramaribo, Suriname: Conservation International.
- Monsels-Thompson, L. 1998. *POPs problems, issues and management in Suriname*. Geneva, Switzerland: United Nations Environment Programme. Section Persistent Organic Pollutants. [http://irptc.unep.ch/pops/POPs\\_Inc/proceedings/cartagena/MONSELS.html](http://irptc.unep.ch/pops/POPs_Inc/proceedings/cartagena/MONSELS.html)
- Naughton, L. 1993. Conservation versus small-scale gold mining in Corcovado National Park, Costa Rica. *CLAG Yearbook* 19:47–55.

- Peterson, G. D., and M. Heemskerk. 2001. Deforestation and forest regeneration following small-scale gold mining in the Amazon: The case of Suriname. *Environ. Conserva.* 28(2):117–126.
- Polimé, T. S., and H. U. E. Thoden van Velzen. 1992. *Vluchtelingen, Opstandelingen en Andere Bosnegers van Oost Suriname, 1986–1988 [Refugees, rebels, and other Maroons in eastern Suriname, 1986–1988]*. Bronnen Voor de Studie van Afro-Surinaamse Samenlevingen, Vol. 13. Utrecht, the Netherlands: Rijks Universiteit Utrecht.
- Price, R. 1995. Executing ethnicity: The killings in Suriname. *Cultural Anthropol.* 10(4):437–471.
- Price, R., and S. Price. 1999. *Maroon arts. Cultural vitality in the African diaspora*. Boston: Beacon Press.
- Rawana, D. 2000. Report—Survey on environmental and health impacts. *Transition* 27–28 [Special issue: Guyana's gold industry]:99–109.
- Rodrigues, R. M. 1994. *Mulheres do Ouro: O Trabalho Feminino nos Garimpos do Tapajós. [Women of gold. Female workers in the gold mining fields of Tapajós]*. Governo do estado do Pará and Secretaria de estado de Indústria, Comércio e Mineração (SEICOM), Belém, Brazil.
- Schmink, M., and C. H. Wood. 1992. *Contested frontiers in Amazonia*. New York: Columbia Press.
- Slater, C. 1994. “All that glitters”: Contemporary Amazonian gold miners’ tales. *Comp. Stud. Society Hist.* 36(4):720–742.
- Sponsel, L. E. 1997. The master thief: Gold mining and mercury contamination in the Amazon. In *Life and death matters. Human rights and the environment at the end of the millennium*, ed. B. R. Johnson, 99–127. Walnut Creek, London: AltaMira Press.
- Thoden van Velzen, H. U. E., and W. van Wetering. 1991. *The Great Father and the danger. Religious cults, material forces, and collective fantasies in the world of the Suriname Maroons*. Caribbean Series, Vol. 9. Leiden: Koninklijk Instituut voor Taal-, Land- en Volkenkunde (KITLV) Press.
- United Nations. 1996. Recent developments in small-scale mining: A report by the Secretary General of the United Nations. *Nat. Resources For.* 20(3):215–225.
- Van der Kooye, R. 1997. *Porknockerij in de Media. Berichtgeving en Effecten van Dagbladberichtgeving over kleinschalige goudwinning in Suriname, 1994–1995 [Poor-knocking in the media. Newspaper reporting about small-scale gold mining in Suriname]*. Master’s thesis, Akademie voor Hoger Kunst- en Cultuuronderwijs, Paramaribo, Suriname.
- Veiga, M. M. 1997a. *Introducing new technologies for abatement of global mercury pollution. Phase II: Latin America*. Program Document. Vancouver, BC, Canada: United Nations Industrial Development Organization.
- Veiga, M. M. 1997b. *Small-scale gold mining activities in Suriname*. Report. Vancouver, BC, Canada: United Nations Industrial Development Organization.
- Veiga, M. M., J. A. Meech, and R. Hypolito. 1995. Educational measures to address mercury pollution from gold-mining activities in the Amazon. *Ambio* 24(4):216–220.
- World Resources Institute. 1998. *Facts and figures: Environmental data tables. Forest cover and change, and forest industry structure*. Washington, DC: WRI. <http://www.wri.org/facts/data-tables-forests.html>