Impacts of artisanal gold and diamond mining on livelihoods and the environment in the Sangha Tri-National Park landscape

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CIFOR

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Center for International Forestry Research (CIFOR)
CIFOR advances human wellbeing, environmental conservation and equity by conducting research to inform policies and practices that affect forests in developing countries. CIFOR is one of 15 centres within the Consultative Group on International Agricultural Research (CGIAR). CIFOR's headquarters are in Bogor, Indonesia. It also has offices in Asia, Africa and South America.

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Units of measure

1 kilogram = 5000 carats

Exchange rate at 30 January 2009
Communauté Financière

Africaine Francs BEAC		United States dollars
1.0 CFA	=	0.00196388 US dollars
509.000 CFA	=	1.0 US dollars

List of abbreviations

ANOVA	Analysis of variance
ASM	Artisanal and small-scale mining
BECDOR	Bureau d'Évaluation et de Contrôle de Diamant et d'Or
CAPAM	Support and Promotion Framework of Mining Activities in Cameroon
CAR	Central African Republic
CASM	Community Artisanal and Small-scale Mining initiative
CBFP	Congo Basin Forest Partnership
CEFAID	Centre pour l'Education, la Formation et l'Appui aux Initiatives de Développement au Cameroun
CEMAC	Economic and Monetary Community of Central Africa
CFA	Central African Franc
CIFOR	Centre for International Forestry Research
DRC	Democratic Republic of Congo
EITI	Extractive Industries Transparency Initiative
GDP	Gross domestic product
GTZ	German Technical Corporation
HDI	Human Development Index
IIED	International Institute for Environment and Development
ILO	International Labour Organization
IUCN	International Union Conservation of Nature
LLS	Livelihoods and Landscape Strategy
LNP	Lobeke National Park
LSM	Large-scale mining
MINIFI	Ministry of Finance
MINIMIDT	Ministry of Industry, Mines and Technological Development
MMSD	Mining, minerals and sustainable development
MINEF	Ministry of Environment and Forestry
MINEP	Ministry of Environment and Nature Protection
MINFOF	Ministry of Forestry and Wildlife
NTFP	Non-timber forest products
NGO	Non-governmental organisation
PNNN	Nouabale-Ndoki National Park
RoC	Republic of Congo
SPSS	Statistical Package for Social Sciences
STD	Standard deviation
SAESSCAM	Service d'Assistance et d'Encadrement du Small-Scale Mining or Service for the assistance and organisation of small-scale mining
TNS	Tri-National de la Sangha, or Sangha Tri-National Park
UFA	Forest Management Unit (Unité d'aménagement forestière)
UNCTAD	United Nations Convention on Trade and Development
UNEP	United Nations Environment Programme
UNESCO	United Nations Educational, Scientific, and Cultural Organization
USGSMRP	United States Geological Survey Mineral Resources Program
WWF	World Wide Fund for Nature

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Executive summary

Gold and diamond mining constitute more than half of all mineral exploitation worldwide, with an estimated 6 to 9 million artisanal miners active in the gold and diamond sectors. Africa hosts a third of the world's natural mineral wealth, including 65 percent of global diamond deposits. While mineral exploitation contributes to the livelihoods of many, it generally leaves a negative impact on the environment, which may ultimately be detrimental to livelihoods. The impacts on both the environment and livelihoods are of particular concern around areas with high conservation values, such as in the Sangha Tri-National Landscape (TNS) a landscape which includes 3 national parks and covers Cameroon, the Central African Republic and the Republic of Congo. This report on the impact of artisanal gold and diamond mining in the TNS results from a joint initiative of the Centre for International Forestry Research (CIFOR) and the International Union Conservation of Nature, Central and West African offices (IUCN-PACO).

The TNS includes the Lobeke National Park in Cameroon, the Ndouable-Ndoki National Park in the Republic of Congo (RoC) and the Dzanga-Ndoki National Park and the Dzanga-Sangha Dense Special Reserve in the Central African Republic (CAR). TNS is home to around 25,000 people. Artisanal mining and other economic activities in and around the park are critical livelihoods to sustain people but can threaten the valuable TNS landscape. Small-scale miners in these countries have limited rights typical of artisanal miners, and often expose themselves to harsh working and living conditions in a high-risk context. Nonetheless, such mining activity continues to expand. Artisanal and small-scale mining (ASM) is both poverty driven and poverty alleviating; its continuing attraction is the opportunity it provides to many to secure their household's survival, however marginal. The main purpose of this study is to understand how artisanal mining affects livelihoods and the environment in the TNS landscape, thereby closing a general knowledge and policy gap about the nature of ASM. Specifically, the study offers recommendations that support poverty reduction by addressing key issues in small-scale mining activities in the context of sustainable management of the TNS.

The research methodology consisted of a literature review, interviews with 131 (63 gold and 68 diamond) miners regarding household, mining and environmental aspects of their activities, discussions with stakeholders and field visits to 17 mining sites (13 in Cameroon and 4 in CAR) located within 50 km of the TNS. Data was analyzed using 12 parameters to calculate annual production, costs, gross and net revenues, and aggregates of observed values. Miners were dichotomised by their level of dependency on artisanal mining. Coefficients, of which one includes 'absolute miners' income' and another is based upon 'absolute income excluding mining', were compared in order to reveal whether mining incomes reduce inequality.

Artisanal and small-scale mining (ASM) is of particular importance in developing countries. Worldwide, 100 million people are involved in the sector, 10 to 15 million of whom are artisanal miners, who depend on the exploitation of minerals for their livelihoods. The gold and diamond sectors are responsible for about 60% of all artisanal mining. In general, ASM has a low level of financial investment and technical input and is very labour intensive, with low levels of mechanisation, production and efficiency. Miners typically gain a small income from mining and are simultaneously engaged in other activities such as subsistence agriculture. Beyond the direct income for artisanal miners, governments re-distribute mineral exploitation revenues (from royalties, taxes, licenses and other fees) to essential government services. This responsibility demands 'good governance' and appropriate policies, regulations and fiscal regimes in the country. Laws and regulations are also crucial in defining the rights of miners and communities, setting standards for environmental impact assessment and mitigation measures, and requiring financial and social obligations for new mining operations. All these factors co-determine the eventual outcomes of mining in terms of national economic impact, employment

creation, infrastructure development, improvement in health and education, and environmental impact.

The countries of this study, Cameroon and the Central African Republic, both have mineral sectors characterised by ASM. On an international and regional level, small-scale mining receives little attention. On a national level, in both countries, mining falls under a legal framework structured by a Mining code, a Tax code and an Environmental code. Cameroon's sector has been invigorated as a result of new diamond deposits being discovered and industrial exploration permits being granted. One challenge recognised by the 2001 Mining Code is to mitigate problems related to ASM and large-scale mining (LSM) occurring on the same site. In 2003, the *Support and Promotion Framework of Mining Activities organization* (CAPAM) was created to facilitate, assist and promote small-scale mining. The CAR, however, has no industrial mining due to a history of political instability in combination with land-locked geography and minimal infrastructure. The government recently developed investor-friendly regulations in the form of the 2004 Mining Code, which regulates the issuance and renewal of artisanal mining permits. CAR has significant artisanal diamond production with a special administrative unit *Bureau d'evaluation et de Control de Diamond et d'Or* (BECDOR) overseeing the market, producing statistics and issuing licenses to diamond diggers and 160 collecting agents who sell to the two purchasing offices in Bangui. The CAR is member of the Kimberley Process, an international diamond certification scheme aiming to stop the trade of 'conflict diamonds'.

Interviews with **key actors** and village meetings between September and December 2008 provided insights into the problems of artisanal mining activities in and near the TNS. Key actors included park conservators, government representatives in charge of mines, forest and the environment and representatives of international nongovernmental organisations. Key **issues for the artisanal mining sector** are:

- Lack of organisation and technology
- Lack of information and awareness about the mining codes
- The buffer zone of the Lobeke National park is being attributed to mining operators under research permit titles
- Miners operate within the interior of the reserve (especially in the northern section of the Dzanga-Ndoki National park in CAR and the southern part of Lobeke National Park in Cameroon)
- Miners do not capitalise the economic value of their revenues (no savings culture/reinvestment)
- Lack of environmental impact assessment and lack of information for miners on more environmentally friendly exploitation techniques. These lead to water and soil pollution, disturbance of fish breeding grounds, encroachment of infrastructure into the forest environment, unrecovered exploited mining pits and poaching of wild animals.

Two types of miners were observed: 'diggers' who dig shallow pits and **'divers'** who scoop sand and soil from the Sangha River. Although miners come from diverse ethnic groups, the vast majority (95% Cameroon and 87% in CAR) of them are permanently based in nearby towns and villages. The age of miners varied from 17 to 75 years old with an average 37 years in Cameroon and 36 years in CAR. In CAR the miners averaged 17 years of experience, nearly double that in Cameroon, where the average number of years spent mining was 9.5 years. In CAR, no **women** were mining on their own, but in Cameroon 13% of miners were women. In both countries, most miners are married, and often are assisted by family labor that includes women and **children**. Education among the miners is generally low, with over 70% having completed only primary school level or having no formal **education** at all.

Mining is the **principal activity** for 79% and 88% of the miners in Cameroon and CAR, respectively, but it is often supplemented with anywhere from one to six other activities. Agriculture is the second most important source of income, followed by non-timber forest product gathering in Cameroon and by fishing in CAR. The dependency of artisanal miners on mining activities in the TNS Landscape was found to be significant. Ethnic group, educational level and time spent mining were the main explanatory variables that showed significant effect on mining dependency. Other variables, such as number of wives, mineral mined and occupation as miner (full versus part-time) showed a positive, but not significant, relationship with dependency.

All minerals extracted in the region by ASM are sold unprocessed. Generally, artisanal miners are **not organised** and have little bargaining power; thus, they largely remain 'price takers' vis-a-vis their sponsors or traders. Variability in the price of diamonds is

enormous, because miners possess no methods or tools to analyze weight or quality and thereby calculate unit prices. Most miners sell to individual buyers: 67% in Cameroon and 94% in CAR. In Cameroon, the Government-run CAPAM initiative has brought a level of structure to the market and provided equipment and technical assistance to small-scale miners since 2006. The mean **annual net income from gold and diamonds** - after subtracting costs for production materials, labour and transport - was 575 338 CFA and 812 644 CFA (1130 US$ and 1596 US$), respectively, in Cameroon. On the CAR side of the TNS, diamond miners obtained an average annual net income of 368 084 CFA (723 US$). These incomes are generally above the World Bank standard poverty line of 2 US$ a day (Cameroon gold miners average 3.10 US$, Cameroon diamond miners 4.37 US$ and CAR diamond miners 1.80 US$), but they still are low incomes. Miners are therefore slightly better off than an 'average' Cameroonian (1010 US$ per miner annually) and significantly better off than non-miners in the TNS (average of 250 US$ annually). The variation of incomes among miners is enormous, however, ranging from considerable net profit to significant net losses that can reach 1 032 450 CFA (2028 US$) annually in CAR.

At least **3,510 people** (517 miners and their dependents, averaging 5.3 members per household in Cameroon and 8.1 in CAR), or approximately **14%** of the total population in the TNS Landscape, loosely based in four main villages, are dependent upon mining. Mining incomes were spent on six **basic needs** in Cameroon and CAR, primarily food (of which alcoholic drinks represented 20%), with significant fractions for the education of children, purchase of clothes, medicine, housing construction and purchase of radios and televisions. It is clear that mining income in the TNS is already used, but could possibly be more efficiently applied, in trying to meet the Millennium Development Goals of reducing poverty and satisfying basic needs.

The role of the **government** in the artisanal mining sector was more obvious in the CAR because labour taxes are collected from a little over 56% of the miners. Small- scale miners pay an annual tax of 2000 CFA (3.90 US$) while the head of a site pays an annual tax of 30 050 CFA (59 US$). Collectors or buyers pay an annual tax of up to 1 100 000 CFA (2161 US$). In Cameroon, small-scale miners do not pay tax but the mining code has a provision for an annual tax. Overlaps between large-scale mining and timber concessions and the TNS have the potential to create serious conflicts, a situation that indicates the lack of coordination between authorities.

Environmental impacts from artisanal mining in the TNS Landscape appear to be temporal, of limited size, short-term and of low significance. The majority of mining takes place along streams, so that direct but insignificant impacts include temporal diversions, siltation and sedimentation of streams. Only limited felling of trees or land clearance was observed, and mainly short-term. Land tended to be cleared for the period of mining, generally temporal or seasonal, and then abandoned, with no or little farming activities taking place in the mining areas. The indirect effects of working in the forest areas, resulting in timber and non- timber forest products (NTFPs), particularly bush meat and medicinal plants, appear limited because only up to 21% (Cameroon) and 28% (CAR) of respondents indicated these products as a secondary or alternative activity. NTFPs, hunting and fishing were all classified as important alternative sources of income, but they contributed less to annual incomes than farming. In both Cameroon and CAR, over 53% of the artisanal miners stated that gold and diamond are infinite resources, and 67% of the miners believed that mining had no negative environmental impacts. Stakeholders who stated that they were aware of environmental impacts mentioned the issues of unfilled open mines and water contamination or diversion of streams. In Cameroon, 20% of the miners indicated that they (also) mine inside the reserve, in contrast to only 1 (out of 32 miners) in CAR. The miners did not report any use of mercury or cyanide for gold extraction.

The **problems** reported by small-scale miners in the TNS include: lack of food and medicine, harassment by conservation agents, dishonesty of sponsors, low production, harsh government laws and actions, inadequate detection of minerals and other exploitable materials, price changes and lack of start-up capital. In Cameroon, the most crucial problems include: lack of detection and exploitation tools, lack of food/medicine at sites and low production. In the CAR, the two most crucial problems are: low production and lack of detection and exploitation equipment.

In **conclusion**, poor governance and informality characterise the artisanal mining sector in the Sangha Tri-National Landscape. Mining provides a considerable income for over 3,000 people (miners

and their dependents) and pays for important basic needs. However, it leaves other miners with close to nothing or debts. Miners in the TNS Landscape cited a number of opportunities for resolving their problems, including assistance to obtain tools and legal papers.

Key recommendations to regional governments, ministries, non-governmental organisations, private enterprises and development agencies:

1) **Improve coherence of strategies across the mining and forestry sectors** in order to enhance livelihoods and minimise environmental impacts. Special attention should go to mitigating conflicting interests: between small-scale and large-scale mining; and with regard to mining in timber concessions and protected areas.
2) **Harmonise mining policies and resource governance strategies in the Congo Basin** at large and the three countries—Cameroon, the Republic of Congo and the Central African Republic—that share the TNS area. This harmonised approach to mining in the TNS area would address issues about artisanal and small-scale mining (ASM) and trans-boundary trafficking. The approach strengthens the outcomes of existing Park-related trans-boundary agreements on sustainable management that follow the 2000 "Yaoundé Declaration" signed by countries in Central Africa.
3) **Promote development policies that stimulate environmentally sound mining practices** in the TNS region, such as chemical-free mining. Environmental and social impact of large-scale mining operations should be studied thoroughly and in a transparent manner before exploitation licences are being granted. Mining companies should stress how they will interact with local communities and artisanal miners in their daily operations and social responsibility.
4) **Inform and sensitise artisanal miners about their rights** under the national mining laws and explain how to access mining titles and operate in a legal way.
5) **Improve mining livelihoods** by:
   a. **Transferring knowledge** about sustainable techniques, tools, valuation and price
   b. **Helping miners organise**, for example by creating forums for cross-boundary information exchange and sharing experiences on production, processing, financial management and marketing
   c. **Encouraging miners to diversify incomes** with alternative activities such as more efficient farming and livestock rearing and NTFP cultivation.

1

Introduction

The Centre for International Forestry Research (CIFOR) was commissioned by the International Union for the Conservation of Nature, Central and West African Office (IUCN-PACO) to research the impacts of artisanal gold and diamond mining on livelihoods and the environment in the Sangha Tri-national Park (TNS), as part of a multi-partnership project termed Livelihoods and Landscapes Strategy (LLS). The project is led by IUCN-PACO, aiming for the sustainable management of the Sangha Tri-national Landscape and the reduction of poverty in adjoining populations. Economic activities that are major sources of livelihoods for the local people but also highly threatening to the TNS include logging, poaching, fishing, collection and sale of non-timber forest products, slash-and-burn agriculture and artisan gold and diamond mining (Tieguhong and Ndoye, 2007). Gold is a precious metal found in appreciable quantities in all six countries of the Congo Basin (Equatorial Guinea, Gabon, RoC, DRC, CAR and Cameroon). In five of these countries (except Equatorial Guinea), appreciable quantities of diamonds have also been found (Reed and Miranda, 2007). The main uses or applications of gold are in electronics, dentistry, decorative plating jewellery and as a reservoir of value. The main applications of diamonds include jewellery, industrial fittings and machinery.

Available information on the management of natural resources in the Congo Basin is at best qualitative and the extent to which individual or collective activities affect the landscape and the lives of the people is poorly understood, making conservation/development policy and decision-making difficult (Tieguhong and Zwolinski, 2008). Such is the case with artisanal and small-scale gold and diamond mining in the TNS region in particular and central Africa in general. For example, according to MINEF (1996), irrational exploitation of mineral resources in Cameroon can be attributed to four direct causes: inadequate knowledge of the resource, poor management and control of the trade chain, inadequate exploitation techniques, and unfavourable conditions that hinder development. There is a general lack of knowledge about the nature and importance of artisanal and small-scale mining (ASM) around the world; thus, basic statistics on the number of miners, health, safety and environmental impact are not available (MMSD, 2002). However, research on ASM gradually is contributing to an understanding of how the sector can achieve sustainable development (MMSD, 2002). Dublin and Taylor (1996) emphasised the need for basing management decisions on sound data, which forms the major reasoning behind our study. Indicators include: the definition of the number of villagers, characteristics of networks and estimation of the income generated by locals; and a proper mapping of the areas being exploited, fostering understanding of the environmental and livelihood impacts of ASM. Therefore, the objective of our research was to elicit information on the problems and prospects for better artisanal mining arrangements and to provide recommendations that can meet future needs for socially equitable and environmentally friendly small-scale mining. Ideally, all artisanal miners could have equitable access to the resource in an organised marketing system under better governance arrangements.

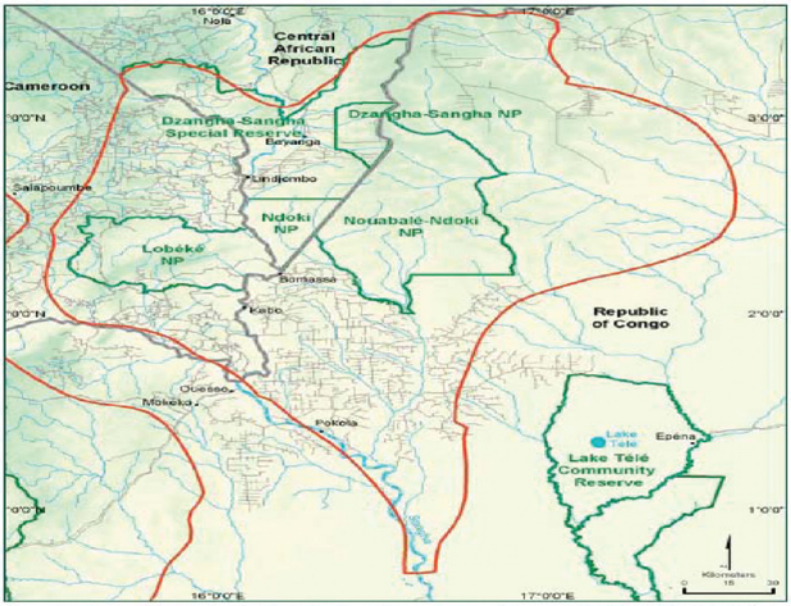
2

Methodology

2.1 Study site

This research was conducted in the Sangha Tri-national Park (TNS) landscape in Cameroon, the Republic of Congo (RoC) and the Central African Republic (CAR).

he Sangha Tri-national Landscape is spread over three countries: Cameroon, the Central African Republic (CAR) and the Republic of Congo (Figure 1). The Congolese section of the Landscape covers the administrative departments of Sangha and Likouala (together 21 470 km²) and includes Nouabale-Ndoki National Park (PNNN) plus five forest management units (UFAs) which total 17 280 km² and form a buffer zone around the national park. In the north is the UFA of Mokabi; in the south, the UFAs of Pokola and Toukoulaka; in the east, the UFA of Loundoungou, and in the west, Kabo. The west side of Nouabale-Ndoki National Park (PNNN) borders on the Dzanga-Ndoki National Park and Dzanga-Sangha Special Reserve in CAR. The CAR section covers 4644 km² and includes Dzanga-Ndoki National Park and Dzanga-Sangha Special Reserve. The Cameroonian section is centered on Lobéké National Park.



Map of Sangha Tri-National Landscape (Sources: Atlas of Cameroon GFW/WRI, CARPE, JRC, SRTM, WCS-Congo, WCS-Gabon, WWF-Jengi).

The Landscape in brief

Coordinates: 3°32'12"N – 0°40'29"N; 15°28'26"E – 17°34'8"E
Area: 36,236 km²
Elevation: 330-700 m
Land ecoregions: Northwest Congolese forests ecoregion
Aquatic ecoregion: Sangha ecoregion
Protected areas: Nouabalé-Ndoki National Park, 419,000 ha, 1993, Republic of Congo
Lobéké National Park, 43,000 ha, 2001, Cameroon
Dzanga-Ndoki National Park, 125,100 ha, 1990, Central African Republic
Dzanga-Sangha Special Reserve, 310,100 ha, 1990, Central African Republic

Figure 1. The TNS Landscape

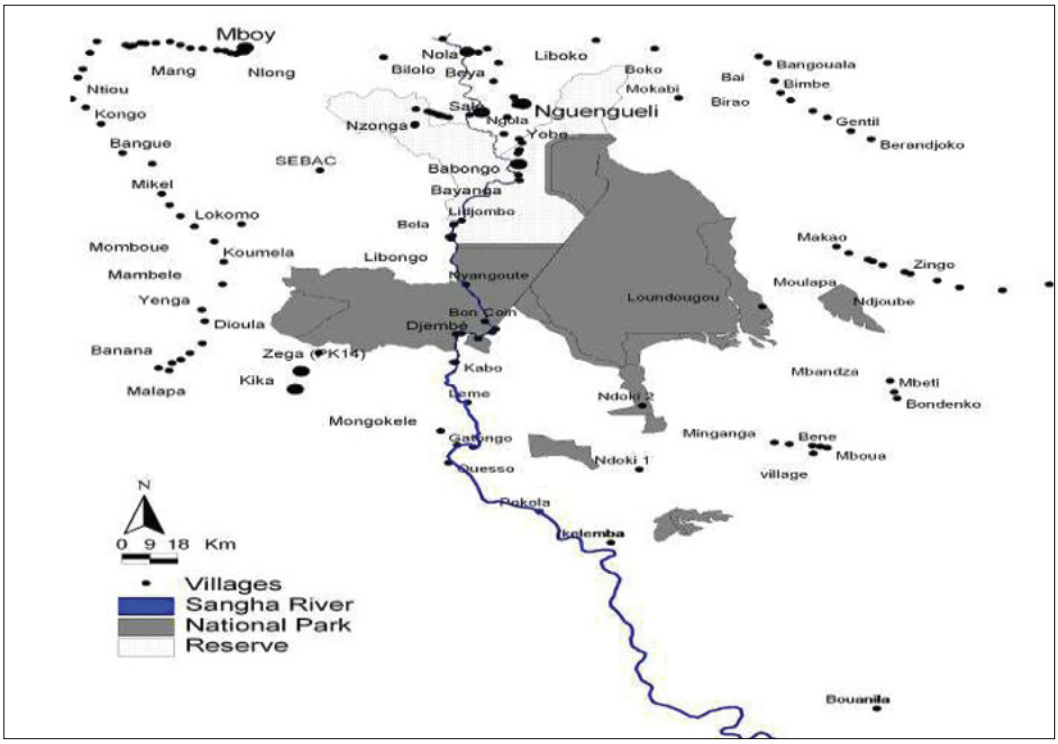


Figure 2. Map of the Sangha Tri-National Park Landscape

2.1.1 Environmental context of TNS

The entire Landscape consists of plateaus broken by alluvial plains. Altitude varies between 330 and 600 m in the Republic of Congo and reaches nearly 700 m in CAR. The Landscape contains the headwaters of four major rivers draining into the north of the Congo River:the Mabale, the Likouala and the Ndoki headwaters are in PNNN; the Ibenga headwaters are in the UFA of Mokabi. The average annual precipitation is 1450 to 1600 mm, with a dry season lasting two to three months (centered on January-February), and August being the rainiest month.

The vast majority (93%) of the Landscape is composed of highly biodiverse dense rainforest, with some semi-caducifoliated terra firma forests rich in tree species. Trees with commercial value include *Terminalia superba* (Limba), Sterculiaceae, in particular Triplochyton scleroxylon (Ayous), and Ulmaceae. Its forests show a monodominance of *Gilbertiodendron dewevrei* and Marantaceae. An estimated 5.6% of the Landscape is inundated, containing mixed swamp forests with riparian forests of *Uapaca heudelotii* and raffia palm groves. These forests are punctuated by grassy clearings called 'bais' that comprise 0.3% of the total Landscape area, as well as lakes, rivers and streams. In the areas that have been logged, rattan forests are now growing.

Less than 0.6% of the total Landscape is forest cultivation mosaic. In the Congolese section more than 1700 species have been inventoried. Among the trees, several species appear on the IUCN Red List: *Autranellacongolensis*, Pericopsis elata (afrormosia), *Diospyros crassifl ora* (ebony) and *Swartzia fi stuloides* (paorosa or African tulip wood). In addition, all the species of the genera E*ntandrophragma* and *Khaya* that have been logged are considered vulnerable, as are other commercial species: *Aningeria altissima* (anigre), *Mansonia altissima, Pausinystalia macroveras* (tsanya) and *Gambeya pulpuchra* (longhi). The PNNN is a sanctuary for all these species, but it depends upon sustainable management of the surrounding concessions in order not to lose these important resources.

The Landscape also has an exceptionally rich biodiversity of fauna. In the CAR sector, 105 species of land mammals have been identified, including: the African forest elephant *Loxodonta africana cyclotis*; 16 species of primates, among them the gorilla *Gorilla gorilla*, the chimpanzee P*an troglodytes* and at least 6 small nocturnal species; 14 species of ungulates, including the bongo antelope *Tragelaphus euryceros* (a species that is declining rapidly in Central Africa and is very rare in East Africa); and 14 species of carnivores, including the leopard Panthera pardus

and the spotted neck otter *Lutra maculicollis*. The hippopotamus *Hippopotamus amphibius* still has a significant population along the Sangha River. Over 428 species of brids have been recovered in the Congolese section, 379 in the CAR section and 350 in the Cameroonian section. A significant population of the Dja River warbler *Bradypterus grandis*, a species endemic to the marshes of *Rhynchospora* of Lower-Guinea, exists in Lobéké National Park; this species is also known in the marshes of PNNN. An as yet undescribed species of night jar *Caprimulgus sp*. has been found in Lobéké National Park and PNNN. A new species of Turdidae, *Stiphrornis sanghae*, was described in 1999 in Dzanga-Sangha Special Reserve and has not yet been found elsewhere.

Reptiles found in this Landscape are typical of the region, including: the Nile crocodile *Crocodylus niloticus,* the slender-snouted crocodile *Crocodylus cataphractus*, the dwarf crocodile *Osteolaemus tetraspis* (an endangered species), the Nile monitor lizard *Varanus ornatus*, the softshell turtle *Trionyx triunguis,* the African rock python *Python sebae*, the royal python *Python regius*, the coiled Gabon viper *Bitis gabonica* and the green mamba *Dendroaspis jamesoni.*

Fish species are little known, despite their importance for the local population. In the Cameroonian portion of the Sangha Basin, more than 200 species of fish have been identified, and the whole basin has nearly 300 identified species. The Sangha is a very dynamic environment because of silting and seasonal fluctuations that influence the reproduction, feeding regime and distribution of the fish. Among the most remarkable families in the areas of the flooded or floodplain forests are the Alestiidae with *Hydrocynus goliath*, the Aplocheilidae, the Cichlidae with the genus *Tilapia*, the Claroteidae with the genus *Auchenoglanis*, the Cyprinidae with the genuses *Labeo* and *Barbus*, the Mochokidae with the genus *Synodontis*, the Malapteruridae with the electric catfish *Malapterurus sp*. and the Schilbeidae. (CBFP 2006).

2.1.2 Social context of TNS

The Landscape has a very low population density, estimated at 0.7 inhabitants/km², but this varies across the estimated 25 000 people. In CAR, 5977 inhabitants are estimated in the protected areas of Dzanga Sangha, with an average density of 1.2 inhabitants/km². These inhabitants are distributed along the Bayanga-Lindjombo-Bomandjokou and Bayanga-Yobé axes in the interior of the Dzanga Sangha Special Reserve. The urban and industrial area of Bayanga houses 60% of these residents, with high density areas north of the Salo reserve, a major industrial logging site. In Congo, population density averages 1.5 inhabitants/km² and the inhabitants around PNNN centre around permanent villages established along the Sangha and around the logging bases of Kabo and Pokola, and the Mokabi UFA, with the Pokola Concession the largest population center in the region (13 417 inhabitants), representing the greatest potential impact on the national park. The logging company CIB developed the infrastructure of Pokola between 1999 and 2003, leading to the population increasing by 11% per year (CBFP 2006).

Population growth in the 'South East Technical Operational Unit" (SE TOU), has been predicted to increase 1.6 fold over 25 years, mainly due to births because in- and out-migration are estimated to be about equal. Out-migration is predicted to increase in the future, with a continuation of the present trend of moving to cities (Sandker *et al.* 2009).

Two dominant indigenous ethnic groups inhabit the Landscape area: Bantus (predominantly farmers) and pygmies (predominantly forest-centred hunter-gatherers) (Jackson 2004). The pygmies and Bantus are respectively known as Baka and Bangando/ Bakwele in southeast of Cameroon, and Ba'aka/ Bayaka and Bilos in south-western CAR (Jackson 2004). Both in Cameroon and CAR, the pygmies are known as prior occupants of forest lands and have a distinctive social structure, lifestyle and livelihood strategy intimately dependent on natural resources (Tieguhong and Ndoye 2007). Apart from indigenous populations many people from various ethnic backgrounds also inhabit the region.

Household surveys conducted in 2008 in the SE TOU, part of which is in the Sangha Tri-National Landscape, indicate an average cash income of 250 US$ per capita per year (Sandker *et al.* 2009). Poverty levels are considerably higher than in the rest of Cameroon, where the average annual per capita income is 1010 US$ (World Bank 2006 in Sandker *et al.* 2009). Of the TNS region households surveyed, 70% live below 1 US$ per person per day. The difference between the Bantu and Baka average cash income was significant: 1966 US$ and 864 US$ per household per year, respectively. For the Bantu, agriculture was the most important cash source,

but for the Baka, the collection of forest products, bushmeat hunting, and agriculture were equally important (Sandker *et al.* 2009).

The major economic activities around the landscape in CAR and Cameroon are: logging, mining, hunting, fishing, agriculture, livestock breeding, gathering, conservation, tourism and trade. In the Republic of Congo: industrial logging, services for employees of the logging companies, hunting, fishing and agriculture. Fishing is mostly practiced in the dry season, hunting in the rainy season (hunting is prohibited in the dry season). Men tend to hunt and fish, women gather NTFPs, do household work, agriculture and occasional fishing (CBFP 2006). Direct threats to the Landscape emerge from many of these activities. Commercial hunting represents the primary threat to wildlife throughout the Landscape, but especially in Cameroon and CAR, where it is exacerbated by increased access to forests via logging roads and by the general population increase. The pressure on elephants from ivory hunting is substantial in the southern part of the concession of Pokola and the northern edge of PNNN in the CAR. Rising populations in Kabo and Pokola villages, Republic of Congo, is reducing wildlife for the sake of subsistence. The increased number of species felled by industrial logging contributes to the loss of forest canopy; consequently, non-sustainable logging of certain species will eventually change the composition of the forest around PNNN. The disturbance of the clearings and 'bais' by logging threatens wildlife that depends on these habitats. Traditional diamond mining is a threat in the north of the special reserve in CAR (Ngakeu *et al.* 2002).

Mining villages such as Souanke and Punga (Boloko, Golana and Pandama mining sites) exist in the northwestern part of the Republic of Congo but are over 50 km from the TNS and thus were not visited during this study. All of the mining sites we visited were located in Cameroon and Central African Republic (Figure 2).

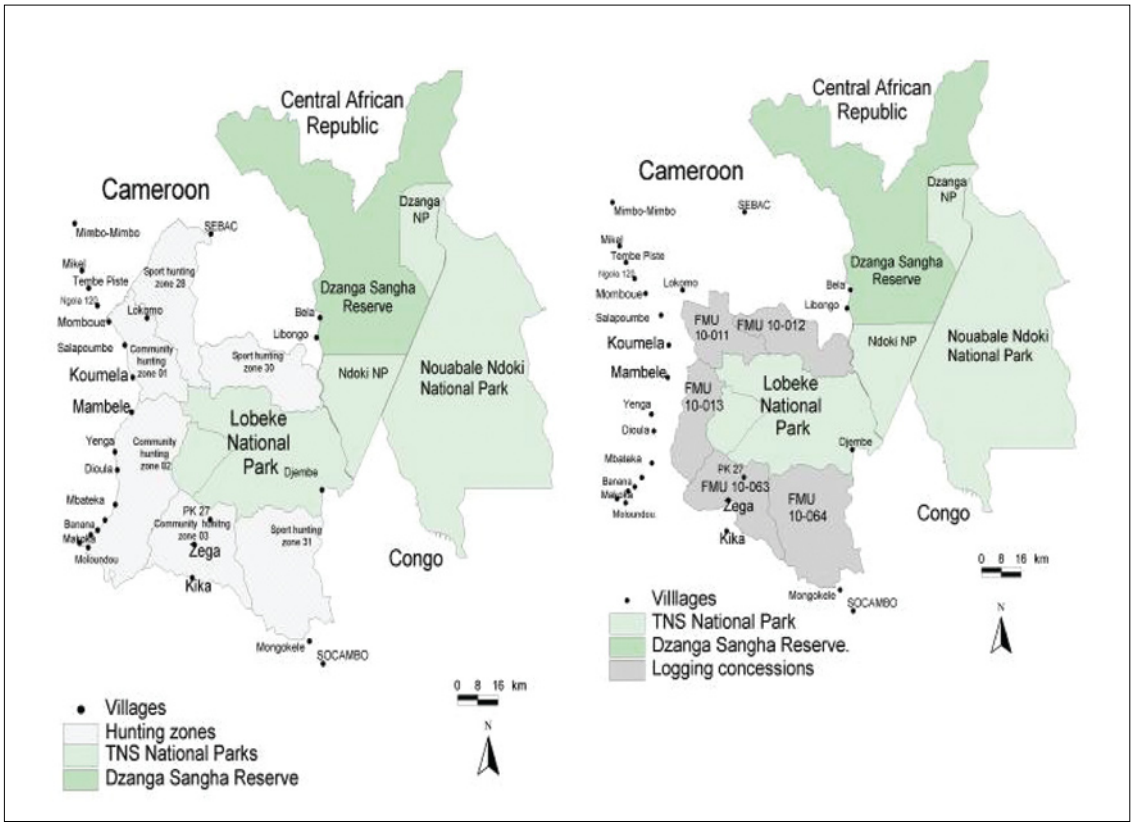


Figure 3. Hunting zones and timber concessions around Lobeke National Park

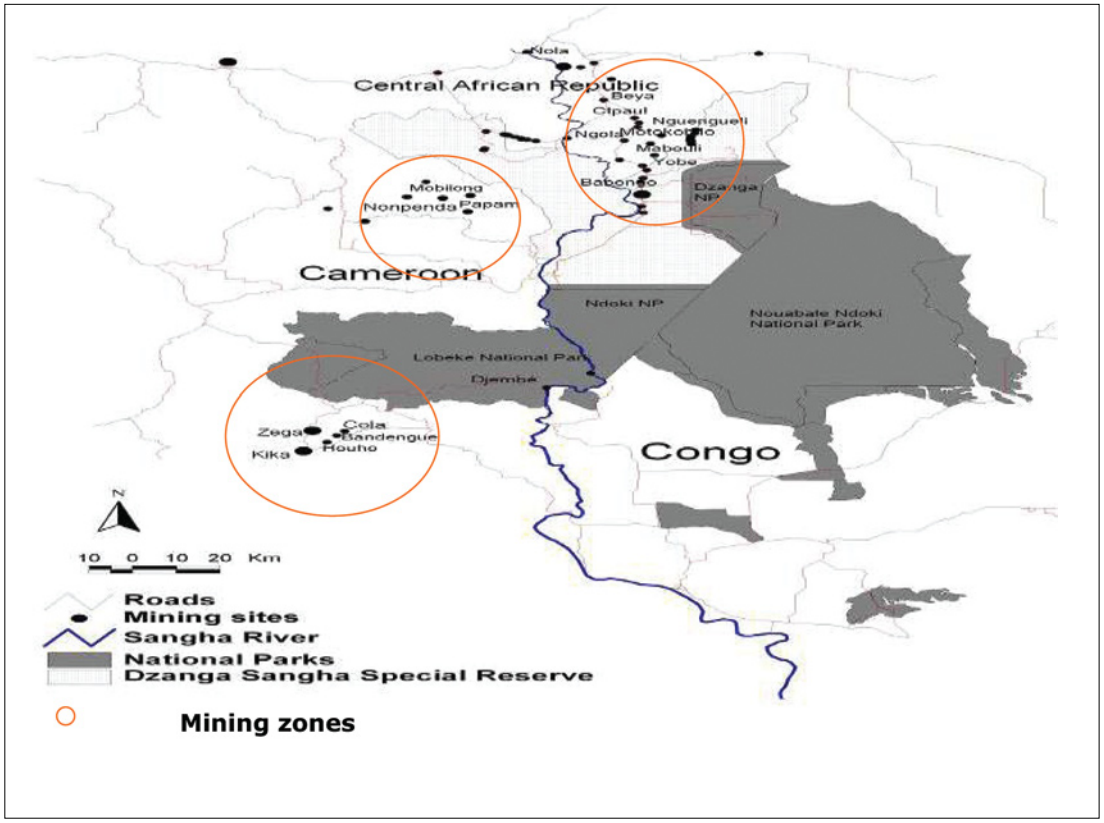


Figure 4. Artisanal mining sites in the Sangha Tri-National Park Landscape

2.1.3 Importance of the TNS Landscape

The TNS landscape contains vast extents of different types of pristine forests with high ecological integrity, a rare phenomenon in the Congo Basin and worldwide. It provides habitats for some of the largest intact communities of large mammals in Africa, being particularly important for forest elephants and great apes. The 'bais' (open grassy areas, often with water) are environments much sought after by many mammals and birds, forming an essential asset.

The forests of the Landscape have been recognised as critical for conservation in Africa and as one of the priority areas for forest conservation in the northwest Congolese ecoregion. There are major opportunities for conservation thanks to protected areas covering 21.5% of the whole landscape (752 000 ha) and cross-border cooperation agreements signed in 2000 by the three countries. The governments and international organisations such as WWF, IUCN and UNESCO actively engage in the conservation of the protected areas and move towards sustainable management of the buffer zones in two of the three countries.

2.2 Data collection methods

The methods used to collect data and calculate results included:

- Interviews of 24% (sample) of miners, guided by questionnaires (Appendix 4), and semi-structured interviews of stakeholders (Appendix 3) on general perceptions of the types and trends of mining processes and other income portfolios, perceptions of environmental degradation, benefit flows, characteristics of mining and its governance
- Consultation meetings and focus group discussions with local administrators, TNS park officials, village chiefs, counsellors and other local stakeholders
- Documentary analysis or desk reviews of literature pertaining to published mining permits, national laws and regulations, as well as documents produced by support and mining organisations
- Consultation regarding unpublished reports from government ministries (MINFOF, MINEP, MINIMIDT-CAPAM) and local NGOs
- Informal discussions with staff in stakeholder organisations on the social and environmental impacts of small-scale mining, covering sources of

conflicts, problems and risks to the sustainability of their activities, and definition of the four main interviewed villages
- Field visits (in Cameroon and CAR) to current mines located within 50 km of the borders of the TNS area for observation, mapping and photographic documentation.

To elicit relevant information from respondents on the extent that revenues from mining activities were used to meet basic household needs, respondents were asked to score their individual uses of mining revenues on a scale ranging from zero to ten (0-10), with 10 implying that mining income fully met the specified basic need while zero implied that the specified need was not met using mining income. The scores were converted into percentages by the interviewer.

2.3 Data entry and analysis

Data analysis was done in three phases: data entry, checking and correcting; calculation of descriptive statistics; and logistic regression analysis. Field data entry was performed in the CPros version 3.0 typing mask and later transferred using Stat-Transfer version 5.0 into SPSS Program version 12.0 for analysis. STATA version 8.0 was used for the logistic regression analysis. Information provided by partners and field organisations was recorded as their perceptions and later used to cross-check data provided by artisanal miners.

Twelve equations (see Figure 5) were derived and used in the calculation of annual quantities of minerals, annual costs of production, gross and net revenues, as well as the aggregation of observed values.

An analysis of variance (ANOVA) level one test was used to find differences among two or more independent groups. The mean income was separated from other livelihood parameters and ranked using the multiple comparison Tukey test at 5% level of significance. Similar tests and rankings were conducted to separate the means of the various ways in which miners spend their mining income.

Logistic regression analysis

In order to apply the logit model, miners were dichotomised into those who were highly dependent on artisanal mining and those who had lower dependency on it. For this study it was assumed that a miner in any of the studied villages was dependent on mining if the proportion of his/her total mining income was more than the calculated average gold/diamond mining income. According to Masozera and Alavalapati (2004) and Gujarati (1995), by dichotomising the income of natural resource users into high and low dependencies, one can design better policies and strategies to reduce or improve their dependency.

The model used to estimate miner dependency was specified as follows:

$\ln [Pi/(1-pi)] = \beta_0 + \beta_1 X_1 i + \beta_2 X_2 i + \ldots\ldots + \beta_k X_k i$

where subscript i denotes the i-th observation in the sample, p is the probability of the outcome, β_0 is the intercept term, and β_1, β_2,…., β_k are the coefficients associated with each explanatory variables X1, X2……Xk (Tieguhong and Zwolinski 2008; Vedeld *et al.* 2007; Anderson *et al.* 2006; Dewi *et al.* 2005; Masozera and Alavalapati, 2004; Bahuguna 2000; Gujarati 1995).

The explanatory variables used to explain miner dependency were: country where mineral is being mined, mining village, number of wives of miner, number of dependents, sex, education, ethnic affinity, mining experience (years), occupation as miner (full-time or part-time) and other sources of income.

Test of income inequality and the role of mining income

A test to determine how mining income could narrow or widen the gap between the rich and the poor in the region, taking into account environmental resources, was performed by calculating Gini coefficients (Vedeld *et al.* 2004). This method enables us to test inequality associated with dependence on mining income. The Gini coefficient of absolute total miners' income was calculated as:

$$G_{AI} = \frac{\sum_{i=1}^{n}\sum_{j=1}^{n} | AI_i - AI_j |}{2n^2\mu}$$

Where n is the sample size and μ is the sample average. So the Gini coefficient for income inequality is simply the relative mean difference between all possible income pairs i and j in the sample. If we construct a new variable "absolute non-mining income (ANMI)", that is, absolute income from all sources other than mining, such that:
ANMI = AI – AMI

$$\text{Annual gross mining income} = \begin{cases} \text{Monthly income} * 12 \text{ for all season miners} \\ \text{Monthly income} * 6 \text{ for dry/raining season miners} \end{cases} \quad \text{--- (Eq. 1)}$$

$$\text{Annual quantity of mineral mined} = \begin{cases} \text{Quantity/trip} * \text{No. of trips/month} * 12 \text{ for all season miners} \\ \text{Quantity/trip} * \text{No. of trips/month} * 6 \text{ for dry/raining season miners} \end{cases} \quad \text{--- (Eq. 2)}$$

$$\text{Annual net mining income} = \text{Annual gross mining income} - \text{Annual mining cost} \quad \text{--- (Eq. 3)}$$

$$\text{Annual mining cost} = \text{Annual material cost} + \text{Annual transport cost} + \text{Annual tax cost} + \text{Annual labour cost} \quad \text{--- (Eq. 4)}$$

$$\text{Annual material cost} = \sum_{i=1}^{n} (\text{material cost})_i / (\text{life span})_i \quad \text{--- (Eq. 5)}$$

Annual tax cost was fixed among all miners that paid labourers' tax (2000 CFAF) or chief of site's tax of 30050 FCFA in CAR. No miner in Cameroon reported to have paid taxes to the government, thus tax costs were not included in the costs calculation for miners in Cameroon.

$$\text{Annual transport cost} = \begin{cases} \text{Total monthly transport cost} * 12 \text{ for all season miners} \\ \text{Total monthly transport cost} * 6 \text{ for dry/raining season miners} \end{cases} \quad \text{--- (Eq. 6)}$$

$$\text{Annual labour cost} = \begin{cases} \text{Total number of paid workers} * \text{amount paid per day} * 30 * 12 \text{ for all season miners} \\ \text{Total number of paid workers} * \text{amount paid per day} * 30 * 6 \text{ for dry/raining season miners} \end{cases} \quad \text{--- (Eq. 7)}$$

Aggregations

$$\text{Total miners' income} = \sum_{i=1}^{131} (\text{income from mining})_i + \sum_{i=1}^{131} (\text{income from other sources})_i \quad \text{--- (Eq. 8)}$$

$$\text{Income from other sources} = \sum_{i=1}^{8} (\text{other sources}) \quad \text{--- (Eq. 9)}$$

Where other sources include: NTFP gathering, fishing, farming, hunting, livestock rearing, paid labour and trading.

$$\text{Total income from natural sources} = \sum_{i=1}^{131} (\text{income from NTFPs} + \text{hunting} + \text{fishing} + \text{mining}) \quad \text{--- (Eq. 10)}$$

$$\text{Relative mining income} = \frac{\text{Total income from mining} * 100\%}{\text{Total miners' income}} \quad \text{--- (Eq. 11)}$$

$$\text{Relative income from natural sources} = \frac{\text{Total income from natural sources} * 100\%}{\text{Total miners' income}} \quad \text{--- (Eq. 12)}$$

Figure 5. Twelve equations for data analysis

then we can calculate another Gini coefficient for absolute incomes excluding mining income:

$$G_{ANMI} = \frac{\sum_{i=1}^{n}\sum_{j=1}^{n} | ANMI_i - ANMI_j |}{2n^2\mu}$$

A comparison of these two Gini coefficients will reveal whether, and to what extent, mining incomes contribute to reducing inequality (Vedeld *et al.*, 2004). If GANMI > GAI, then it implies that mining incomes help reduce income inequality in the region, else the reverse holds true. For instance, Aryal (2002) found GAI in his study at Budongo, Uganda increased from 0.55 to 0.61 when forest income was excluded (Vedeld *et al.* 2004).

2.4 Definitions

Surface mine means an excavation in the earth above ground (open-pit mine) for the purpose of opening-up, proving or producing any mineral from a natural deposit. It includes all facilities belonging to or used in connection with the mine (Walle and Jennings 2001).

Risk means the likelihood that something will cause injury or damage to the health of people and **hazard** means the potential to cause injury or damage to the health of people (Walle and Jennings 2001).

Artisanal and small-scale mining (ASM) broadly refers to mining by individuals, groups, families, or cooperatives with minimal or no mechanisation, often in the informal (illegal) sector of the market (Hentschel *et al.* 2002). No universally accepted definition of ASM has been established and in some countries a distinction is made between 'artisanal mining' (that is purely manual) and 'small-scale mining' (that is more mechanised and on a larger scale). For example, in Mali, Niger and Burkina Faso, small-scale mining is differentiated from artisanal mining by the presence of permanent installations established after the existence of an ore body is confirmed (Hentschel *et al*. 2000). However, in this report, the two terms are used interchangeably.

Large-scale mining (LSM) refers to major companies as well as to mid-tier and small companies, or any formal company that complies with international performance standards (CASM 2008).

Formal miners in this report are understood as those organised into groups and/or following procedures in their mining activities, while informal miners do not follow any procedure and are unorganised, acting individually (either in the exploitation or marketing of their products). Legal miners are those who have documents backed by the law or mining code of their country, while illegal miners do not have any legal document that supports their mining operations.

3

Results

The results are categorised into country overviews of the sector, followed by impacts derived from literature reviews, stakeholder consultation and interview-based field data.

3.1 Country mining sector overviews

Artisanal mining is a nature-dependent activity that has evolved differently due to national differences in governance and legal systems, as well as the presence or absence of political will to promote the sector. This section provides an overview of the artisanal mining sector in Cameroon, Congo and CAR.

3.1.1 Cameroon

Cameroon's exports are dominated by non-manufactured goods, which account for over 28% of GDP.

Six major items—forest products (timber and lumber), petroleum and other oil products, cocoa, coffee, cotton and palm oil—dominate its primary exports (MINEFI 2003 in Njong 2008).

Geologically, Cameroon is characterised by Archaean basement, Proterozoic volcano—sedimentary packages (similar to that of the auriferous Birimian belt of West Africa) and several late stage intrusive phases. Cameroon has extensive bauxite reserves at Minim–Martap and Ngaouanda, but requires substantial infrastructure development in order to exploit them. These two northern deposits have an estimated combined resource of 1100 Mt of bauxite. Alucam is Cameroon's largest aluminum company, and its aluminum smelter produces 90,000 t/year of aluminum from bauxite, currently imported from Guinea. The Mbalam Iron Ore Project is located in close proximity to the Belinga Iron Ore Project in Gabon, which is being developed by the China National Machinery and Equipment Import and Export Corporation (CMEC). The Mbalam and Belinga Projects form part of an emerging iron ore region– that extends through the Republic of Cameroon, the Republic of Congo and Gabon.

The artisanal mining sector was organised even before national independence, contributing up to 20% of the economy. After independence, the activity continued but was hindered by smuggling and by exploitation of local actors. Numerous artisanal gold mining sites are known (producing around 1500 kg/year), but it appears that no modern exploration methods have been used to locate Cameroon's primary gold potential (Mbendi 2008). The resources mined in Cameroon are limited, with annual artisanal production of around 45 000 oz/year of gold and 12 000 ct of diamonds, as well as various building materials. To date no primary gold deposits have been located. However, work carried out by the *Bureau de Recherches Géologiques et Minières* (BRGM) suggests that gold mineralisation is related to the volcano-sedimentary belts characteristic of the Birimian belt in Niger, Burkina Faso and Mali.

Alluvial gold production is derived from elluvial and alluvial workings. The effect on miners is a contradictory creation of both significant wealth and extreme poverty, with very limited contributions to national economies. Despite the richness of the Cameroonian basement, solid mining in the 1997/98 fiscal year contributed only 4.8 billion CFA or 0.08% to GDP (Sale 2003). The absence of a coherent operational strategic code was blamed for the relegation of the mining sector in favour of agriculture and other sectors as pillars of development. However, in recent years, there has been a revamping and reorganising of the mining sector. The government is currently examining the assistance it gives to the artisanal mining sector (Gweth 2003).

As of April 2008, Cameroon had no industrial mining exploitation permits. Lom River Gold Corp (formerly Lorica Resources Inc) from Canada has an

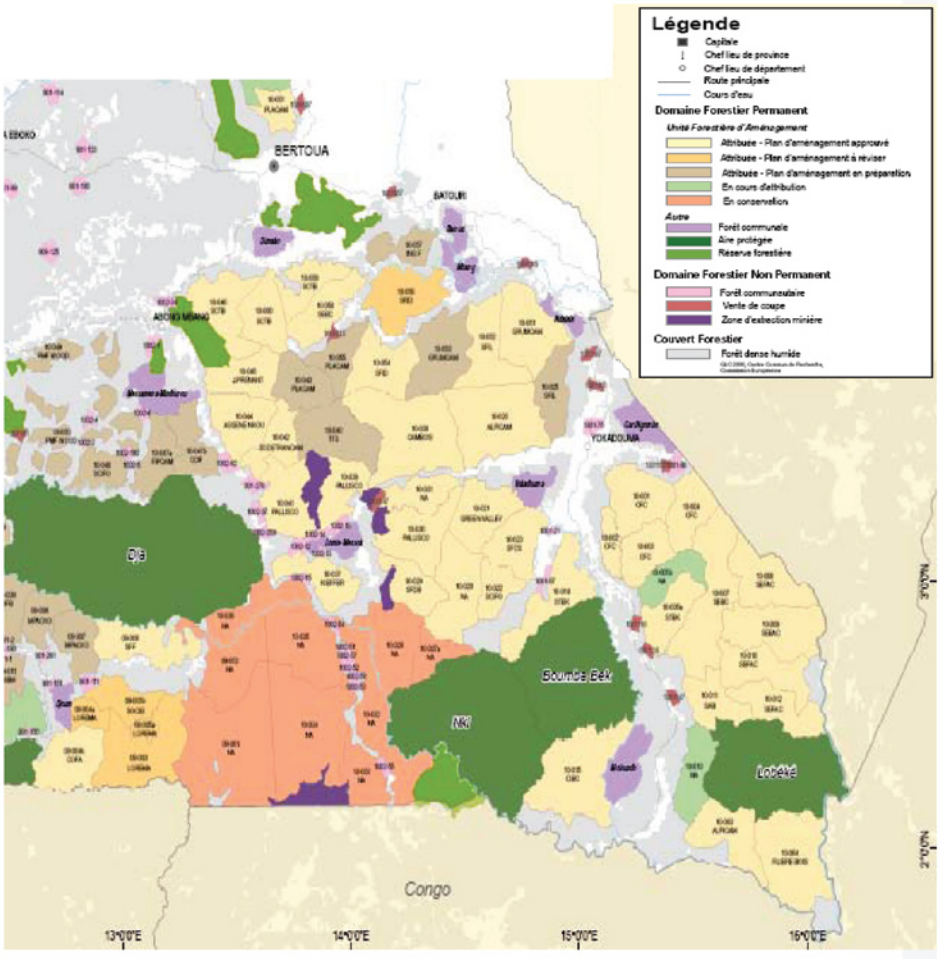


Figure 6. Map of forest exploitation and protected areas, Cameroon
Source: Global Forest Watch, Situation de l'exploitaiton forestiere au Cameroon, May 2006

option to prospect gold in southeastern Cameroon (Mbendi 2008) and three exploration licences for gold were valid during 2001 (Akonolinga 2009). Cameroon's undeveloped mineral resources include bauxite, cobalt, gold, granite, iron ore, nickel and rutile. Strong metal and industrial mineral prices since 2003 have encouraged companies to develop mines. The southeast region and nearby regions in Gabon, Republic of Congo, and Central African Republic have few productive mineral deposits and few with near-term production potential. Alluvial gold is artisanally exploited from stream gravels in parts of Cameroon, Gabon, Congo, and Central African Republic.

However, the U.S. Geological Survey's 2002 estimate for total gold production from all four countries combined was less than 1600 kilograms (Wikipedia 2008).

The Korean company C&K Mining, in collaboration with CAPAM, has proven a huge potential of diamond deposits (estimated 740 million carats) at Mobilong, East Province. Despite this being about five times the world's current annual production, Cameroon has not yet been globally recognised as a country of significant diamond production (Gweth 2008). Almost all artisanal mining sites in Cameroon are covered by industrial mining research permits. In 2003 there were only two such permits, but today there are over 70 exploration permits (Gweth 2008). However, the local miners at Mobilong are wary of the presence of C&K Mining Company, fearing they could be evicted when the company starts operations. In response to this, the 2001 Mining Code of Cameroon provides for resolving problems related to small-scale mining and large-scale mining (LSM) operations at the same site.

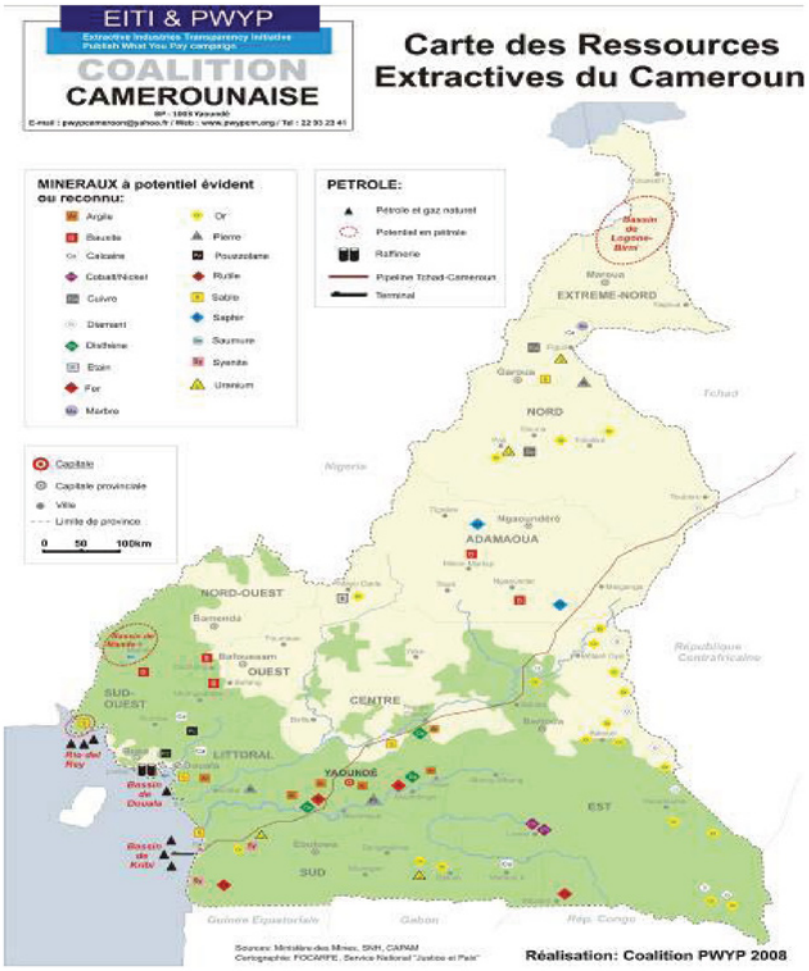


Figure 7. Map of mining activities, Cameroon

Figure 7 and Figure 8 highlight the overlap of mining and timber concessions and National parks in the TNS. This overlap demonstrates very clearly the lack of coordination between the responsible authorities. There is a potential conflict of interest not just between industrial timber and mining concessions (which are normally different enterprises), but also between their operations and protected areas and, more critically for this study, between large-scale industry and the livelihoods of those working and/or living in the TNS area.

Cameroon mineral policy and regulations

Cameroon's geological and mining sector has two objectives. The scientific objective is promoted by the Ministry of Scientific and Technical Research, which oversees a variety of research institutes in the areas of geology and geophysics, hydrology and energy. The industrial objective is promoted by the Ministry of Industry, Mines and Technological Development (MINIMIDT), which also has responsibility for the national geological survey through the Directorate of Mines and Geology. In terms of Fiscal Regime and Commercial Legislation in Cameroon, mining activities are subject to the following laws: Mining Code under the Ministry of Industry, Mines and Technological Development; Tax Code including customs, labour and investment codes under the Ministry of Finance; and Environmental Code under the Ministry of Environment and Nature Protection (MINEP).

The legal framework for Cameroon's companies follows French law. The Mining Code consists of a law (1964) which regulates mineral substances, and another law (1978) which defines taxes, including royalties and mining taxes. The latter was supposed to define the fiscal framework for mining, but this did not happen until 2001 when the New Mining

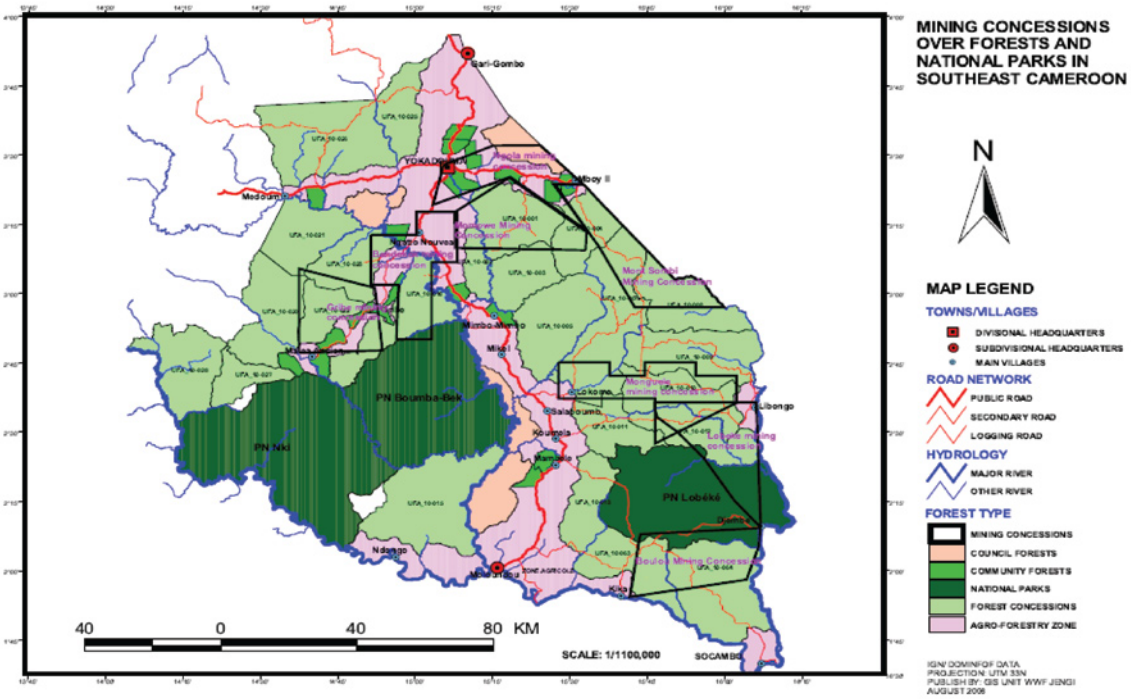


Figure 8. Map of mining concessions, forest areas and parks, Cameroon

Source: WWF Cameroon 2009

Code was promulgated (Law No. 1 of April 2001) with the help of the World Bank. This New Mining Code includes fiscal laws necessary for the regulation of the sector with provisions for investors to negotiate on a case-by-case basis for the establishment of mining companies. This legal framework has reduced administrative burdens and increased the evaluation of investment opportunities (which often require rapid decisions). One advantage of the new code is a reduction in the role of the State in mining operations as well as its discretionary powers. On the other hand, there is an increase in the State's role as a supervisor and regulator of the mining sector. Environmental aspects are also properly addressed by the new code. According to the code, all mineral resources belong to the State. Prospecting, exploration and mining activities for any mineral deposit are regulated by permits, including: quarrying, prospecting/research, exploration, exploitation and mining concession permits (Republic of Cameroon 2001). These permits have various objectives, property rights, validity and delivery authorities. According to the Investment Code, a Cameroon company must be established, with more than 35% of capital owned by Cameroonian citizens, before investment is allowed in any of the country's activities. National subsidiaries are allowed (Mbendi 2005).

In Cameroon, traditional administrative structures have controlled the small-scale mining sector post-independence. Over the course of time, a large number of difficulties led to a drastic reduction in the sector's contribution to national income. In order to circumvent the difficulties embedded in the 1964 mining code, the 2001 mining code made it possible to set up an autonomous unit to play the roles of facilitation, assistance, promotion of small-scale mining and fostering evolution towards large-scale mining. This unit, created in 2003 is called CAPAM (Support and Promotion Framework of Mining Activities in Cameroon).

3.1.2 Central African Republic

The Central African Republic (CAR) has a small economy dominated by agriculture and forestry. Over 70% of the population of 3.7 million live in rural areas and engage in subsistence farming. The agricultural sector accounts for over 50% of the GDP of 1.5 billion US$ (estimated for 2005). The GDP real growth rate was estimated at 2.5% for 2005. Export earnings are dominated by diamond sales (40%) and forestry revenue (16%), and were estimated at 0.13 billion US$ for 2004. The CAR has commenced restructuring and upgrading its infrastructure. The country receives economic aid

from France and the European Union recently granted 65.5 million US$ to rehabilitate a section of the main road linking the capital city of Bangui with the Cameroonian border town of Garoua-M'Boulay to the west (CIA 200).

The CAR's mineral industry is relatively small, due to a historical lack of exploration and mining investment. The country attracted little interest until recently, due to its remote locality and competition with larger countries that have well-known mineral resources, such as Angola and the Democratic Republic of Congo (DRC). A large number of international companies have recently taken up concessions to explore the CAR for diamonds, gold and petroleum products. These companies include De Beers Group, Axmin Inc, UraMin Inc, Pan Africa Resources PLC, GEM Mining Ltd and Energem Resources Inc. Lack of infrastructure coupled with the fact that the country is landlocked has hindered development of the mineral industry.

Artisanal mining of diamonds and gold in the CAR occurs mostly in the regions of Berbérati, Upper Kotto, and Sangha. Since 1962, 98% of diamonds and 100% of gold production came from ASM in these regions. Diamonds were discovered in alluvial deposits in 1935 and 1947. Production reached 609 360 carats in 1968, and was estimated at 530 000 carats in 2000, with 75% being of gem quality. Sizeable quantities were smuggled out of the country. About 60% of the nation's diamonds came from the upper Sangha region. Gold production began in 1930 and peaked at 521 kg in 1980, falling to 26 kg in 1982 and climbing back to 100 kg in 2000. Diamonds and gold are mined in alluvial deposits by about 40 000 artisanal miners, primarily in the Bandas and Bogoin-Boali greenstone belts (Encyclopedia of the Nations 2008).

The CAR mining sector is dominated by diamonds and gold, but it includes small tonnages of industrial minerals. Diamond production reached an estimated 350 000 ct in 2004, primarily sourced from alluvial deposits in the north. The country produced 7 kg of gold in 2004. ASM annually produces 400 000 to 800 000 carats of diamond, worth roughly 50 billion CFA. In terms of revenue, the CAR is the tenth largest producer of diamonds in the world and the gem accounts for some 54% of export earnings (Forster and Bill, 1992). The CAR is well known for the quality of its diamonds, ranking fifth in the world in terms of quality (Mbendi 2008).

The government keeps statistics concerning diamond production and trading through the Bureau d'Évaluationet de Contrôle de Diamant et d'Or (BECDOR). BECDOR was established in 1982 to oversee the internal diamond market and to valuate official exports. It also maintains a database concerning all diamond production in the country. BECDOR estimates that there are approximately 50 000 licensed diamond diggers, or 'creuseurs', in the CAR. These artisanal miners sell their production to about 160 certified collecting agents who, in turn, sell to two purchasing offices located in Bangui.

The CAR's gold production is also produced by artisanal mining. Official production is estimated to be about 100 kg per year, but actual production is estimated to exceed 2 tonnes a year. Gold production is almost entirely from alluvial operations. The CAR has two exposed greenstone belts (Bandas and Bogoin-Boali) which have attracted most of the artisanal activity, producing around 1 tonne of gold per year (Mbendi 2008). Due to years of rampant fraud, however, at least twice that amount arrives in Antwerp, Belgium from CAR every year.

The mining sector contributes less than 5% to national GDP, but this figure is suspect, due to the amount of smuggling (Mbendi 2005). Diamonds were the country's leading industry and top export commodity in 2002. Mining accounted for about 4% of GDP and 40–50% of export earnings. The geology of the CAR is poorly known and, in conjunction with ongoing political risk, this fact explains why the country has been devoid of primary exploration. Following small-scale exploitation of alluvial diamonds and gold during the colonial period, artisanal production of gold has simply been quasi-ignored (Forster and Bill 1992). The CAR is a member of the Kimberley Process diamond certification scheme. This process, initiated by the World Diamond Council and the United Nations, and implemented by a UN General Assembly vote in 2003, requires the certification of all rough diamonds from the time of mining through every transfer of ownership. The process was implemented to combat the sale of so-called "blood" or "conflict" diamonds which funded armed conflict, rebel activities, government overthrows and the arms trade, especially in Sierra Leone, Angola and the DRC.

Mining Code of CAR

The mining sector is under the responsibility of the Ministry of Mines and Energy, having previously

been attached directly to the Presidency. A General Directorate for Mineral Resources implements the laws and policies regarding permits. The directorate processes requests prior to their submission to the government for approval. The Mining Code regulates all mining activities. All mining licences in the country were suspended in 2003, following an overthrow of the government. After being criticised by many experts in the sector for its inflexibility, unattractive fiscal policy and excessive administrative powers, the Mining Code of 1961 was replaced in 2004 by the promulgation of Ordinance No. 04.001 (CAR 2004). Licenses were re-instated in 2004 based on the new mining code. The new code includes more attractive fiscal policies and other flexibility that can help deregulate the mining sector and encourage its development. As in Cameroon, the new Mining Code was designed to attract foreign investors.

All mineral resources in the ground or on the surface are the property of the State but any person may be granted access to them. They are classified into 'quarry' (construction minerals including sand, gravel and stone) and 'mine' (all other mineral substances). In the new Mining Code, permits for exploration and mining fall under six categories: artisanal mine, prospecting, exploration type A, exploration type B, mining, and mine concession (Mbendi 2008). These permits serve different purposes, in relation to various surface areas, validity and delivery authorities. All permits provide exclusive rights on the defined property. They can be sold or transferred with the authorisation of the Ministry of Mines. When a deposit is discovered, the right to mine is guaranteed to the owner of the exploration permit. A major factor in the CAR mining sector is the prevalence of fraud and the financial dependence of artisanal miners on collecting agents (Mbendi 2008).

The new Mining Code establishes a mining policy that reduces the influence of the State on mining operations, and creates favourable conditions for investors (CAR 2004). The strategic approach is by implementing fiscal incentives (e.g., tax exemption on equipment during exploration) and establishing an organisation responsible for geological exploration and mining to promote the discovery of new deposits via prospecting campaigns (CAR 2004). The issuance and renewal of artisanal mining permits is well codified in the new Mining Code of CAR.

3.1.3 Republic of Congo

The Republic of Congo's mineral industry mainly focuses on petroleum products, which contribute 60% of foreign exchange earnings annually. The Congo has base metal, gold, iron ore and phosphate potential. Geologists from Ashanti Goldfields have discovered primary gold mineralisation at the Mougongo prospect that covers the newly identified 180-km-long Mayombe belt. Traces of alluvial diamonds have been observed near the border with the Central African Republic. Portuguese-based Escom secured diamond exploration rights in the northern Congolese region of Likouala. Their licence covers 6000 km^2 and exploration began in late 2001 (Mbendi 2008). In November 2000, Arena Gold Resources Inc. of Canada signed an agreement, subject to completion of its due diligence evaluation, to acquire a minimum 15% interest in the Yangadou gold mine in the Sangha Region from S.E.M.I., SA, which was a Congo (Brazzaville) corporation (Arena Gold Resources Inc. 2000). Oil, diamonds and potash are the principal mineral exports. In 2004, diamond exports to most world markets were banned when the diamonds lost certification. The Republic of Congo was excluded from the Kimberly Process in 2004 amid allegations that most of its diamond exports were in fact being smuggled out of the neighbouring DRC. The RoC was re-admitted by the certification group in 2007 (Kimberly Process 2004, 2007).

Mining Code of the Republic of Congo

The prospecting, research, exploitation, circulation and transformation of all mineral substances in the Republic of Congo are protected by Law No. 4-2005 of 11 April 2005, dubbed the Mining Code (Republic of Congo 2005). Investment in the mining sector is governed by the Investment Code of 1992 and Hydrocarbon Law 24/94 of 23 August 1994, which regulates the terms of production-sharing agreements. In general, mining is carried out by the state or through state-owned joint ventures under the auspices of the ministry in charge of mines. According to Article 3 of the Mining Code, mineral and fossil substances are subdivided into seven categories. The fifth category concerns precious substances such as gold and diamonds. According to the United States Geological Survey Mineral Resources Program, the Republic of Congo produces an average of 10 kg of gold per year (USGSMRP 2008). Articles 39-44 of the Mining Code of the Republic of Congo govern the artisanal mining sector, including procedures for annual artisanal mining permits.

3.1.4 Artisanal mining institutions

The mining sector has evolved over the years. Not only has the national government been developing laws and regulations, but regional and international organisations have also exerted influence.

National initiatives

In the Congo Basin, only Cameroon and the DRC have set up nationally supported structures to facilitate small-scale mining. In Cameroon, traditional administrative structures controlled small-scale mining after independence. Difficulties related to the 1964 mining code led to a drastic reduction of the sector's contribution to national income. The 2001 mining code set up an autonomous unit to fulfil the roles of facilitation, assistance and promotion of small-scale mining and to foster evolution towards large-scale mining. Created in 2003, the unit is called Support and Promotion Framework of Mining Activities in Cameroon (CAPAM). A sister autonomous government agency in the central African sub-region is Service d'Assistance et d'Encadrement du Small-Scale Mining (SAESSCAM or Service for the assistance and organisation of small-scale mining) established in the Democratic Republic of Congo. SAESSCAM was created in March 2003 with a mandate to:

- promote the emergence of middle-class Congolese in the small-scale mining sector
- ensure the training of and technical and financial aid to mining cooperatives and operators in the small-scale mining sector, in order to strengthen their managerial capacities
- ensure the monitoring of market channels and flows from exploitation sites to sale points to clarify official marketing circuits
- recover after-sale government taxes and other fees that are due
- sensitise about safety measures at exploitation sites as well as ensure their strict application
- participate in the creation and management of mining funds to promote small- and medium-scale mining operations (Matip 2003).

Regional initiatives to promote the small-scale mining sector are more pronounced in the western, eastern and southern parts of Africa. An example of such an initiative is the Community Artisanal and Small-scale Mining (CASM) initiative under the auspices of the World Bank. CASM increases networking, information exchange and best practices sharing among ASM stakeholders and plays a coordination role between ASM assistance projects and donor funding (MMSD 2002). In the Congo Basin, only Cameroon and the Democratic Republic of Congo have been able to set up nationally supported structures to facilitate better performance of the small-scale mining sector. Other central African countries facing similar issues would probably benefit from sharing lessons learned on a regional level, which is especially relevant for cross-border landscapes such as the TNS.

A plethora of **international organisations** exist in the mining sector, mostly tackling issues governing large-scale mining rather than dispersed small-scale mining. Examples include:

The **International Labour Organization (ILO)'s Convention on Safety and Health in Mines**, 1995 (No. 176) provides minimum safety standards against which all changes to mine operations should be measured. The Convention sets out procedures for reporting and investigating accidents and dangerous occurrences in mines. Governments that ratify it undertake to adopt legislation for its implementation, including the designation of a competent authority empowered to monitor and regulate safety and health in mines. Guidelines can be found in the ILO's Code of Practice on Safety and Health in Open Cast Mines (Walle and Jennings 2001).

The International Council on Mining and Metals (ICMM) is a multi-partnership organisation that commits corporate members to implement its principles under a sustainable development framework, including global standards, public reporting, independent assurance and sharing best practices. (http://www.icmm.com/sd_framework.php)

The World Gold Council (WGC) is a global advocate for gold committed to playing a key role in the development of responsible gold mining. As a member of the ICMM, the WGC seeks to improve sustainable development (http://www.icmm.com/icmm_principles.php). The World Diamond Council (WDC) has a mandate similar to the WGC.

The Council for Responsible Jewellery Practices (CRJP) promotes ethical, social and environmental practices throughout the diamond and gold jewellery supply chain, from mine to retail shop (http://www.responsiblejewellery.com/what. html).

The Kimberley Process was initiated by African diamond-producing countries in May 2000 to develop an international certification scheme for rough diamonds to prevent "conflict diamonds" from entering legitimate markets (Kimberly Process 2004). This process was supported by the World Diamond Council and the United Nations, and implemented by a UN General Assembly vote in 2003. The certification process follows each diamond from mine through every transfer of ownership to retail sale. The process is supported by a broad range of international stakeholders in the diamond trade, including government officials, industry representatives and non-governmental organisations. Participants officially launched the Kimberley Process Certification Scheme (KPCS) on January 1, 2003. Participants are required to export rough diamonds in tamper-resistant containers and provide certificates validating that the contents are conflict-free. Participants are also prohibited from importing/exporting rough diamonds from/to countries that are not implementing the KPCS. The process aims to reduce the use of diamonds to fund armed conflict, rebel activities, government overthrows and the arms trade, especially in Sierra Leone, Angola and the Democratic Republic of Congo (DRC). At present, Côte d'Ivoire is the only country under embargo by the United Nations for the export of conflict diamonds (since December 2005). The CAR, DRC, Gabon and Republic of Congo are currently participants in the KPCS and in 2007 Cameroon affirmed its intention to join.

Extractive Industries Transparency International (EITI) founded in 2002 encourages governments to disclose their revenues from oil, gas and mining operations, verified by reports of company payments to governments. EITI starts by gaining consent from host governments for reporting their revenues and the payments by companies. Most of the consenting countries have called for disclosure of aggregate company payments across all reporting companies (EITI Fact sheet, 2008). This method meets the primary purpose of transparency initiatives, to ensure that governments use their revenues to benefit their citizens. It is worth emphasising that the implementation of EITI in Cameroon affects only oil. In many of the countries that are rich in natural resources, revenue generated by extractive industries historically has not improved the living standards of the general population; on the contrary it has long been associated with poverty, conflict and corruption (EITI, 2008). This situation is often a result of the lack of transparency. A key problem is non-respect of the obligation to account for all payments made by the private enterprises that exploit the natural resources. The Extractive Industries Transparency Initiative (EITI) aims to remedy such poor governance by applying six guiding principles:

1. All payments into government coffers from oil, gas and mining exploitation, and all revenue received by the government from enterprises in the extractive industries sector, are regularly communicated to the general public in an accessible and explicit form.
2. In the absence of government auditing of payments and revenue, a reliable independent audit is requested in conformity with international norms.
3. Payments and revenue are reconciled by a reliable independent administrator, who expresses his opinion on the conciliation of figures (or the discordance).
4. The approach extends to all enterprises, including State corporations.
5. Civil society takes an active part in designing, monitoring and assessing this process and contributes to the public debate.
6. The government and all contracting parties elaborate a financially viable work schedule with the help of international financial institutions. The schedule is accompanied by measurable targets, an implementation schedule and an evaluation of potential constraints (EITI 2008).

Cameroon is currently a candidate country of EITI and has until March 2010 to undertake validation. Other countries in the sub-region that have achieved EITI candidate status are Gabon, the Republic of Congo and the Democratic Republic of Congo. The Cameroon government's objectives for joining are tied to those of EITI including:

- Enhancing governance in the management of resources derived from extractive industries
- Reducing poverty and foreign debt (Service of the Prime Minister, 2008; http://www.eitransparency.org/Cameroon).

The mining industry has been a key in the development of many civilisations, underpinning the iron and bronze ages, the industrial revolution and the infrastructure of today's information age. ASM takes place throughout the world but it is more widespread in developing countries in Africa, Asia, Oceania and central and South America (Hentschel *et al.* 2000) Today more than 100 million people worldwide depend directly or indirectly on artisanal mining for their livelihoods (CASM 2008).

The world's 10 to 15 million artisanal miners produce 25% of the world's gold, the rest being produced by large-scale mining (LSM) companies (UNIDO 2009). Artisanal miners exploit over 40 different minerals but gold and diamond typically occupy about 60% of their mining. In DRC and Sierra Leone, artisanal gold and diamond mining make up 75% of national mining production (CASM 2008).

The main socioeconomic characteristics of ASM include:

- Low income in economies characterised by low level of earnings
- Provision of accessible livelihoods to poor and marginalised people
- Alluvial mining along rivers
- Minimal start-up time, capital and technical input
- Frequently labour-intensive, employing semi-skilled or unskilled workforce
- Low levels of mechanisation, production, productivity, recovery and efficiency
- Simultaneous engagement of workers in other low-income activities such as subsistence agriculture (CASM 2008).

Small-scale mines are testimonies for the existence of mineral resources, often pioneering alluvial production close to primary sources that later become industrial discoveries. The small-scale mining operations are also appropriate activities for marginal deposits, where industrial exploitation might not be economically feasible (Gweth 2003).

During the past 10–15 years, governments and donor organisations have implemented an array of technology, support-related, sustainable-livelihood and poverty-reduction projects for ASM. Most of these interventions failed to improve the industry's productivity and thereby raise the living standard of subsistence operators. Hilson (2005) argues that a poor understanding of the demographics of target populations has precipitated such outcomes. Strengthened policy for assistance in the sector should be based on more precise data regarding the number of people operating in ASM regions, as well as their origins and ethnic backgrounds, ages and educational levels. Improved understanding can be achieved by carrying out basic and localised census work before promoting ambitious sector-specific projects that aim to improve working conditions.

3.2 Livelihood impacts of artisanal mining

Currently yielding more than 60 metal and mineral products, Africa is a major producer of several of them including gold and diamonds. Although underexplored, Africa is known to possess about 30% of the planet's mineral reserves, including 40% of its gold, 60% of its cobalt and 90% of the world's precious gems (AfDB 2007; 2009). The revenues generated from diamond and gold mining have transformed the lives of many people on the continent. The income not only increases the overall standard of living, but also funds essential government services such as health, education and development (Diamondfacts 2006). With good governance and appropriate laws, these benefits can be achieved continuously. Countries such as Botswana, Namibia and South Africa offer ongoing proof that diamond revenues benefit the economy greatly in countries where the stones are sourced. These benefits are evident in their United Nations Human Development Index (HDI) ratings, which measure poverty, literacy, education, life expectancy, childbirth and other aspects of development worldwide (Diamondfacts 2006).

Countries in the Congo Basin, and the TNS region in particular, are not investing in large-scale mining (LSM). Gold and diamond are two major minerals exploited in the TNS region, primarily on an artisanal scale. In Cameroon, gold mining started in 1933 and totalled about 20 tonnes between 1934 and 1984, which is an average annual production of 300 kg, currently worth about 2 billion CFA (Lang 2007). In the East Province of Cameroon, an estimated 100 kg of gold is now produced per month by some 10 000 small-scale miners, mostly channelled through informal circuits (Sale 2003). Official figures by the Department of Mines and Geological Research are much lower: approximately 500 kg of gold produced annually by ASM throughout the entire country (Lang 2007). With regard to diamonds, the 700-km border between Cameroon and the Central African Republic has significant diamond production evaluated at 800 carats per month in 1993, despite the inadequate experience of Cameroonians in diamond exploitation (Gweth 2003). In most countries in central Africa, gold and diamond mining remain artisanal, albeit significant revenue contributors to local and national economies. This informal system can still yield significant quantities.

For instance, in the Central African Republic, between 400 and 800 thousand carats of rough diamond valued at 50 billion CFA is produced each year by ASM (Matip 2003).

In addition to providing cash income to local and national economies, ASM is labour intensive and thus a major purveyor of employment, reducing rural unemployment rates. ASM often precedes LSM because the former serves as a proxy for industrial prospecting by providing evidence of significant deposits (Gweth 2003). This discovery process opens a window for possible social conflicts if the small- and large-scale miners operate at the same site. The 2001 Mining Code of Cameroon differentiates between small- and large-scale mining, and gives provisions for the two types to operate at the same site. The reasons for coexistence include the fact that small-scale mines cannot go deeper than 30 m but industrial mines can go as deep as 4000 m, already achieved in South Africa (Sale 2003). Another reason is that the code recognises that local miners typically reside in the areas for decades, sometimes from generation to generation, and their entire families often depend on that livelihood.

At the beginning of the 21st century, mining constituted a major source of hope for many poor African countries, which were characterised by a rich resource base and a very poor population (Sale 2003; CASM 2008).

National economic impacts

The creation of a sustainable future for Africa may lie in its ability to develop and maximise its natural resources (Commission for Africa 2005; Diamondfacts 2006). Bearing in mind that Diamond Facts is owned by the diamond industry and is essentially a PR tool to reassure consumers about 'conflict diamonds', one can utilise their information with a proverbial grain of salt. Diamond Facts estimates that 65% of the world's diamonds, worth approximately 8.4 billion US$ a year, are sourced in African countries, inevitably contributing to economic growth. In Cameroon, solid mining during the 1997/98 fiscal year contributed only 4.8 billion CFA or 0.08% to the GDP (Sale 2003). In CAR, diamond mining was the country's leading industry and top export commodity in 2002, previously accounting for about 4% of GDP and 40%–50% of export earnings (Diamondfacts 2006).

Diamonds account for 76% of Botswana's annual export revenue, 45% of its government revenue and 33% of its GDP (approximately 3 billion US$). Since the discovery of diamonds in Botswana, shortly after independence in 1966, GDP growth has averaged 7% per year, which is one of the fastest rates in the world. In Namibia, diamonds provide approximately 10% of GDP, 40% of export revenue and 7% of government revenue each year. In 2006, Namibia produced approximately 700 million US$ of diamonds, While South Africa produced more than 1.5 billion US$. Corporate social responsibility (CSR) projects receive millions of dollars from diamond mining companies in South Africa. Sierra Leone exported approximately 142 million US$ worth of diamonds in 2005 (Diamondfacts 2006).

Employment creation

Artisanal mining is an attractive employment option in rural areas. Barriers to entry are minimal (low technology and little capital is needed) and activity levels are dynamic because precious minerals often rise in value during periods of economic crisis. The diamond industry provides livelihoods for large numbers of Africans in: Democratic Republic of Congo (750 000), Zimbabwe (350 000), Tanzania (600 000), Mali (300 000), Burkina Faso (150 000), Botswana (38 000) and Cameroon (20 000-30 000 with plans for 60 000 due to implementation of CAPAM) (Gweth 2003; Matip 2003). About 80 000 autonomous artisanal miners form the backbone of mining activity in CAR (Encyclopedia of the Nations 2008). These employment opportunities allow several million Africans to earn money, obtain healthcare, create a better home environment and provide education for their children.

Infrastructure development

The revenues generated from the diamond trade help build infrastructure in the respective countries. For example, in 1966, there were only 3 miles of paved roads in Botswana. Today, there are nearly 4000, as well as a public transportation system. There is now a country-wide digital telephone network in Botswana, consisting of several thousand miles of fibre optic cable. Now that travel and communications have improved, the people of Botswana have better access to employment opportunities, health care and schools.

Education and health care improvements

Educational opportunities have increased thanks to mining revenues. Botswana and South Africa highlight the potential for either direct state distribution of revenues or the LSM industry contributing to education and health care. African countries with formal diamond mining do well in terms of human development; for example, South Africa, Botswana and Namibia (Diamondfacts 2006).

3.3 Environmental impacts of artisanal mining

The environmental impacts of small-scale mining have been studied worldwide. A literature review indicates that the main impacts are: deforestation and land degradation; open pits causing animal traps and health hazards (including acting as mosquito breeding grounds due to stagnant water collection after being abandoned by the miners); mercury runoff from gold amalgamation; waste accumulation from inefficient extraction; dust and noise pollution; underground instability and long-term hazards (Hentschel 2000; 2002, Labonne and Gilman 1999; USAID 2000, UNESC 2003).

Concerns about the impact of mining on forests and protected areas (CSAM 2001; World Rainforest Movement 2002) have focused on: rising levels of mining in sensitive areas; uncontrolled mining that is not organised, often leading to political abuse and manipulation that reduce self-determination of miners; environmental degradation typical of ad hoc development and exploitation; sedimentation and contamination of water catchment; negligent use of Hg compounds and lack of reclamation.

Absolute dependence on large amounts of water for mining operations dictates that ASM be located as close to a water source as possible. Alluvial ore is a result of river deposition and is therefore part of a river system. The use of water for mineral concentration results in accelerated evaporation of surface water, drainage of wetlands and siltation of rivers and dams in countries like Mozambique, South Africa and Zimbabwe (Shoko 2003).

One of the most significant environmental impacts arises from the use of mercury (Hg). This pollutant is known to have long-term impacts on ecosystems and human health. In contrast to other sectors where mercury utilisation is decreasing, ASM remains a significant source of mercury pollution (UNIDO 2009). Despite the risks, it is a preferred chemical employed by artisanal gold miners. However, the general population is unaware of the effects of mercury and does not attribute such pollution to ASM. Moreover, individuals in positions of political or economic influence tend to be negatively biased towards artisanal mining; consequently. government policies do not effectively address its activities. Affected communities have been ignored, and mistrust towards outside parties is high. Not surprisingly, miners are suspicious of externally crafted solutions to reduce mercury emissions and therefore are unlikely to employ them (Meiga & Hinton 2002).

Mining is a geographically concentrated activity which results in a number of negative impacts on both the immediate vicinity and distant areas. These effects include water and air pollution, river and dam siltation and loss of biodiversity (deforestation, over-fishing and poaching). As a result, there are a number of extinct and threatened species within the Zambezi Basin (Shoko 2003).

3.4 Links between environmental and livelihood impacts

The link between environment and livelihoods has long been made in many parts of the world. In particular, a vicious circle of degradation of the environment from small-scale mining can increase poverty and thus exacerbate dependence upon natural resources (Figure 9).

Labonne and Gilman (1990) note that poverty results from a denial of choices, which implies living in a marginal and vulnerable environment; lack of opportunities further exhausts this environment. Most rural poverty is exacerbated by a lack of access to productive resources, in this instance land, good soil and water. A key to livelihood improvement is ensuring that the natural resource base used by the poor is maintained and even improved. Sustainable livelihood strategies imply that the economic needs of individuals and communities are integrated into the maintenance of the environment. Poverty is multidimensional and the approaches to reduce it have to be similarly multidimensional: political, economic, social and environmental. Therefore, the reduction of poverty requires opportunities for the poor to do more for themselves in all these sectors.

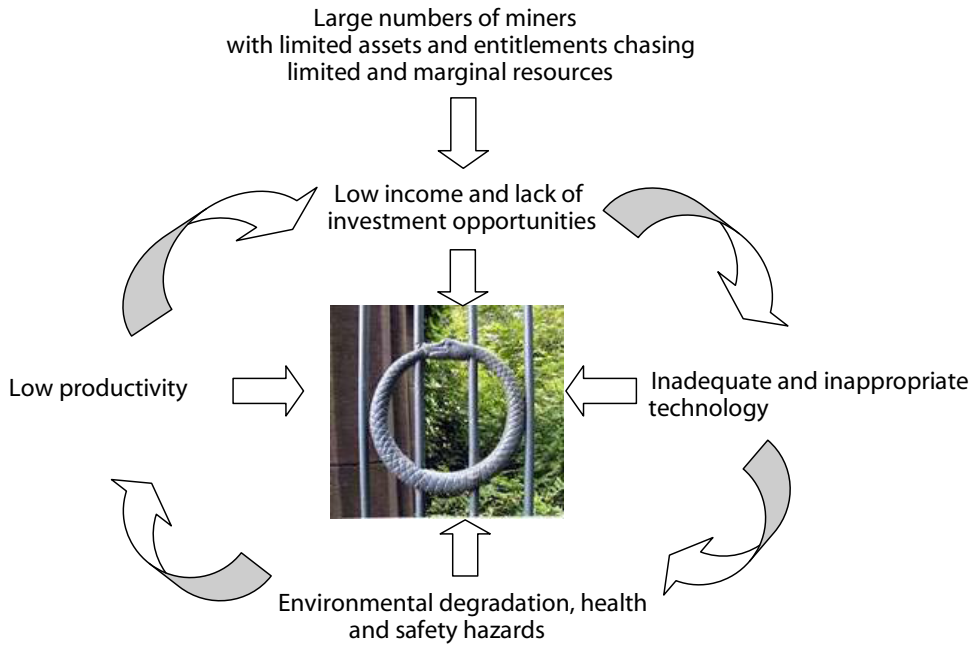


Figure 9. Artisanal Mining Poverty Trap
Adapted from UNESC 2003

The major challenge in devising pro-poor policies for artisanal miners is to understand the perception of the poor. By interacting with them, one can gain their trust to achieve a real and lasting ownership of the development process. The poorest miners need access to productive resources and appropriate knowledge of their use. In the case of artisanal mining, where there already is access to resources, the challenge is to improve organisation and techniques. One method would be to channel some of the income to spur alternative production activities that demonstrate the possibility of sustainability. In some rural communities, there is an over-reliance on mining as the sole potential economic engine. This dependence suggests a potential opportunity to invest mining income in other livelihood activities. In addition, upscaling of mining technology may contribute towards poverty reduction. Within poor artisanal communities, women and children contribute significantly to household income. However, their contributions are not acknowledged in economic and social terms.

Integrated natural resource management (INRM) is a tool that can help resource users, managers and others avoid the poverty trap common to both artisanal mining and consumption of forest resources. It is an approach to manage resources sustainably by considering, reconciling and synergising the interests of all stakeholders. Many social and environmental problems need to be tackled at a range of scales if they are to be resolved successfully. In the TNS Landscape, INRM is an essential tool that can aid the interests of local people by intersecting with those of the outside world. Frost and colleagues (2006) proposed eight guidelines for successful INRM programs, based on experiences in the TNS Landscape:

- Focus on multiscale analysis and intervention
- Develop partnerships and engage in action research
- Facilitate change rather than dictating it
- Promote envisioning and development of scenarios
- Recognise the importance of local knowledge
- Foster social learning and adaptive management
- Concentrate on people and their natural resources, including biodiversity
- Embrace complexity.

These guidelines can help empower local stakeholders to be more articulate advocates of conservation and active participants in their own development.

3.5 Stakeholder consultations

This sections details the results of interviewing key players in the field: conservators of national parks; government representatives and delegates in charge of mines, forests and the environment; and representatives of international non-governmental organisations.

Conservator of Lobeke National Park (LNP), Cameroon

According to the conservator of the LNP, major problems in the artisanal mining sector include:

- Informal exploitation of minerals by local population
- Rudimentary tools
- Lack of organisation of the sector
- Lack of environmental impact assessment of activities
- Short-term objective that drives small-scale miners to quickly get minerals with no concern for efficient working materials or improved technologies.

The best way to deal with these problems would be to organise the miners and to formalise their activities. Instead of giving all research permits to individuals who are not indigenous to the region, the government should organise local groups by giving them prospecting permits and training them on environmental issues. The role of government in improving the small-scale mining sector is very important. The decisions do not need to be taken unilaterally by one arm of the government, but can be coordinated among all government departments that interact with the environment (MINFOF, MINEP, MINIMIDT), as well as economic operators and conservation NGOs. The conservator was not aware of any programme/project around the Lobeke National park that was helping the small-scale mining sector become more environmentally responsible and socially efficient. However, he was fully aware that the entire buffer zone of the park has been allocated by the government to mining operators under research permit titles. An example was the Boulou Permit (Permis Boulou) awarded in November 2008 overlapping the southern segment of the park., This permit covers 991.5 km^2 of which about 19 840 ha of which lies inside the park.

Divisional Delegate of Mines

The delegate of mines for the Boumba and Ngoko Division in Cameroon affirmed his high level of experience in the mining sector. He believes that small-scale miners do not want to follow the rules and regulations governing the sector, because this could cost them 5000 CFA per year. However, he believes the sector is socially important for the livelihoods of the local miners. The major obstacle in regard to local miners capitalising the economic value of their mining revenue is that they do not have a savings culture. Most local miners spend over 40% of their money on alcoholic drinks. There are numerous anecdotal stories of drunken violence and abuses following the celebration of 'big finds'. Local miners are generally not aware of the provisions in the mining code. He feels that there is a great need to sensitise miners about the code, and thereby legalise their operations. The government and its funding partners are better positioned to sponsor sensitisation programmes about the mining code of Cameroon.

Divisional Delegate of Environment

According to the divisional delegate of the Ministry of Environment and Nature Protection (MINEP) in Cameroon, the problems besetting the small-scale mining sector are environmental, economic, social, legal and technical. He pinpointed the need to organise the trade chain, to sensitise small-scale miners about the mining code and to train miners in environmentally friendly exploitation techniques. He acknowledged that CAPAM is trying to bring sanity to the sector in terms of organisation of miners and commercialisation of minerals. The work of CAPAM is yielding fruits around Mboy, with the formation of common initiative groups (eight of them recently registered), unions and a federation of common initiative groups. The long-term vision for the sector is to implement sustainable management systems in terms of organisation, exploitation and financial management. The delegate mentioned negative impacts of ASM: water pollution and diversion of stream courses; soil depression associated with haphazard excavation; and poaching of wild animals. Alternatives to mining include agriculture and livestock rearing, which could be rendered economically viable with outside supports.

Bio-monitoring and socio-economic officers, Dzanga-Sangha Project

The bio-monitoring officer of the Dzanga-Sangha Project in CAR noted that mining activities in the Ngola and Nola segments of the Sangha River have led to a drastic reduction in daily catch. He asserted

that this was probably due to the disruption of breeding grounds for fish in tributaries and along river banks. The multiplication of forest routes, derooting of trees and intrusion of domestic crops in the forest milieu were also potentially harmful to the forest environment. The socio-economic officer mentioned the increase in the number of the people living in the forest as a major social problem. The children living there are completely cut off from access to modern education and health care. A major environmental impact is that open mines are never refilled after mining operations cease (Figure 10).

With respect to environmental risk, the increasing scarcity of gold and particularly diamonds outside the reserve area is pushing some miners towards the interior of the reserve. This trend is more pronounced in the northern section of the Dzanga-Ndoki National Park in CAR and the southern part of Lobeke National Park in Cameroon.

Senior Divisional Officer, Sangha-Mbaere

Mining (especially diamond mining) contributes enormously to the economy of households in the Sangha-Mbaere Division in CAR. No one really knows how important this income source is, because economic estimates have not been conducted and many operators are informal. In this regard, the TNS project is timely and the study is most welcome.

Village Perceptions

Village meetings revealed issues related to organisation, practices outside mining and the role of traditional rights and fetishism in artisanal mining.

Each mining site is headed by an elected chief of site (chef de chantier), who is usually the oldest or the most experienced at the site. He has some special mining rights and exercises leadership at the camp. For example, the chief of a diamond mining site in Ngola (CAR) is informally entitled to 25% of proceeds from sales. Formally, the chief pays an annual government tax of 30 050 CFA. Werthmann (2003) observed that formal and informal modes of power and legitimacy intersect to control small-scale mining operations. Although the chief is elected by other miners to represent them, his leadership typically reflects prestige, violence and garnering of personal wealth.

Most mining camps grow agricultural crops and some raise livestock (mostly fowls, goats and sheep). Livestock is particularly important for making sacrifices to receive good luck from the god of diamonds. In addition to mining, other activities such as the collection of non-timber forest products, hunting to meet protein needs and trade in basic commodities (soap, cigarettes, palm oil, salt, alcoholic drinks, etc.) are common among miners.

Fetish practices and sacrifices have been observed among diamond miners in both Cameroon and CAR. For gold mining, these practices are less often reported. The sacrifices take three forms: gravel washing; women's activities; and children's activities. The 'gravel washing sacrifice' involves the slaughter of a big cock or goat/sheep on the soil dug from an excavation. It is performed before the standard washing process to search for diamonds. A 'women's sacrifice' consists of women partying all night (dancing, eating and drinking) to appease the god of diamonds. This activity strengthens the power of women in diamond discovery the following day. If the gods are satisfied, the women will find

Figure 10. Open mines in the TNS

many diamonds. If nothing is found by the women, a 'children's sacrifice' is conducted (particularly in Ngola, Central African Republic). Small sugary gifts (puff-puff, sweets and candies) are bought for children to enjoy themselves in the early hours of the morning before mining expeditions are conducted.

3.6 Field results

3.6.1 Biodata of artisanal miners in the TNS

A total of 131 artisanal miners (63 gold and 68 diamond miners) were interviewed during this study in Cameroon and the Central African Republic. In Cameroon, most of the interviewees had permanent or temporary residence in Zega and Mboy. In the Central African Republic, most of the interviewees had their base or supply centre at Nguenguili and Ngola (Table 1).

A total of 17 mining sites were visited: 13 in Cameroon and 4 in Central African Republic. In Cameroon, both gold and diamond miners were interviewed, but in Central African Republic only diamond miners were found within the limits of the study territory (Table 2).

An estimated 3510 people (517 miners plus dependents averaging 5.3 per miner in Cameroon and 8.1 per miner in CAR) are dependent upon mining income from the TNS Landscape.

The rainy season is inconvenient for most miners. Scarcely a quarter of the total annual miners were found on the mining sites during the survey period, and students were completely absent because the survey was conducted during the school term.

Background information was available for some of the mining sites, such as their histories, size and leadership. For example, Cola was opened in 1998, headed by Nguerium Japhael on the Mekia stream. The name Cola arose because of the presence of many cola trees at the site. The site is about 150 m long by 15 m wide, occupying an area of 2250 m^2. The Bandengue site was sampled in 1998 but mining only started in 1999, under the direction of Nguerium Japhael. Badengue is the name of the stream where the mining takes place, in a location 200 m along the stream and 30 m wide, occupying 6000 m^2. Houho is a new site, known to be more productive than others. It became operational in 2008, covering an area of 8000 m^2. According to Nguerium Japhael, long-term experience enhances a miner's ability to detect zones rich in minerals. The length of time each miner had been engaged in the profession ranged from 2 to 46 years, with an average of 17 years of experience in CAR and 9.5 years spent mining in Cameroon.

Two types of artisanal miners were observed during this study: divers and diggers. Diggers are those who dig pits in the soil to get their minerals, and divers are those who dive into the Sangha River to scoop sand and soil (from the riverbed) to get their diamonds. All gold miners were diggers but diamond mining in Central African Republic included both diggers and divers (Table 3).

Miners gender

High gender disparity was observed in diamond mining in CAR where no woman was found leading mining activities. A traditional belief of local miners in CAR is that diamond mining is supernatural and can render women sterile. In Cameroon, 13 % of women mined diamonds or gold independently (Table 4).

Table 1. Small-scale miners in TNS by country and by village

Country	Village name	Frequency	Percentage by country (%)	Overall percentage in TNS (%)
Cameroon	Zega	63	63.64	48.09
	Mboy	36	36.36	27.48
	Total	99	100.00	75.57
Central African Republic	Nguenguili	11	34.38	8.40
	Ngola	21	65.63	16.03
	Total	32	100.00	24.43
Total		131	-	100.00

Ethnic affinity

Artisanal miners originated from diverse ethnic backgrounds in both Cameroon and CAR: 24 ethnic groups in the former and 8 ethnic groups in the latter. The higher diversity in Cameroon is a reflection of the fact that the country is home to over 250 ethnic groups, in contrast to a smaller nationwide number in CAR. In the Cameroon segment of the TNS, two groups of indigenous people (Baka and Bangando—the latter also known as Bogongo) represented 27% of the artisanal miners surveyed. This proportion corresponds with the pygmy population constituting around 30% of the total people in the reserve (Sandker, 2006; CBFP 2006). The corresponding figure for indigenes in CAR (Baaka, Bogongo and Sangha-Sangha) was 71%. Four major immigrant ethnic groups in the Cameroonian segment were Mpiemo of CAR (9.09%), Foulbe or Haoussa (8.08%), Kako (7.07%) and Mvongmvong (4.04%). In the CAR segment, the Bilo, Bossangoa and Ngondi ethnic groups constituted the main immigrants (Table 5).

Marital status

Marriage was found to be an important social status for artisanal miners in the region. About 97% and 71% of the miners in CAR and Cameroon, respectively, were married. A total of 109 wives (including deceased and divorced) were reported by the 131 artisanal miners, ranging from zero to two wives, with a mean of 0.83 wives (std=0.50). Having wives implies producing children, and the 131 miners were found to have 433 children (mean=3.31; std=2.82). In addition to wives and children, other relatives dependent on the miner made the overall household size appreciably higher, totalling 785 persons (mean=5.99; std=3.82) for the 131 miners. In Cameroon, a more youthful mining population was observed, with over 21% being single (Table 6). The lower frequency of marriage could be attributed to far longer walking distances to the mining sites in Cameroon, compared to CAR. One consequence of being single is that young miners tend to become independent miners earlier in Cameroon than in CAR.

Nationality of miners

In Cameroon, about 82% of the miners had Cameroonian nationality and the rest had other African nationalities: Central Africans (14.14%), Ghanaians (2.02%), Malians (1.01%) and Congolese (1.01%) (Table 7).

Most miners were part-timers: about 78% and 69% were in that category in Cameroon and CAR, respectively. The relatively low proportion of full-time miners suggests diversification of income and livelihood strategies.

In terms of age, 76% and 78% of artisanal miners in Cameroon and CAR, respectively, were younger than 45 years. Although the oldest artisanal miner was found in Cameroon, overall CAR had a higher proportion of miners older than 45 years (Table 9).

The age of miners varied from 17 to 75 years in Cameroon and 15 to 60 years in CAR. The mean age in Cameroon was 37.16 years (std =11.16) versus 35.84 years (std = 11.77) in CAR. Miners in Cameroon averaged 2.87 (std = 2.34) children versus a mean of 4.44 (std = 3.68) in CAR. Miners were found to have a high number of dependents with mean of 5.3 (std = 3.39) in Cameroon and 8.13 (std = 4.32) in CAR. This household situation is typical in most villages in the region, where cousins, mother-in-law, nephews and nieces, brothers and sisters often become permanent visitors in the houses of relatives who work. In fact, the ratio of the total number of dependents to the total number of children (supposedly the primary responsibility of the miner) was 1.74 in CAR and 1.85 in Cameroon. These high ratios suggest that a miner needs a huge income to pull out of poverty, or else his dependents need to generate income from other sources to increase the overall household income. The mean number of years working as a miner was conspicuously higher in CAR (17.34 years; std = 9.71) than in Cameroon (9.54 years; std = 7.11) (Table 10). This difference could be associated with CAR's exclusive focus on diamond mining. Migration, frequent discovery of new sites, higher commodity prices, easier access and lack of alternative livelihood activities could also contribute to the longer reliance on artisanal mining in CAR.

Education

In both Cameroon and CAR, over 70% of the small-scale miners had either primary level education or no formal education, with less than 9.0% having gone through senior high school.

3.6.2 Mining operations in the TNS

Among the artisanal miners interviewed, mining was the principal activity for 78.79% and 87.50%

Table 2. Small-scale miners in TNS by mining site

Country	Mineral mined	Mining site	Head of site	Date created	N	Percentage by country (%)	Total number of miners at site during year
Cameroon	Gold	Cola	Bombo Faustin	1998	14	14.14	37
		Badengue	-	1999	9	9.09	10
		Houho	Ngwerium Japhael	2007	11	11.11	20
		Johvah Jire	-	-	14	14.14	23
		Mokopaka	-	-	9	9.09	35
		Bongoli	-	-	6	6.06	36
	Diamond	Nompenda	Melelo Simeon	1970	5	5.05	10
		Papam	Abah	1968	4	4.04	8
		Montsombe	Bandi Victor	1963	7	7.07	15
		Mobilong	Mekonji George	1970	8	8.08	20
		Lingui	Mpaye Fabien	-	3	3.03	6
		Momekok	Kokono Anatol	1976	7	7.07	18
		Kolongo	Ndewa Antoine	-	2	2.02	4
	Total	99	100.00	242			
Central African Republic	Diamond	Ngola	Madingo Dieudonne	-	21	65.63	180
		Boto	-	-	5	15.63	10
		Motokobilo	Luc Achille	1994	4	12.50	80
		Mabouli	-	-	2	6.25	5
	Total	32	100.00	275			
Total				131	-	517	

Table 3. Distribution of small-scale miners in TNS area

Country	Mining type	Mineral mined		Total
		Gold	Diamond	
Cameroon	Diggers	63 (63.64%)	36 (36.36%)	99 (100%)
	Total	63 (63.64%)	36 (36.36%)	99 (100%)
Central African Republic	Diggers	0	20 (62.50%)	20 (62%)
	Divers	0	12 (37.50%)	12 (37%)
	Total	0	32 (100.00%)	32 (100%)
Total		63 (48.09%)	68 (51.91%)	131 (100%)

of them in Cameroon and CAR, respectively. These miners were initiated into the profession by their parents, friends already on site or outsiders. The role of parents in transmitting mining skills to their children was more obvious in CAR (59.38%) than in Cameroon (25.25%). Local friends, and especially outsiders, were more influential in inculcating mining skills to Cameroonian artisanal miners (Table 12). This trend was particularly obvious in Mboy, where most miners claimed they were trained in diamond mining by people from CAR. As noted (Table 7), CAR citizens currently constitute an appreciable

Table 4. Small-scale miners in TNS by sex

Country	Sex	Mineral mined		Total
		Gold	Diamond	
Cameroon	Male	55 (55.56%)	31(31.31%)	86 (86.87%)
	Female	8 (8.08%)	5 (5.05%)	13 (13.13%)
	Total	63 (63.64%)	36 (36.36%)	99 (100.00%)
Central African Republic	Male	0 (0.00%)	32 (100.00%)	32 (100.00%)
	Female	0 (0.00%)	0 (0.00%)	0 (0.00%)
Total		0 (0.00%)	32 (100.00%)	32 (100.00%)

* Figures in parentheses ( ) represent proportion of country's total sample.

Figure 11. Small-scale gold mining at Badengue: use of weighing scale

proportion of the miners in the Cameroonian segment of the TNS.

Mining is a good avenue for self-employment. Of the miners interviewed, over 70% and 63% in Cameroon and CAR, respectively, worked for themselves. Mining in groups or cooperatives was unusual, except for the recently introduced CAPAM project in the Mboy region of Cameroon. About 29% in Cameroon and 37% in CAR were working for sponsors, who purchase materials, food and medicine for their workers. The location of mining sites in the TNS area was somewhat in flux but generally more stable outside reserved areas. About 80% and 97% of the miners in Cameroon and CAR, respectively, work outside protected areas (Table 13).

Labour

In Cameroon, 59.6% of the miners interviewed were being assisted, with a mean of two labourers (std = 1.37) per miner. All miners in CAR were assisted by one to eight labourers, with a mean of 3.94 (std = 2.08). Totals of 117 and 126 labourers assisting the 59 and 32 small-scale miners/employers were found in Cameroon and CAR, respectively. Family constituted the major source of such labour in both Cameroon and CAR representing 84.62% and 64.29%, respectively. Own children represented 34.19% of labourers in Cameroon and 24.60% in CAR. According to Jennings (1999), hundreds of thousands of children work in small-scale mines globally, with a few countries showing figures around 250,000 (including full-time and part-time). Such work exposes them to risks and jeopardises their long-term development –- both physical and socio-economic (Jennings 1999). Men were generally assisted by women, with over 57% of labourers being female in Cameroon and 21% in CAR (Table 14).

Quantification of mineral production per month

Getting data on the weight of gold or diamond produced by artisanal miners in the TNS region entailed two major difficulties. First, miners of both minerals in both countries appeared to have incomplete recall of the quantity they produce per month. Production data was therefore derived by asking miners to state the average quantity they could exploit per trip and the possible number of trips per month. The second difficulty was more applicable to the production of diamonds, which are mined in a rough (uncut) state that is not conducive to judging quality. No miner knew exactly how to measure his production quantitatively in terms of carats (the conventional weight unit for diamonds), nor how

Table 5. Small-scale miners in TNS by ethnic group

Country	Ethnic group	Frequency	Percentage by country (%)	Overall percentage in TNS (%)
Cameroon	Banda	1	1.01	0.76
	Bamoun	1	1.01	0.76
	Bassa	1	1.01	0.76
	Manzah	1	1.01	0.76
	Kako	7	7.07	5.34
	Bimo	19	19.19	14.50
	Mezimi	3	3.03	2.29
	Ngondi	2	2.02	1.53
	Bangando*	5	5.05	3.82
	Mpiemo (CAR)	9	9.09	6.87
	Ngombe(DRC)	1	1.01	0.76
	Yakoma	1	1.01	0.76
	Foulbe/ Haoussa	8	8.08	6.11
	Bakare	1	1.01	0.76
	Eton/Beti	3	3.03	2.29
	Bambara (Malian)	1	1.01	0.76
	Bororo	2	2.02	1.53
	Voko	1	1.01	0.76
	Baya	1	1.01	0.76
	Baka*	22	22.22	16.79
	Mvongmvong	4	4.04	3.05
	Badjoue	2	2.02	1.53
	Ashanti (Ghanian)	2	2.02	1.53
	Yamba	1	1.01	0.76
	Total	99	100.00	75.57
Central African Republic	Ngondi	2	6.25	1.53
	Yakoma	1	3.13	0.76
	Baya	1	3.13	0.76
	Baaka*	8	25.00	6.11
	Bilo	3	9.38	2.29
	Sangha-Sangha*	14	43.75	10.69
	Bossangoa	2	6.25	1.53
	Bogongo*	1	3.13	0.76
	Total	32	100.00	24.43
Total		131	-	100.00

Indigenous peoples*

to assess the quality and shapes of rough stones in terms of market prices. In contrast, gold is easier to quantify because there are well-known ways to weigh one's production (Figure 11). Another indirect method for obtaining production data would be to interview dealers in the main towns and approach the estimation from the supply side. However, this approach was not possible given the time and scope of this study, and it would likely be hindered by the secretive nature of dealers.

On average, a gold digger was observed to produce 18.4 g (std=9.7) per month, ranging from a minimum of 4 g to a maximum of 43 g. Thus, the 63 gold diggers in the southern part of the Lobeke National Park could produce an estimated 1159 g per

Table 6. Small-scale miners in TNS by marital status

Country	Marital status	Frequency	Percentage by country (%)	Overall percentage in TNS (%)
Cameroon	Married	70	70.71	53.44
	Single	21	21.21	16.03
	Divorce	2	2.02	1.53
	Widow	6	6.06	4.58
	Total	99	100.00	75.57
Central African Republic	Married	31	96.88	23.66
	Single	1	3.13	0.76
	Total	32	100.00	24.43
Total		131		100.00

Table 7. Small-scale miners in TNS by nationality and by country

Country	Nationality	Frequency	Percentage by country (%)	Overall percentage in TNS (%)
Cameroon	Cameroonian	81	81.82	61.83
	Central African	14	14.14	10.69
	Congolese	1	1.01	0.76
	Ghanaian	2	2.02	1.53
	Malian	1	1.01	0.76
	Total	99	100.00	75.57
Central African Republic	Cameroonian	1	3.13	0.76
	Central African	31	96.88	23.66
	Total	32	100.00	24.43
Total		131	-	100.00

Table 8. Small-scale miners in TNS by occupation and by country

Country	Occupation as miner	Frequency	Percentage by country (%)	Overall percentage in TNS (%)
Cameroon	Full-time	22	22.22	16.79
	Part-time	77	77.78	58.78
	Total	99	100.00	75.57
Central African Republic	Full-time	10	31.25	7.63
	Part-time	22	68.75	16.79
	Total	32	100.00	24.43
Total		131	-	100.00

month or 13 908 g per year. Extrapolating this figure to the total of 161 small-scale gold miners at the six gold mining sites in the TNS area yields a total of 35 543 g (35.54 kg) of gold per year.

In regard to diamond, a mean of 9.22 (std=9.12) fragments or pieces were obtained per miner per month in the Mboy mining sites in Cameroon, ranging from a minimum of 2 to a maximum of 40 pieces per month. This rate would amount to 332 pieces obtained by the 36 miners interviewed, or 747 per month by the 81 miners at all seven sites visited in this study. The total of 81 miners could have been an underestimate, because the interviewees said only

Table 9. Small-scale miners in TNS by age and by country

Country	Age group	Frequency	Percentage by country (%)	Overall percentage in TNS (%)
Cameroon	[15 ; 25[	17	17.17	12.98
	[25 ; 35[	17	17.17	12.98
	[35 ; 45[	41	41.41	31.30
	[45 ; 55[	20	20.20	15.27
	[55 ; 65[	2	2.02	1.53
	[65 ; 75]	2	2.02	1.53
	Total	99	100.00	75.57
Central African Republic	[15 ; 25[	6	18.75	4.58
	[25 ; 35[	9	28.13	6.87
	[35 ; 45[	10	31.25	7.63
	[45 ; 55[	4	12.50	3.05
	[55 ; 65[	3	9.38	2.29
	Total	32	100.00	24.43
Total		131	-	100.00

Table 10. Social characteristics of small-scale miners in TNS by country

Country	Variables	Frequency	Minimum	Maximum	Sum	Mean	Standard deviation
Cameroon	Age	99	17	75	-	37.16	11.16
	Number of children	99	0	10	284	2.87	2.34
	Number of wives	99	0	2	-	0.76	0.52
	Total number of dependents	99	0	15	525	5.30	3.39
	Number of years as miner	99	0.04	31	-	9.54	7.11
Central African Republic	Age	32	15	60	-	35.84	11.77
	Number of children	32	0	14	149	4.66	3.68
	Number of wives	32	0	2	-	1.06	0.35
	Total number of dependents	32	2	17	260	8.13	4.32
	Number of years as miner	32	3	51	-	17.34	9.71

about a third of them were active during the rainy season, the period when survey data was collected. It was also noteworthy that all the school children were absent from the mining sites, because the study was conducted during the school term.

In CAR diamond mining, a minimum of 1 and a maximum of 60 pieces per month were observed, with a mean of 16 (std=14.17). This was equivalent to a total of 512 pieces per month obtained by the 32 miners interviewed (Table 16). This tally could be extrapolated to 4400 pieces obtained by the 275 small-scale diamond miners at all four sites in CAR. In the northwestern part of the Dzanga-Ndoki National Park around River Lobe, Kamiss (2006) visited 15 diamond mining sites and found the total

Table 11. Small-scale miners in TNS by education level and by country

Country	Education	Frequency	Percentage by country (%)	Overall percentage in TNS (%)
Cameroon	No formal education/SIL/ CP/CE1	34	34.34	25.95
	Primary	45	45.45	34.35
	Secondary	12	12.12	9.16
	High school	7	7.07	5.34
	University	1	1.01	0.76
	Total	99	100.00	75.57
Central African Republic	No formal education/SIL/ CP/CE1	4	12.50	3.05
	Primary	20	62.50	15.27
	Secondary	6	18.75	4.58
	High school	2	6.25	1.53
	Total	32	100.00	24.43
Total		131	-	100.00

number of miners to be 362. However, no details were collected to indicate how many were actual miners versus labourers (e.g., women and children the miner). Nor did that survey estimate the quantities of diamond mined in a given period.

Processing and production

All minerals mined in the region are sold unprocessed by the small-scale miners. When miners were asked whether the equipment they currently used was appropriate for their activities, over 60% of them in both countries confirmed that it was efficient (Table 15). This survey result could be related to a complete lack of knowledge about modern (more efficient) equipment rather than satisfaction with the status quo.

The context of the efficiency of current tools was confirmed by 89% of the interviewed miners in Cameroon and 97% in CAR stating that extraction methods have remained the same over the years. Most of the miners who mentioned a certain level of change (11%) were located in Cameroon (Mboy), where a government agency called CAPAM has been providing equipment and technical assistance to small-scale miners since 2006. At Mobilong, CAPAM gives motorised pumps to artisanal miners free of charge, which they might otherwise rent at 5000 CFA per day. The CAPAM marketing facility in 2006 served as a structure to channel 50 kg of gold and 300 carats of diamonds to buyers. One part of the sales proceeds goes into a revolving fund; a second part goes for amortisation of materials; and a third part (about 3% for gold and 8% for diamonds) pays value-added tax (VAT). Of the VAT, 50% goes into the public treasury, 15% to the local council (Mairie), 10% to local residents and 25% to a monitoring and control organisation.

According to the small-scale miners in Cameroon, the main reasons behind the changes in extraction methods were government support (70%), increase in personal capital (10%) and sponsorship by outsiders (20%). In CAR, the singular reason mentioned was increase in personal capital (specifically in regard to the purchase of motorised boats and pumps).

In general, it is very encouraging that a miner can earn income from mining either gold or diamonds. However, the distribution of income is not adequately described by looking at average production per trip or per month, because some miners might get nothing at all for long periods of time. For example, over 87% of the gold miners got less than 30 g per month while only about 6% got over 40 g per month.

Similarly, about 92% of the diamond diggers in Cameroon obtained less than 20 pieces per month, while only about 8% got over 20 pieces per month. In CAR, nearly 35% of the diamond miners obtained more than 20 pieces per month (Table 17). This advantage over Cameroon could be attributed to natural availability and/or the longer experience of miners in CAR.

Table 12. Small-scale miners in TNS by initiator and by country

Country	Initiator into mining work	Frequency	Percentage by country (%)	Overall percentage in TNS (%)
Cameroon	Parent	25	25.25	19.08
	Local friend	43	43.43	32.82
	Outsider	31	31.31	23.66
	Total	99	100.00	75.57
Central African Republic	Parent	19	59.38	14.50
	Local friend	12	37.50	9.16
	Outsider	1	3.13	0.76
	Total	32	100.00	24.43
Total		131	-	100.00

Table 13. Small-scale miners in the TNS by location of mining site and by country

Country	Location of mining activities	Frequency	Percentage by country (%)	Overall percentage in TNS (%)
Cameroon	Inside reserve	4	4.04	3.05
	Outside reserve	79	79.80	60.31
	Both inside and outside	16	16.16	12.21
	Total	99	100.00	75.57
Central African Republic	Inside reserve	1	3.13	0.76
	Outside reserve	31	96.88	23.66
	Both inside and outside reserve	0	0	
	Total	32	100.00	24.43
Total		131	-	100.00

Cost of production materials

Materials costs for artisanal mining can be divided into short- and long-term. Short-term costs were evaluated on a monthly basis, primarily food and medicine consumed at mining sites. Long-term costs were prorated over the lifespan of working materials, ranging from 1 to 10 years. A typical artisanal miner can spend up to 26 000 CFA on food and medicine per month, forming the largest item of expenditure. Long-term capital items such as motorised pumps (costing about 250 000 CFA each) are the most difficult to obtain. In fact, most artisanal miners still bail water from their mining pits manually. However, after a motorised pump has been acquired, alluvial mining becomes less strenuous and annual costs may be reduced to 25 000 CFA amortised over a 10-year lifespan (Table 18).

Small-scale miners make one to four trips to mining sites per month, with a mean of two in Cameroon (std = 0.47) and a mean of three (std = 1.15) in CAR. Over 50% of the buyers of ASM gold and diamonds in both Cameroon and CAR originate from a town or city, with few of them residing in mining villages or other villages (Table 19). This urbanization reflects the role of intermediaries in linking the small-scale mining business to broader markets outside the region.

Further enquiry into the names of specific towns/cities showed that 73.24% of the miners in the Cameroon segment of the TNS sold their products to buyers based in Kika, a logging town of over 3000 people in the southern part of the Lobeke National Park. Nola formed the centre of commerce for diamond miners in the CAR, commanding over 81% of trade (Table 20). Apart from being a commercial centre, Nola is the administrative headquarters of the Sangha-Mbaere Division, where legal miners obtain required permits.

Table 14. Small-scale miners in TNS by number of labourers and by country

Country	Variables	Frequency	Minimum	Maximum	Sum	Mean	Standard deviation
Cameroon	Number of labourers	59	1	6	117 (100.00)	1.98	1.37
	Family labour	58	1	5	99 (84.62)	1.71	1.14
	Hired labour	10	1	4	18 (15.38)	1.80	1.03
	Children >15 years	23	1	3	40 (34.19)	1.74	0.86
	Adults	58	1	5	77 (65.81)	1.33	0.76
	Men	28	1	4	50 (42.74)	1.79	0.99
	Women	57	1	3	67 (57.26)	1.18	0.43
Central African Republic	Number of labourers	32	1	8	126 (100.00)	3.94	2.08
	Family labour	22	1	8	81 (64.29)	3.68	2.19
	Hired labour	11	1	8	45 (35.71)	4.09	2.12
	Children >15 years	15	1	4	31 (24.60)	2.07	0.96
	Adults	30	1	8	95 (75.40)	3.17	2.12
	Men	29	1	8	99 (78.57)	3.41	1.68
	Women	15	1	4	27 (21.43)	1.80	0.86

Figures in parentheses ( ) represent proportion of labourers in each dichotomous category.

On average, small-scale miners in the Cameroon segment of the TNS spend 3065 CFA (std = 2168) per month to get their product to the market. On the CAR side, miners spend an average 3840 CFA (std = 2379) to get their product to the market. The latter average is a little higher because most miners in CAR go to Nola via hired transportation. In contrast, most Cameroon miners go to Kika, which entails more trekking and thus lower transportation costs. It is important to note that only those who spent any money on transportation to get their minerals to the market were considered: only 62.63% of all miners interviewed in Cameroon and only 78% in CAR.

Mining revenues, costs and net incomes

Annual gross income from ASM varied from a minimum of 96 000 CFA to a maximum of 2 400 000 CFA for gold miners and 74 000 CFA to 2 520 000 CFA for diamond miners in Cameroon. Mean annual net incomes from gold and diamonds were 575 338 CFA (std = 461 913) and 812 644 CFA (std = 676 487), respectively, in Cameroon. In CAR, ASM diamond miners earned a mean annual net income of 368 084 CFA (std = 904 427) (Table 21 Characteristics of income among small-scale miners in TNS landscape). The fact that the standard deviation in CAR was about three times the mean clearly indicates the enormous variability in mining income, with some miners earning huge sums and others almost nothing.

In dollar terms, the mean annual net incomes from gold and diamonds were 1130 US$ and 1596 US$, respectively, in Cameroon. In CAR, the diamond miners' mean annual net income of 368 084 CFA was equivalent to723 US$. These incomes are low, even though all are above the poverty line of 2 US$ a day for Cameroonian gold miners at 3.10 US$ and diamond miners at 4.37 US$. However, most diamond miners in CAR remain poor at average of 1.80 US$. Miners in Cameroon are therefore slightly better off than an 'average' citizen, who had an income of 1010 US$ annually in 2006. Nevertheless, they are significantly better off than non-miners in the TNS, who had an average income of 250 US$ annually (Sandker, Campbell *et al.* 2009). However, the variation among miners is enormous, ranging from considerable profit to significant losses. In

Table 15. Perceptions on the use of current mining equipment in TNS

Country	Current equipment is efficient	Frequency	Percentage by country (%)	Overall percentage in TNS (%)
Cameroon	Yes	50	75.76	57.47
	No	16	24.24	18.39
	Total	66	100.00	75.86
Central African Republic	Yes	13	61.90	14.94
	No	8	38.10	9.20
	Total	21	100.00	24.14
Total		87	-	100.00

Table 16. Characterisation of gold and diamond production in TNS

Country	Mineral	Frequency	Minimum	Maximum	Sum	Mean	Standard deviation
Cameroon	Gold (g)	63	4	43	1159	18.40	9.70
	Diamond (pieces)	36	2	40	332	9.22	9.12
Central African Republic	Diamond (pieces)	32	1	60	512	16.00	14.17

particular, net losses ran as high as 1 032 450 CFA (2 028 US$) in CAR. The attraction of mining as a livelihood is therefore a kind of gamble.

Although some miners made a very good income, and others a mediocre income, some actually lost significant sums of money. Net losses were as high as 1 032 450 CFA in CAR and 404 000 CFA in Cameroon. Most of the miners who were losing money at the time of the study had hopes that one day they would have the luck to make sizeable finds to cover all their costs.

Further analysis shows that a little over 9% of miners had negative net income in Cameroon and nearly 44% suffered a net loss in CAR. Losses ranged from 2000 CFA to 404 000 CFA with a mean of 152 711 CFA (std=145 588 CFA) in Cameroon. Higher losses were observed among miners in the CAR, with a mean of 364 400 CFA (std=273 732 CFA). In Cameroon and CAR, respectively, 46% and 34% of all miners earned net incomes below the mean of all positive net incomes. Those who earned more than the mean of all positive net incomes represented by 44% and 22% of the miners in Cameroon and CAR, respectively (Table 22). For these miners, respective mean mining incomes in Cameroon and CAR were 1,180,646 CFA (std=338,562) and 1 752,007 CFA (std=704,430).

The cost of hired labour per day quoted by the miners, varied from 250-500 CFA in Cameroon, with mean of 350 CFA (std=122.47). In CAR daily rates were slightly higher, varying from 450-1500 CFA with mean of 990 CFA (std=317). This difference may be related to demand and supply.

Control and regulations

When artisanal miners were asked whether they ever experience disturbances during operations, 91% and 66% in Cameroon and CAR, respectively, stated they had no disturbances of any kind. Further questioning on the nature of disturbances experienced by the 34% in CAR and 9% in Cameroon revealed government agents, conservation agents and individual buyers as control agents who were sources of harassment. Government agents formed the major source of harassment in CAR, but conservation agents were the leading source in Cameroon (Table 23).

The presence of government in the artisanal mining sector was more obvious in CAR because taxes are

Table 17. Tier distribution of gold and diamond production in TNS

Country	Mineral	Quantity range (g)	Frequency	Percentage by country (%)	Cumulative percentage (%)
Cameroon	Gold	[0 ; 5[	2	3.17	3.17
		[5 ; 10[	9	14.29	17.46
		[10 ; 15[	15	23.81	41.27
		[15 ; 20[	10	15.87	57.14
		[20 ; 25[	10	15.87	73.02
		[25 ; 30[	9	14.29	87.30
		[30 ; 35[	4	6.35	93.65
		[40 ; 45[	4	6.35	100.00
	Total		63	100.00	-
	Diamond (pieces)	[0 ; 5[	15	41.67	41.67
		[5 ; 10[	8	22.22	63.89
		[10 ; 15[	6	16.67	80.56
		[15 ; 20[	4	11.11	91.67
		[20 ; 25[	0	0.00	0.00
		[25 ; 30[	0	0.00	0.00
		[30 ; 35[	1	2.78	94.44
		[35 ; 40[	1	2.78	97.22
		[40 ; 45[	1	2.78	100.00
	Total		36	100.00	-
Central African Republic	Diamond (pieces)	[0 ; 5[	8	25.00	25.00
		[5 ; 10[	4	12.50	37.50
		[10 ; 15[	5	15.63	53.13
		[15 ; 20[	4	12.50	65.63
		[20 ; 25[	5	15.63	81.25
		[25 ; 30[	2	6.25	87.50
		[30 ; 35[	1	3.13	90.63
		[40 ; 45[	1	3.13	93.75
		[50 ; 55[	1	3.13	96.88
		[55 ; 60]	1	3.13	100.00
Total			32	100.00	-

collected from miners there, unlike in Cameroon. Individual buyers control miners through sponsorship of mining activities. The miners in turn are expected to be loyal and sell their products exclusively to their sponsor; harassment results when a miner has been discovered selling to another buyer.

Strategies for dealing with harassment in Cameroon are: run away (22%), bribe the controller (11%), speak angrily (33%), and stay quiet (33%). In CAR, artisanal miners react either by speaking angrily to the controller (64%) or producing their papers to prove they operate legally (36%) (Table 24).

Almost all the artisanal miners in both countries mentioned that they do not face any problem in transporting their products to market. This could be attributed to the nature of the products themselves, which can easily be hidden in trouser pockets or other locations without anybody realising that the miner is carrying something precious.

In Cameroon, 94% of gold and diamond mining activities take place year round and only 6% take place exclusively during the rainy season. In CAR, 59% of the miners said diamond was available in all seasons but 41% said the mineral was more available in the dry season. The latter group of miners consisted

Table 18. Characteristics of mining materials and costs in TNS

Materials cost (CFA)	Frequency	Minimum	Maximum	Mean	Standard deviation	Life span
Food	131	3 000	65 000	23396.95	12283.78	Monthly
Medicine	131	0	15 000	2 820.23	2 688.48	Monthly
Pelle	131	10 000	10 000	10 000	0.00	10 years
Polyane	131	4 000	5 000	4 100	301.37	2 years
Bate/tamis	131	2 500	2 500	2 500.00	0.00	2 years
Baramine	131	20 000	22 000	20 488.55	862.61	10 years
Canoe	131	50 000	50 000	50 000	0.00	5 years
Matchet	131	2 500	3 000	2 622.14	215.65	5 years
Pots	131	5 000	5 000	5 000.00	0.00	2 years
Gicque	131	5 000	5 000	5 000.00	0.00	5 years
Motorised pump	131	250000	250000	250000	0.00	10 years
Bucket/plates	131	3 000	3 000	3 000.00	0.00	1 year

Table 19. Origin of gold and diamond buyers who deal with TNS miners

Country	Origin of buyer	Frequency	Percentage by country (%)	Overall percentage TNS (%)
Cameroon	Within the village	24	24.24	18.32
	From a town/city	71	71.72	54.20
	From other villages	4	4.04	3.05
	Total	99	100.00	75.57
Central African Republic	Within the village	12	37.50	9.16
	From a town/city	16	50.00	12.21
	From other villages	4	12.50	3.05
	Total	32	100.00	24.43
Total		131	-	100.00

mostly of those who dive in the Sangha River to search for diamonds at the bottom Miners that hate working in rainy weather avoid mining in the wet season. Mining is also very difficult in flooded conditions.

In Cameroon, the distance to mining site varied from 14 km to 65 km, with a mean of 29.87 km (std=17.38 km). Mean working distance was far shorter in CAR 6.31 km (std =11.05 km), because most of the miners in Ngola worked in their own backyards. Walking long distances to mining sites was a common phenomenon, with over 55% and 87% in Cameroon and CAR, respectively, walking to their sites. Miners also made use of cars (43.43% in Cameroon and 12.5% in CAR) to cover long distances on major access roads before continuing on foot to relatively inaccessible mining sites in the forest.

In both Cameroon and CAR, more than 53% of miners sponsor their operations from their own finances. About 32% in Cameroon and about 47% in CAR got financial support for their operations from either a village sponsor or an external sponsor. Only in Cameroon did some (13%) miners borrow money to finance their operations (Table 26).

Functioning of markets

Generally the market for ASM products is not organised. Most miners (66.67% in Cameroon and 93.75% in CAR) sell to individual collectors. The role of an organisation to assist marketing became apparent in Cameroon, with the Government initiative CAPAM. Sponsors also served as collectors of minerals from their miners, but their function was primarily to offer arbitrary take-it or leave-it prices. Sponsor purchases were

Table 20. Origin of urban buyers purchasing from TNS artisanal miners

Country	Name of city/town	Frequency	Percentage by country (%)	Overall percentage in TNS (%)
Cameroon	Kika	52	73.24	59.77
	Yokadouma	7	9.86	8.05
	Yaounde	12	16.90	13.79
	Total	71	100.00	81.61
Central African Republic	Nola	13	81.25	14.94
	Salo	3	18.75	3.45
	Total	16	100.00	18.39
Total		87	-	100.00

Table 21. Characteristics of income among small-scale miners in TNS

Country	Mineral	Variables	Frequency	Minimum	Maximum	Mean	Standard deviation
Cameroon	Gold	Annual gross income	63	96 000	2400000	887823.81	526268.24
		Annual total costs	63	74 000	962 000	312485.71	175905.56
		Annual net income	63	-38 000	2 092000	575338.10	461912.66
	Diamond	Annual gross income	36	36 000	2520000	1212666.67	706437.66
		Annual total costs	36	99 000	758000	400022.22	157529.34
		Annual net income	36	-404000	1966000	812644.44	676486.78
Central African Republic	Diamond	Annual gross income	32	9 600	3000000	1082456.25	837885.20
		Annual total costs	32	136950	2832450	714371.88	657104.57
		Annual net income	32	-1032450	2517550	368084.38	904426.74

more prevalent in Cameroon (23.23%) than in CAR (6.25%) (Table 27).

As noted (Table 20), most buyers are resident in cities or towns such as Kika, Yokadouma, Nola, Salo and Yaounde. As is generally true of itinerant merchants, the absentee intermediaries come to buy the products with pre-determined prices in mind. The miners have no bargaining power, due to their wide distribution and lack of networking. In short, artisanal miners in the TNS region are price takers.

Price trends and ambiguities

Global commodity prices for gold and diamond have more than doubled in recent years. The question posed by this research study was whether such increases had trickled down to the artisanal miners at the grassroots of the trade chain. Survey results showed that the prices of gold paid to ASM miners have almost doubled during the period in question (2003-2008). The minimum current price per gram is 6500 CFA and the maximum is 9500 CFA compare favourably with the range of 3500-5000 CFA that prevailed five years ago (Table 28).

However, the prices of diamonds in both Cameroon and CAR varied enormously with no clear pattern for determining unit prices.

Table 22. Tier distribution of net income of artisanal miners in TNS

Country	Variable	N	Percent (%)	Min (CFA)	Max (CFA)	Sum (CFA)	Mean (CFA)	Standard deviation
Cameroon	Negative net mining income	9	9.1	-404 000	-2 000	-1 374 400	-152 711	145 588
	Net mining income below mean of all positive net mining incomes	46	46.5	28 000	726 400	14 927 500	324 511	230 391
	Net mining income above mean of all positive net mining incomes	44	44.4	748 000	2 092 000	51 948 400	1 180 646	338 562
	Positive net mining income	90	90.9	28 000	2 092 000	66 875 900	743 066	517 134
	Total	99	100.0	-404 000	2 092 000	65 501 500	661 631	558 203
Central African Republic	Negative net mining income	14	43.8	-1 032 450	-38 950	-5 101 600	-364 400	273 732
	Net mining income below mean of all positive net mining incomes	11	34.4	93 050	699 050	4 616 250	419 659	214 193
	Net mining income above mean of all positive net mining incomes	7	21.9	970 750	2 517 550	12 264 050	1 752 007	704 430
	Positive net mining income	18	56.3	93 050	2 517 550	16 880 300	937 794	805 489
	Total	32	100.0	-1 032 450	2 517 550	11778 700	368 084	904 427

The extreme variability in pricing diamonds became too evident early in the implementation of CAPAM in Cameroon. In 2007, the response was to channel ASM diamonds to the central CAPAM project office for sale according to an approved price list (Table 29). This standardisation nevertheless had several setbacks. In 2008, the purchase of diamonds from artisanal miners by CAPAM was suspended by the Minister in charge of mines. When surveys were conducted for this study in November 2008, CAPAM was only purchasing gold from artisanal miners.

Even though there was a stated range of unit prices, the actual prices paid to small-scale miners were

Table 23. Mining control agents in TNS

Country	Control agent	Frequency	Percentage by country (%)	Overall percentage in TNS (%)
Cameroon	Government agent	1	11.11	5.00
	Conservation agent	6	66.67	30.00
	Individual buyer	2	22.22	10.00
	Total	9	100.00	45.00
Central African Republic	Government agent	10	90.91	50.00
	Individual buyers	1	9.09	5.00
	Total	11	100.00	55.00
Total		20	-	100.00

Table 24. Reaction of artisanal miners to control agents in TNS

Country	Reaction to control agent	Frequency	Percentage by country (%)	Overall percentage in TNS (%)
Cameroon	Run away	2	22.22	10.00
	Bribe	1	11.11	5.00
	Speak angrily	3	33.33	15.00
	Do nothing	3	33.33	15.00
	Total	9	100.00	45.00
Central African Republic	Speak angrily	7	63.64	35.00
	Show legal papers	4	36.36	20.00
	Total	11	100.00	55.00
Total		20	-	100.00

negotiable, based on characteristics related to defects (broken, full or coloured). Unfortunately, no single miner today clearly understands these characteristics, such as the definition of defects or the best colour that commands the highest price. No small-scale miner even has a scale for measuring the weight precisely enough to determine the size (weight range). These assessments are determined unilaterally by the buyers (middlemen generally known as collectors). The foundation of major cartels in the diamond business is rooted in these practices, with severe consequences for the small-scale miner's bargaining power. Small-scale miners who work for sponsors generally do not know the unit price of their product. Sponsored miners were ignorant of the level of business capital provided to them, claiming they were basically fed and paid to perform their job. However, the perception of some small-scale miners at the Mobilong site (associated with the intervention of CAPAM) differed. Most of them initially had no capital, but now some of them have received capital up to 300 000 CFA. This financing is one way they can assess the impact of assistance given by CAPAM.

Fiscal regimes

Artisanal mining in the TNS region is basically informal and illegal. This is particularly true on the Cameroonian side, where none of the interviewees confirmed having paid an annual fee or tax of any kind nor being in possession of a legal mining permit. However, in the CAR, a little over 56% of the artisanal miners pay the labourers' tax and possess an annual miner identification card (Table 30).

In Cameroon, no tax was mentioned as being paid by any small-scale miner even though the Mining Code of Cameroon includes a provision for an annual tax payment. According to the Divisional Delegate for Mines, Boumba and Ngoko, small-scale miners are required by Law to pay an annual tax of not more than 5000 CFA. A major challenge in Cameroon is to help small-scale miners formalise their activities. In CAR, small-scale miners were observed to pay an annual labourers' tax of 2000 CFA and the head of a site must pay an annual tax of 30 050 CFA. Collectors or buyers normally pay an annual tax as high as 1 100 000 CFA.

Table 25. Tier distribution of distance to mining sites in TNS

Country	Distance to mining site (km)	Frequency	Percentage by country (%)	Overall percentage in TNS (%)
Cameroon	0	1	1.01	0.76
	0<d<10	0	0.00	0.00
	[10 ; 20[	49	49.49	37.40
	[20 ; 30[	0	0.00	0.00
	≥ 30	49	49.49	37.40
	Total	99	100.00	75.57
Central African Republic	0	6	18.75	4.58
	0<d<10	17	53.13	12.98
	[10 ; 20[	8	25.00	6.11
	[20 ; 30[	0	0.00	0.00
	≥ 30	1	3.13	0.76
	Total	32	100.00	24.43
Total		131		100.00

Table 26. Sources of capital for artisanal miners in TNS

Country	Source of capital	Frequency	Percentage by country (%)	Overall percentage in TNS (%)
Cameroon	Self financed	54	54.55	41.22
	Village sponsor	13	13.13	9.92
	External sponsor	19	19.19	14.50
	Borrowed money	13	13.13	9.92
	Total	99	100.00	75.57
Central African Republic	Self financed	17	53.13	12.98
	Village sponsor	8	25.00	6.11
	External sponsor	7	21.88	5.34
	Total	32	100.00	24.43
Total		131	-	100.00

There is no organised sale of products in the TNS because each miner sells individually to buyers. Among the artisanal miners in Cameroon. 74% believed that the current situation of mining as a livelihood is better than it was five years ago. This is contrary to what was observed in CAR, where 81% of the artisanal miners stated that the current situation was worse than five years ago (Table 31).

For most miners in Cameroon, income from mining is better now than five years ago and 74% quoted price increases as the major reason. Government suspension of diamond purchase offices that led to a fall in prices was the major reason behind the drop in income reported by 81% of the artisanal miners in CAR. The difference between countries may also be explained partly by the increasing gold price, because gold was only associated with Cameroon (Table 32).

3.6.3 Environmental impacts

In both Cameroon and CAR, the majority of artisanal miners believe that gold and diamond are infinite resources. However, more artisanal miners in CAR (47%) were aware of the possibility of mineral exhaustion at their sites than miners in Cameroon (17%) (Table 33).

The notion of infinite resources held by most artisanal miners in Cameroon seems more justifiable when one considers that about 72% of them stated they were producing more now than 5-10 years ago. However, in CAR about 81% of the diamond diggers said they were getting lower quantity now than 5-10 years ago (Table 34).

Mixed reasons were given for the decrease or increase in the production of gold and diamond

in the TNS. Most miners in Cameroon stated that increased production was associated with: increases in prices (19.77%), the use of hired labour (23.26%), and the purchase of new tools (16.28%). Other reasons included support from government agencies and gaining more experience over the years. For those who mentioned a decrease in production, the most important reasons were: more people entering the business, leading to over-exploitation; and less money per unit of time. In CAR, very few miners mentioned an increase in income as the reason for increased production. However, many mentioned over-exploitation and lack of external support as the major reasons for decreased production (Table 35).

From the income and production results, one would expect a greater optimism among artisanal miners in Cameroon than in CAR. Indeed, about 65% of the miners in Cameroon envisioned that production would be better in the next 10-20 years. On the contrary, in CAR, about 72% were pessimistic about future production (Table 36). This difference in outlook could be one of the reasons why more Central Africans were observed as immigrant miners in Cameroon than Cameroonians in CAR (Table 5).

In addition to their perceptions of production trends, artisanal miners were asked to give their impressions on the link between their activity and the natural environment. About 68% and 66% of miners in Cameroon and CAR, respectively, were of the opinion that mining had no negative environmental impact (Table 37). This could be associated with basic ignorance of what environmental impacts consist of, or possibly due to fear of being criminalised. Within the approximately one third who were aware of one or more environmental impacts, 47% and 58% in Cameroon and CAR, respectively, stated that unfilled open mines were a crucial issue related to the environment (Table 38).

Water contamination or diversion of streams was mentioned by 35% of the environmentally aware miners in Cameroon and 25% in CAR. Water contamination could refer to siltation and sedimentation in disturbed water courses, not necessarily to the use of chemicals. Poaching, soil contamination and biodiversity loss were less cited environmental consequences of mining in the TNS region (Table 38). Poaching could be a problem because most of the miners depend on bushmeat for their daily protein needs. Except for endemic species around water courses, the impact of artisanal mining might be minimal on biodiversity loss due to the small total area involved. The comments elicited from the small-scale miners were similar to those from conservation specialists. Namely, artisanal mining could not threaten biodiversity of the region, nor disrupt logging activities, because the activities were limited to a small territory along water courses (rarely more than 50 m wide or extending over 10 000 m^2 in area). It is important to remark here that environmental impacts could be small at present due to the presence of few artisanal miners. If the number of miners increases continuously to alarming proportions, the overall impacts could be appreciable in the future.

Observed environmental impacts

Current mining is on a small scale and dispersed across the TNS landscape. All observed sites were within 20 m of streams and swampy areas, and none exceeded 10 000 m^2 in area. The open pits were each about two metres deep. Sites are minimally cleared of vegetation, but no large-scale felling of trees takes place. In abandoned sites, regeneration of forest takes place naturally. Some miners divert minor water courses, thereby increasing sedimentation and decreasing water quality. However, these disruptions are short-term and small-scale, with the highest impact occurring during dry seasons. No significant transboundary impacts were noted. The present scale and conduct of direct artisanal mining in the TNS landscape therefore is not assessed as significantly impacting the natural environment.

3.6.4 Safety and health

According to Walle and Jennings (2001), occupational safety and health (OSH) are important issues for the world's 13 million or so small-scale miners (many of whom work in surface mines) and their communities. Properly dealing with disease and accidents affecting small-scale miners will require a better understanding of the risks and hazards of their work practices. Better data is needed to improve preventive health programmes that serve small-scale miners under OSH regulations (Walle and Jennings, 2001). In both Cameroon and CAR, over 73% of artisanal mines do not use any protective equipment, despite being located in remote parts of the forest with numerous dangers and difficult access to emergency care. Physical risks as well as those associated with water-borne diseases (miners remain immersed in muddy water for several hours at a time), sexually transmitted

Table 27. Main buyers of products of artisanal miners in TNS

Country	Buyer	Frequency	Percentage by country (%)	Overall percentage in TNS (%)
Cameroon	Individual collector	66	66.67	50.38
	Organisation	10	10.10	7.63
	Sponsor	23	23.23	17.56
	Total	99	100.00	75.57
Central African Republic	Individual collector	30	93.75	22.90
	Sponsor	2	6.25	1.53
	Total	32	100.00	24.43
Total		131	-	100.00

Table 28. Price trends/variability for gold and diamond in TNS

Country	Variables	Mineral	Frequency	Minimum	Maximum	Mean	Standard deviation
Cameroon	2008 price per unit (XAF)	Gold	63	6 500	9 500	8 468.25	438.78
	Unit price 2003 (XAF)	Gold	63	3 500	5 000	4 079.37	241.07
	2008 price per unit (XAF)	Diamond	17	10 000	350 000	97 264.71	101 265.76
	Price per unit 2003 (XAF)	Diamond	17	5 000	450 000	93 676.47	110 206.19
Central African Republic	2008 price per unit (XAF)	Diamond	32	20 000	350 000	138 437.50	77 755.17
	Unit price 2003 (XAF)	Diamond	32	20 000	600 000	197 968.75	124 264.67

diseases and the HIV virus are of little concern to most artisanal miners. A few miners in Cameroon build semi-permanent huts for protection against animals (11%) and some use mosquito nets to guard against malaria (16%). In CAR, the only protective measure (used by 18% of the miners) was to clear their area of trees and heavy branches (Table 39). In most cases, miners take no precaution other than to trust in God as their protector.

In the TNS region, it would be significantly beneficial to seek the support of the International Labour Organization (ILO) to address safety and health issues. When artisanal miners are sick, they use both modern medicines and traditional herbal remedies to cure themselves. This is true for 77% and 66% of the miners in Cameroon and CAR, respectively. Forest herbs formed the sole source of remedy for 22% of the artisanal miners in Cameroon and 28% in CAR. Miners that depend solely on modern drugs for treatment were rare (Table 40).

None of the small-scale miners in the study were using mercury or cyanide to extract minerals. Nevertheless, they need additional skills and knowledge in regard to possible hazards. By means of education and training (including the use of protective equipment), risks can be minimised at the source

3.6.5 Alternative sources of income

When artisanal miners were asked if they engage in any livelihood activities other than mining, 92% and 93% in Cameroon and CAR, respectively, mentioned

Table 29. CAPAM price points for diamonds in 2007

Size of diamond		Weight range (in carats)	Price per carat (in CFA) for a diamond without defects (first grade)	Observations
Select		0.01 to 0.25	5 000 to 35 000	On the basis of defects (broken, full, colour)
Mixed	**Mixed**	0.25 to 0.50	35 000 to 90 000	
	Firmly Mixed	0.50 to 0.90	90 000 to 150 000	
Carat		0.90 to1	150 000 to 250 000	
		1 to 2	250 000 to 350 000	
		2 to 2.50	400 000 to 450 000 (negotiable)	
		2.50 to 3	450 000 to 650 000 (negotiable)	
		3 to 4	700 000 to 800 000 (negotiable)	
		4 to 6	1 000 000 (negotiable)	
		> 6	> 1 000 000 (negotiable)	

Source: CAPAM, 2007

at least one other source of income. These portions of TNS artisanal miners performed 1-6 activities, with a mean of 2.9 in Cameroon (std=1.29) and a mean of 2.5 in CAR (std=1.41). In both countries, about 90% of the artisanal miners who engaged in non-mining work performed 1-4 activities for additional income (Table 41).

Among the activities mentioned as additional sources of income, artisanal miners preferred agriculture (43% in Cameroon, 83% in CAR) and NTFP gathering (23% in Cameroon, 10% in CAR) (Table 42).

A more detailed enquiry into the economics of the income generated by activities outside mining showed eight other income portfolios relevant for artisanal miners in Cameroon and five for miners in CAR. In both countries, ANOVA tests showed significant differences ($p<.05$) among the means of the different sources of income (Table 43). Appreciable annual income came from agriculture and non-timber forest products (NTFPs) but more specialised activities such as paid labour and trade gave higher mean incomes.

For the full set of 131 artisanal miners interviewed in Cameroon and CAR, annual income generated by non-mining activities exceeded 20.5 million CFA. In both countries, agriculture was the most important source of additional income for miners, followed by NTFP gathering in Cameroon and fishing in CAR. The latter result is associated with the expertise of Central Africans in fishing in the Sangha River and the fact that some of those miners were divers. A Tukey rank test (Appendix 1a) showed that in Cameroon, income from farming, trade, paid labour and gathering NTFPs were not different from each other but they were significantly higher than income from hunting, fishing and raising livestock. A similar test (Appendix 1b) conducted for CAR showed that income from farming was significantly higher than income from gathering NTFPs but was not different from income from fishing, hunting and raising livestock (Table 44). The distribution of mean annual incomes from all sources (including mining) is shown in Figure 12.

The most important NTFPs mentioned in both countries were: wild fruits such as bush mango (*Irvingia* spp.); leafy vegetables such as eru (*Gnetum africanum*); rattan; leaves of Marantaceae; and spices such as bush pepper (*Piper guineensis*). The most important fish species cited were mud fish, catfish, tilapia and crabs. Frequently mentioned agricultural crops included cassava, cocoyam (taro), plantain, groundnuts and banana. Major domestic animals included goats, sheep, chicken and pigs. It is important to point out that no enquiries were made to solicit further details such as the quantities of NTFPs, livestock, agricultural crops and fishing.

Table 30. Self-reports of the payment of mining tax in TNS

Country	Tax paid?	Frequency	Percentage by country (%)	Overall percentage in TNS (%)
Cameroon	No	99	100.00	75.57
	Total	99	100.00	75.57
Central African Republic	Yes	18	56.25	13.74
	No	14	43.75	10.69
	Total	32	100.00	24.43
Total		131	-	100.00

Table 31. Opinions of miners on income trends in TNS

Country	Comparison of present income to past	Frequency	Percentage by country (%)	Overall percentage in TNS (%)
Cameroon	More	67	73.63	54.47
	Less	20	21.98	16.26
	Same	4	4.40	3.25
	Total	91	100.00	73.98
Central African Republic	More	5	15.63	4.07
	Less	26	81.25	21.14
	Same	1	3.13	0.81
	Total	32	100.00	26.02
Total		123	-	100.00

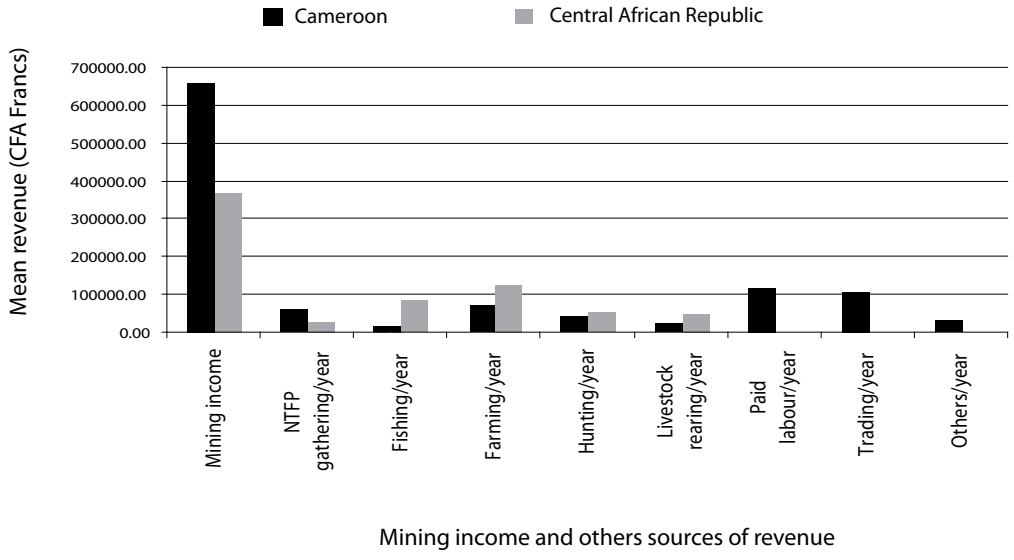


Figure 12. Mean annual income from various activities in TNS

3.6.6 Use of mining income

Artisanal miners were asked to mention the ways in which they spend their income from mining. Interestingly, all the miners used their mining income to meet at least 2 basic needs and some applied the money to as many as 6 needs. In both Cameroon and CAR, over 90% of the miners used their income to meet 4-6 basic needs (Table 45). These basic needs included: education of children, health and medicine, purchase of radio/TV, food, clothing and home improvement/construction.

Considering the numerous uses of income from mining, one-way ANOVA tests revealed significant

Table 32. Reasons for changes in income in TNS

Country	Trend	Reasons for increase/ decrease	Frequency	Percentage by trend (%)	Percentage by reason (%)
Cameroon	Increase	More experience	9	10.98	8.65
		Good prices	61	74.39	58.65
		Help from family/hired labour	7	8.54	6.73
		New site discovered	4	4.88	3.85
		New materials bought	1	1.22	0.96
		Total	82	100.00	78.85
	Decrease	Government suspension	15	68.18	14.42
		Impoverishment of site/ Overexploitation	2	9.09	1.92
		Lack of materials	5	22.73	4.81
		Total	22	100.00	21.15
	Total	104		100.00	
Central African Republic	Increase	More experience	2	33.33	6.45
		Good prices	2	33.33	6.45
		Help from family/hired labour	1	16.67	3.23
		New site discovered	1	16.67	3.23
		Total	6	100.00	19.35
	Decrease	Fall in prices	13	52.00	41.94
		Government suspension	4	16.00	12.90
		Impoverishment of site/ Overexploitation	5	20.00	16.13
		Lack of materials	3	12.00	9.68
		Total	25	100.00	80.65
	Total		31	-	100.00

differences among the various uses in both countries (Table 46).

Tukey rank tests (Appendix 2a and 2b) revealed which needs differed significantly from each other in frequency, as well as pairings that received equal attention (frequency). In both Cameroon and CAR, the purchase of food was the dominant use of income from mining. It is important to note that alcoholic drinks represented over 20% of the food costs mentioned by most miners. In Cameroon, children's education consumed second largest proportion of mining income and the purchase of clothes was third. Medicine, housing construction and radio/ television (information tools) were all roughly equal below clothing. In CAR, education, housing and clothing were roughly the same in second place, with pharmaceutical drugs and information tools close behind (Table 47).

It is clear that mining income in the TNS can help the respective countries meet the millennium development goals of: reducing poverty and hunger; improving health, information and communication; and building infrastructure such as better shelters. The proportions of TNS mining income used to meet basic needs are shown in Figure 13.

3.7 Problems and opportunities of artisanal mining in the TNS

3.7.1 Problems

Small-scale miners in the TNS region reported a variety of problems: lack of food and medicine, harassment by conservation agents, dishonesty of sponsors, low production, harsh government laws and actions, lack of materials for detecting and exploiting

Table 33. Artisanal miners' perceptions of resource availability in TNS

Country	Any thought of mineral exhaustion?	Frequency	Percentage by country (%)	Overall percentage in TNS (%)
Cameroon	Yes	17	17.17	12.98
	No	82	82.83	62.60
	Total	99	100.00	75.57
Central African Republic	Yes	15	46.88	11.45
	No	17	53.13	12.98
	Total	32	100.00	24.43
Total		131	-	100.00

Table 34. Present and past production trends of diamond/gold in TNS

Country	Present production compared to 5-10 years ago	Frequency	Percentage by country (%)	Overall percentage in TNS (%)
Cameroon	More	71	71.72	54.20
	Less	24	24.24	18.32
	Same	4	4.04	3.05
	Total	99	100.00	75.57
Central African Republic	More	4	12.50	3.05
	Less	26	81.25	19.85
	Same	2	6.25	1.53
	Total	32	100.00	24.43
Total		131	-	100.00

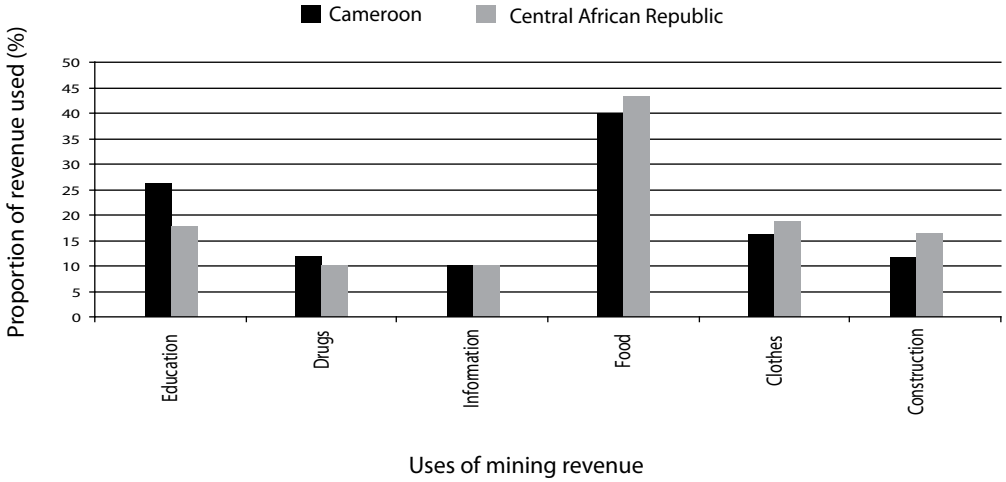


Figure 13. Proportion of mining income used for basic needs in TNS

minerals, price fluctuations and lack of capital. In Cameroon, the three most crucial problems (named by a total of 76% of interviewees) were lack of materials for detecting and exploiting minerals, lack of food/medicine at site and low production. In CAR, the most two crucial problems (named by a total of 65% of interviewees) were low production and lack of materials for detecting and exploiting minerals (Table 48).

The identified problems show characteristics that fit the model of the ASM sector visualised by Hentchel *et al.* (2002). In particular, the most common issues related to government, trade and

Table 35 .Opinions on causes of diamond/gold production trends in TNS

Country	Stated opinion of primary cause	Frequency	Percentage by country (%)	Overall percentage in TNS (%)
Cameroon	Increasing income	17	19.77	15.60
	Decreasing income	9	10.47	8.26
	More support from government agencies	4	4.65	3.67
	Lack of support	9	10.47	8.26
	More people digging/overexploitation	8	9.30	7.34
	New materials bought	14	16.28	12.84
	Hired labourer(s)	20	23.26	18.35
	Have more experience	9	10.47	8.26
	No buyers	4	4.65	3.67
	Total	86	100.00	78.90
Central African Republic	Increasing income	1	4.35	0.92
	Decreasing income	3	13.04	2.75
	Lack of support	7	30.43	6.42
	Fetish/sacrifice practices	2	8.70	1.83
	More people digging/overexploitation	9	39.13	8.26
	New materials bought	1	4.35	0.92
	Total	23	100.00	21.10
Total		109		100.00

operations (exploitation of minerals). The model portrays a vicious circle of informality and inefficient tax administration, including dependence on intermediaries, unfavourable selling conditions, poverty and dependence on mining.

3.7.2 Opportunities

The question that remains to be answered is whether intervention of any type and on any scale can help break the vicious cycle of dependence, thereby enabling small-scale miners to earn a more equitable livelihood. The small-scale miners in the TNS region suggested a number of opportunities for resolving their problems, with the most frequent responses being requests for outside assistance to get working tools (49% in Cameroon and 36% in CAR) and legal papers (23% in Cameroon and 30% in CAR) (Table 49).

Although a number of miners were aware of the need for a mineral detecting tool (called a tester), none of them could state the price of the tool. Some mentioned a price range between 1 and 5 million CFA for a tester. The miners were well informed, however, about the cost of a motorised pump (to bail water from mines) which they stated would cost from 200 000 to 250 000 CFA. Over two thirds of the miners in both Cameroon and CAR believed that the government should help them get working materials such as tools or ensure sensitisation of the mining code. The mining code was even more notable because an additional quarter of the artisanal miners called for greater transparency in sales offices, reduction in the costs of obtaining legal papers and stabilization of prices (Table 50).

62% of the artisanal miners in Cameroon and 81% in CAR were not aware of the respective country's mining code and could not comment on its enforcement. In addition, 64% and 67% of the miners in Cameroon and CAR, respectively, said it was not easy to obtain legal mining papers. Paradoxically, most of those who said it was easy to get legal papers did not actually have them at the time of this research study. The few miners who had legal papers in CAR mentioned that the benefit of having the papers was basically the freedom to exploit and sell minerals. They stated that government and NGO supports were not available to support them in their legal operations.

Table 36. Vision of future artisanal mining in TNS

Country	Vision of mining business in 10-20 years	Frequency	Percentage by country (%)	Overall percentage in TNS (%)
Cameroon	Better	64	64.65	48.85
	Same	20	20.20	15.27
	Worse	15	15.15	11.45
	Total	99	100.00	75.57
Central African Republic	Better	4	12.5	3.05
	Same	5	15.625	3.82
	Worse	23	71.875	17.56
	Total	32	100	24.43
Total		131	-	100.00

Table 37. Artisanal miners' perception of negative environmental impacts of mining in TNS

Country	Does mining have a negative environmental impact?	Frequency	Percentage by country (%)	Overall percentage in TNS (%)
Cameroon	Yes	32	32.32	24.43
	No	67	67.68	51.15
	Total	99	100.00	75.57
Central African Republic	Yes	11	34.38	8.40
	No	21	65.63	16.03
	Total	32	100.00	24.43
Total		131	-	100.00

Table 38. Environmental impacts of artisanal mining according TNS miners

Country	Possible environmental impact	Frequency	Percentage by country (%)	Overall percentage in TNS (%)
Cameroon	Water contamination	17	34.69	27.87
	Air contamination	2	4.08	3.28
	Open mines not filled	23	46.94	37.70
	Biodiversity loss	6	12.24	9.84
	Soil contamination	1	2.04	1.64
	Total	49	100.00	80.33
Central African Republic	Air contamination	3	25.00	4.92
	Biodiversity loss	1	8.33	1.64
	Open mines not filled	7	58.33	11.48
	Poaching	1	8.33	1.64
	Total	12	100.00	19.67
Total		61	-	100.00

When asked about government support of ASM in the TNS region, 67% and 53% of miners in Cameroon and CAR, respectively, mentioned its complete absence. However, 29% in Cameroon mentioned education and technical training, which was specifically the case for diamond miners in the Mboy region under the CAPAM project. In CAR education and technical training totalled 40% of the government support identified by miners (Table 51).

Despite the negative image held by artisanal miners about government support, over 42% of those interviewed in Cameroon believed that the government was the leader in trying to improve

Table 39. Safety measures used by artisanal miners in TNS

Country	Method of protection from harmful elements	Frequency	Percentage by country (%)	Overall percentage in TNS (%)
Cameroon	No protection	41	73.21	56.16
	Build strong huts	6	10.71	8.22
	Use mosquito nets	9	16.07	12.33
	Total	56	100.00	76.71
Central African Republic	No protection	14	82.35	19.18
	Cut nearby big trees	3	17.65	4.11
	Total	17	100.00	23.29
Total		73	-	100.00

Table 40. Sources of medicine used by artisanal miners in TNS

Country	Source of medication when sick	Frequency	Percentage by country (%)	Overall percentage in TNS (%)
Cameroon	Drug store	1	1.01	0.76
	Forest herbs	22	22.22	16.79
	Both	76	76.77	58.02
	Total	99	100.00	75.57
Central African Republic	Drug store	2	6.25	1.53
	Forest herbs	9	28.13	6.87
	Both	21	65.63	16.03
	Total	32	100.00	24.43
Total		131	-	100.00

Table 41. Other income generating activities for TNS miners

Country	Number of other income activities	Frequency	Percentage by country (%)	Overall percentage in TNS (%)
Cameroon	1	15	16.30	12.30
	2	24	26.09	19.67
	3	19	20.65	15.57
	4	24	26.09	19.67
	5	9	9.78	7.38
	6	1	1.09	0.82
	Total	92	100.00	75.41
Central African Republic	1	10	33.33	8.20
	2	7	23.33	5.74
	3	4	13.33	3.28
	4	6	20.00	4.92
	5	3	10.00	2.46
	Total	30	100.00	24.59
Total		122		100.00

Table 42. TNS artisanal miners' perceptions of best alternative source of income

Country	Best alternative activity to mining	Frequency	Percentage by country (%)	Overall percentage in TNS (%)
Cameroon	Gathering NTFPs	21	22.58	17.21
	Fishing	1	1.08	0.82
	Farming	40	43.01	32.79
	Hunting	7	7.53	5.74
	Raising livestock	4	4.30	3.28
	Paid labour	4	4.30	3.28
	Trading	15	16.13	12.30
	Other	1	1.08	0.82
	Total	93	100.00	76.23
Central African Republic	Gathering NTFPs	3	10.34	2.46
	Fishing	1	3.45	0.82
	Farming	24	82.76	19.67
	Hunting	1	3.45	0.82
	Total	29	100.00	23.77
Total		122		100.00

Table 43. One-way ANOVA tests for differences among TNS miners' additional sources of income

ANOVA[a]

amount

	Sum of squares	df	Mean square	F	Sig
Between group	2,10E+11	7	2,996E+10	15,353	,000
Within groups	5,05E+11	259	1951281656		
Total	7,15E+11	266			

a. Country = Cameroon

ANOVA[a]

amount

	Sum of squares	df	Mean square	F	Sig
Between group	1,05E+11	4	2,633E+10	4,282	,004
Within groups	4,24E+11	69	6149649766		
Total	5,305E+11	73			

a. Country = Central African Republic

the sector. Some 20% of the miners believed that individual investors were taking the lead to improve the sector and 38% believed that the sector was static. Corresponding responses in CAR were 80% for government leadership, 8% for individual investor leaderships and 12% for no improvement.

3.7.3 Aggregate data

Despite the high diversity of income sources for most artisanal miners in the TNS region, mining contributes the lion's share of their annual income: over 82% in Cameroon and 65% in CAR. Although some artisanal miners were profiting, others were running serious operating losses. This variance could be associated with the peculiar problems of the sector. Overall income from natural sources (mining, gathering NTFPs, hunting and fishing) represented about 90% and 77% of annual income in Cameroon and CAR, respectively (Table 52). This preponderance shows their high level of dependence on the natural environment in the TNS region.

Table 44. Annual income from non-mining activities in TNS

Country	Type of non-mining activity	Frequency	Min annual income (CFA)	Max annual income (CFA	Sum (CFA)	Contribution to total non-mining income of all miners (%)	Mean (CFA)	Standard deviation (CFA)
Cameroon	Gathering NTFPs	57	20 000	120 000	3 425 000	23.91	60 088[ab]	27 172
	Fishing	49	2 000	40 000	706 000	4.93	14 408[c]	8 085
	Farming	62	12 000	350 000	4 463 000	31.16	71 984[a]	69 211
	Hunting	44	12 000	144 000	1 873 000	13.08	42 568[b]	26 397
	Raising livestock	13	4 500	70 000	348 500	2.43	26 808[b]	20 599
	Paid labour	6	20 000	200 000	710 000	4.96	118 333[a]	73 869
	Trading	22	25 000	300 000	236 6000	16.52	107 545[a]	70 361
	Other	14	15 000	60 000	432 000	3.02	30 857[b]	13 587
	Total	-	-	-	14 323 500	100.00	-	-
Central African Republic	Gathering NTFPs	11	2 500	100 000	297 500	4.79	27 045[bc]	28 627
	Fishing	15	3 000	200 000	1 294 000	20.84	86 267[ac]	65 058
	Farming	29	20 000	420 000	3 635 500	58.54	12 5362[a]	103 645
	Hunting	9	7 000	225 000	498 000	8.02	55 333[ac]	69 520
	Raising livestock rearing	10	2 000	150 000	485 500	7.82	48 550[ac]	44 002
	Total	-	-	-	6 210 500	100.00	-	-

Superscript letters in the column for Mean indicate pairs of income sources that show significant difference ($p<0.05$).

Table 45. Basic needs met by income from artisanal mining in TNS

Country	Number of basic needs	Frequency	Percentage by country (%)	Overall percentage in TNS (%)
Cameroon	2	1	1.02	0.77
	3	7	7.14	5.38
	4	23	23.47	17.69
	5	37	37.76	28.46
	6	30	30.61	23.08
	Total	98	100.00	75.38
Central African Republic	3	2	6.25	1.54
	4	13	40.63	10.00
	5	11	34.38	8.46
	6	6	18.75	4.62
	Total	32	100.00	24.62
Total		130		100.00

Gini Coefficients

The Gini coefficient is a measure of statistical dispersion that reflects the inequality of income distribution or inequality of wealth distribution in a population. It is defined as a ratio varying between 0 and 1. A low Gini coefficient indicates a more equal distribution of income or wealth and a high Gini coefficient indicates a less equal distribution. The value 0 corresponds to perfect equality (everyone having exactly the same income) and 1 corresponds to perfect inequality (where one person has all the income and everyone else has zero income). Calculation of the Gini coefficients to measure income inequality among artisanal miners in the TNS region showed 0.50 for absolute income and 0.43 for absolute non-mining income. The implication of these figures is that the poverty gap between rich and poor miners will widen if they continue mining under the prevailing organisational setup and governance structure. This cautionary result applies only to mining households (the focus of this study), because other studies that survey all rural households in the region show that forest sources of income reduce income inequality (Tieguhong, 2008). A similar reduction was found by Aryal (2002) in Uganda where forest income was helping to reduce income inequality among the people adjoining the Budongo Forest.

Logistic regression results

Logistic regression is a model used to predict the probability of an event by fitting data to a logistic curve. It makes use of several predictor variables, which may be either numerical or categorical. The logistic regression conducted to test the dependency of artisanal miners on mining activities in the TNS region was found to be significant ($p<0.05$). The likelihood ratio test showed that the regression model was significant and the model predicted the dependent variable as having 79.74% probability. In this model, ethnic group, education level and years working as a miner were the main explanatory independent variables having significant effects on mining dependency (Table 53). Ethnicity was a major factor in earning a higher income from artisanal mining. As expected, migrant miners with skills, capital, better education and more experience could earn more from artisanal mining than indigenous Bangandos and Baaka/Baka pygmies. The income differences predominate where governance and organisation of the sector are still very informal, causing possible marginalisation of minorities. Consequently, there is a vicious circle of dependency and poverty (Hentchel *et al.* 2002).

Table 46. One-way ANOVA tests for differences among TNS miners' uses of mining income

ANOVA[a]

percent

	Sum of squares	df	Mean square	F	Sig
Between group	20823,609	5	4164,722	24,923	,000
Within groups	23227,425	139	167,104		
Total	44051,034	144			

a. Country = Central African Republic

ANOVA[a]

percent

	Sum of squares	df	Mean square	F	Sig
Between group	57875,599	5	11575,120	89,654	,000
Within groups	60552,085	469	129,109		
Total	118427,7	474			

a. Country = Cameroon

Table 47. Proportion of mining income used for specific household needs in TNS

Country	Variable	Frequency	Relative frequency (%)	Minimum proportion (%)	Maximum proportion (%)	Mean proportion (%)	Standard deviation
Cameroon	Education	64	65	5	50	26	13
	Medicine	86	87	5	40	12	7
	Information	47	47	5	45	10[d]	8
	Food	96	97	5	80	40[a]	19
	Clothes	97	98	4	45	16[c]	7
	Construction	85	86	5	40	12[cd]	7
Central African Republic	Education	27	84	5	51	18[b]	11
	Medicine	29	91	5	40	10[b]	7
	Information	11	343	2	40	10[b]	11
	Food	31	97	5	75	43[a]	20
	Clothes	31	97	5	60	18[b]	12
	Construction	16	50	5	45	17[b]	10

Superscript letters in the column for Mean proportion indicate pairs of needs that are significantly different ($p<0.05$).

Table 48. Problems faced by artisanal miners in TNS

Country	Major problem	Frequency	Percentage by country (%)	Overall percentage in TNS (%)
Cameroon	Low production	22	19.82	15.17
	Harsh government law/Closure of sales offices	18	16.22	12.41
	Lack of materials for detection and exploitation	32	28.83	22.07
	Lack of food and medicine at site	30	27.03	20.69
	Dishonest sponsor	8	7.21	5.52
	Lack of capital	1	0.90	0.69
	Total	111	100.00	76.55
Central African Republic	Low production	9	26.47	6.21
	Harsh government law	2	5.88	1.38
	Lack of materials for detection and exploitation	13	38.24	8.97
	Lack of food and medicine at site	2	5.88	1.38
	Falling price	2	5.88	1.38
	Lack of capital	6	17.65	4.14
	Total	34	100.00	23.45
Total		145	-	100.00

Table 49. Opportunities suggested by artisanal miners in TNS for resolving problems

Country	Opportunity/Request	Frequency	Percentage by country (%)	Overall percentage in TNS (%)
Cameroon	Assistance to get working materials	55	48.67	37.67
	Assistance to get legal papers	26	23.01	17.81
	Open a sales agency in village	10	8.85	6.85
	Stabilize prices	6	5.31	4.11
	Create a cooperative	9	7.96	6.16
	Receive training in modern mining techniques	7	6.19	4.79
	Total	113	100.00	77.40
Central African Republic	Assistance to get working materials	12	36.36	8.22
	Assistance to get legal papers	10	30.30	6.85
	Open a sales agency in village	4	12.12	2.74
	Stabilize prices	1	3.03	0.68
	Create a cooperative	6	18.18	4.11
	Total	33	100.00	22.60
Total		146	-	100.00

Table 50. Opportunities for government to solve problems faced by artisanal miners in TNS

Country	What the government can do to solve problems	Frequency	Percentage by country (%)	Overall percentage in TNS (%)
Cameroon	Sensitise miners about code	16	13.45	10.19
	Reduce costs of obtaining legal papers	9	7.56	5.73
	Assist miners to get production materials	64	53.78	40.76
	Open transparent sales offices	16	13.45	10.19
	Ensure sponsors respect agreements	5	4.20	3.18
	Fix/increase prices	9	7.56	5.73
	Total	119	100.00	75.80
Central African Republic	Sensitise miners about code	13	34.21	8.28
	Assist miners to get production materials	15	39.47	9.55
	Open transparent sales offices	6	15.79	3.82
	Fix/increase prices	4	10.53	2.55
	Total	38	100.00	24.20
Total		157	-	100.00

Table 51. Types of government support of ASM in TNS

Country	Government support or program	Frequency	Percentage by country (%)	Overall percentage in TNS (%)
Cameroon	Education	1	1.01	0.76
	Technical training	28	28.28	21.37
	Exploration equipment	4	4.04	3.05
	No support	66	66.67	50.38
	Total	99	100.00	75.57
Central African Republic	Education	9	28.13	6.87
	Technical training	4	12.50	3.05
	Exploration equipment	2	6.25	1.53
	No support	17	53.13	12.98
	Total	32	100.00	24.43
Total		131	-	100.00

Table 53. Logistic regression analysis for mining dependency in TNS

Independent variable	Coef.	Std. Err.	z	P>z	95% Conf. Interval	
					Lower bound	Upper bound
Country	2.392	1.519	1.570	0.115	-0.585	5.368
Village	-1.437	0.836	-1.720	0.086**	-3.076	0.202
Mineral mined	1.412	0.960	1.470	0.141	-0.469	3.293
Number of wives	0.501	0.464	1.080	0.28	-0.410	1.411
Total number of dependents	-0.045	0.064	-0.700	0.481	-0.170	0.080
Ethnic group	-0.092	0.032	-2.860	0.004*	-0.155	-0.029
Education level	0.531	0.234	2.270	0.023*	0.072	0.989
Full-time or part-time miner	0.103	0.485	0.210	0.831	-0.847	1.053
Time spent mining (years)	0.056	0.027	2.040	0.04*	0.002	0.109
Cons	-2.534	1.750	-1.450	0.148	-5.963	0.896

Number of obs. = 131
Log likelihood = -79.740339
Prob > chi2 = 0.0293
* significant at 5%
** significant at 10%

Table 52. Characteristics of miners' income sources in TNS

Country	Variable	Frequency	Minimum annual income (CFA)	Maximum annual income (CFA)	Sum (CFA)	Contribution to total annual income (%)	Mean (CFA)	Standard deviation (CFA)
Cameroon	All non-mining sources	99	0	550 000	14 323 500	17.94	144 681.82	117 670.10
	All natural sources	99	-390 000	2 132 000	71 505 500			
	89.58	722 277.78	550 352.11					
	Mining income	99	-404 000	2 092 000	65 501 500			
	82.06	661 631.31	558 202.62					
	Total from all sources	99	-370 000	2 462 000	79 825 000	100.00	806 313.13	567 263.23
Central African Republic	All non-mining sources	32	0	770 000	6 210 500	34.52	194 078.13	155 859.23
	All natural sources	32	-957 450	2 517 550	13 868 200			
	77.09	433 381.25	882 567.97					
	Mining income	32	-1 032 450	2 517 550	11 778 700			
	65.48	368 084.38	904 426.74					
	Total from all sources	32	-767 450	2 767 550	17 989 200	100.00	562 162.50	914 797.12

4

Conclusions

Many countries in Africa have abundant natural resources, which sustain millions of people and even entire national economies. Those resources have the potential to drive economic growth and human development, but this potential is not often realised (Commission for Africa, 2005). Resource-dependent countries in Africa have very poor human development indices, in part because the benefits from their resources do not trickle down to the masses. This unfair situation prevails in the countries of the Congo Basin, where millions of people live in abject poverty and squalor despite abundant forest, minerals, wildlife, and fishery resources literally in their backyards. The World Bank supports the use of natural resources to stimulate economic growth. However, their strategies have been woefully disappointing because most people still remain poor and a few elites enjoy the windfall profits. This inequality is generally associated with poor governance structures that are riddled with corruption, lack transparency and sideline the poor from participating in decisions about growth. According to the report of the Commission for Africa (2005), where incomes are noticeably unequal, most of the benefits from growth go to the wealthy, exacerbating the divide between rich and poor. As evident from this study, the poor governance and informality that characterise the natural resource sector are typical of the artisanal mining of gold and diamonds in the TNS landscape. The consequence of such disorganisation is a possible reduction (though not fully measured by this research) in the contribution of ASM to the livelihoods of people residing in the region.

The socio-economic impacts of artisanal mining in the TNS region are glaring. Livelihood impacts were revealed in this study in terms of employment, income, provision of greater opportunities for education, health and shelter. For example, some 517 artisanal miners were found at 17 mining sites in the TNS. Of these, the 131 miners who were interviewed had 875 dependents including 433 children. Extrapolating yields 3453 dependents, including 1709 children for the entire mining population of 517 persons.

Mean annual net incomes from exploiting and selling gold and diamonds were 575 338 CFA (std = 461 913) and 812 644 CFA (std = 676 487), respectively, in Cameroon. In CAR, ASM diamond miners earned a mean annual net mining income of 368 084 CFA (std = 904 427) (Table 21). The fact that the standard deviation was about three times the mean clearly indicates an enormous gap in mining income distribution in CAR, with some miners getting huge sums and others almost nothing. In fact, some miners were actually losing significant sums of money, with net losses as large as 1 032 450 CFA in CAR and 404 000 CFA in Cameroon. Successful miners (earning more than the mean positive income, represented by 44.4% in Cameroon and 21.9% in CAR), net annual mining incomes in Cameroon and CAR were 1 180 646 CFA (std=338 562) and 1 752 007 (std=704 430), respectively. However, the aspect of luck seemed to keep losers in the game, enthralled by their hopes that one day they might obtain a sizeable find and thereby cover their costs.

The broader livelihoods implication for income earned from mining was that most artisanal miners used that money to meet at least two basic needs and sometimes as many as six needs. In both Cameroon and CAR, over 90% of the miners used their income to meet 4-6 basic needs including food, education of children, health and medicine, purchase of radio/TV, clothes and construction of houses. Meeting these needs fits some of the most important Millennium Development Goals (MDGs). However, the fact that appreciable proportions of miners were actually losing income implies that artisanal mining could be treated as a risky business, with uncertain likelihood of alleviating poverty under prevailing socio-economic and institutional arrangements.

In terms of environmental impacts, the present scale of artisanal mining in the TNS region does not significantly threaten the natural environment. There appear to be few, if any, transboundary environmental impacts associated with the small, local mining operations. However, negative impacts could arise in the future due to the influx of large-scale mining operators combined with possible increase in the number of artisanal miners (an overall estimated population growth in the region is around 1.88% per year)and improved extraction methods. Environmental impacts from artisanal mining in the TNS Landscape now appear to be of limited size and short-term. The majority of mining takes place along streams, causing direct but insignificant impacts such as diversions, siltation and sedimentation of water sources. Only limited felling of trees or land clearance was observed. Land tended to be cleared during the period of mining, which was often seasonal, and then abandoned, with minimal farming activities taking place. The indirect effects of working in the forest areas included timber and non-timber (bushmeat and medicinal herbs) forest product exploitation by 21% (Cameroon) and 28% (CAR) of respondents who indicated such activity as an alternative source of income. Gathering NTFPs, hunting and fishing were classified as alternative sources of income, but provided lower earnings than farming. In both Cameroon and CAR, over 53% of the artisanal miners stated that gold and diamonds are infinite resources and 67% of them believed that mining had no negative environmental impacts. Stakeholders who were aware of environmental impacts mentioned: unfilled open mines and contamination or diversion of streams. In Cameroon, 20% of the miners indicated that they (also) mine inside the reserve, in contrast to only 1 of 32 miners interviewed in CAR. No miner reported using mercury or cyanide for gold extraction. All these results follow the conclusions of earlier studies on the TNS and enhance the need for Integrated Natural Resource Management (INRM) on a landscape level to balance the positive and negative impacts of ASM.

A vivid conclusion is that for the ASM sector to make the expected contribution to poverty alleviation, serious efforts must be made to break the vicious circle of resource-dependence and poverty. Intervention would involve tackling informality in production and trade, increasing access to mining titles by the poor, improving information flow about mining codes at the grassroots and assisting in the provision of basic tools. Government or external (e.g., NGO) programmes could support organisation of the sector and inform stakeholders about the benefits of formalising a business, whether big or small. Current contributions of mining income to meeting the basic needs of the people would thus be expected to increase as a result of a more environmentally friendly and better governance arrangement. It is also important to balance technical improvements and formalisation with measures to discourage mining inside the TNS Park.

Efforts to change the existing situation should account for possible environmental impacts of small-scale mining such as water pollution and diversion of stream courses, soil depression associated with haphazard excavations and poaching of wild animals. Moreover, alternative activities to mining such as gathering NTFPs, farming and raising livestock could be rendered economically viable with outside support, thus increasing incomes and reducing poverty. In conclusion, development policies that can stimulate environmentally sound mining practices and reduce poverty would entail information flows to assist the poorest miners in practising legal mining, improving health and safety standards, and educating their entire families.

5

Recommendations

Overall, this report recommends targeting all intervening stakeholders in the TNS region, including national governments (especially all of their relevant ministerial departments), non-governmental organisations, business entities and development agencies.

1) **Improve coherence of strategies across the mining and forestry sectors** in order to enhance livelihoods and minimise environmental impacts. Special attention should focus on mitigation of conflicting interests: between small-scale and large-scale mining activities; and with regard to mining activities in timber concessions and/or in protected areas.

2) **Harmonise mining policies and resource governance strategies in the Congo Basin** at large and the three countries (Cameroon, the Republic of Congo and the Central African Republic) in the TNS area in particular. A harmonised approach to mining in the TNS area would address issues about artisanal and small-scale mining (ASM) and trans-boundary trafficking. The outcomes would strengthen existing Park-related trans-boundary agreements on sustainable management that follow the 2000 "Yaoundé declaration" signed by central African governments.

3) **Promote development policies that stimulate environmentally sound mining practices** in the TNS region, such as maintaining chemical-free mining practices. Environmental and social impact of large-scale mining operations should be studied thoroughly and in a transparent manner before exploitation licences are granted. Mining companies should state explicitly how they will interact with local communities and artisanal miners during their daily operations and as part of their overall social responsibility.

4) **Inform and sensitise artisanal miners about their rights** under the national mining laws and how to access mining titles and obtain legal permits.

5) **Improve miner livelihoods** by:
   a. **Transferring knowledge** about sustainable techniques, tools, valuation and price.
   b. **Helping them organise themselves,** for example by creating forums for information exchange and sharing of experience about production, processing, financial management and marketing.
   c. **Supporting diversification** of livelihood with alternative income activities such as gathering NTFPs, farming and raising livestock.

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Appendices

Appendix 1a. Tukey test comparing means of non-mining income sources, Cameroon

Multiple Comparisons[a]

Dependent Variable: amount
Tukey HSD

(I) activity	(J) activity	Mean Difference (I-J)	Std. Error	Sig.	95% Confidence Interval	
					Lower bound	Upper Bound
NTFP gathering	Fishing	45679,556*	8605,526	,000	19382,0181	71977,0939
	Farming	-11896,152	8105,880	,824	-36666,8262	12874,5229
	Hunting	17519,537	8864,554	,500	-9569,5606	44608,6356
	Livestock rearing	33280,027	13576,88	,222	-8209,4099	74769,4639
	Paid labour	-58245,614*	18959,08	,048	-116182,4597	-308,7684
	Trading	-47457,735*	11087,27	,001	-81339,2175	-13576,2530
	Others	29230,576	13176,13	,344	-11034,2057	69495,3586
Fishing	NTFP gathering	-45679,556*	8605,526	,000	-71977,0939	-19382,0181
	Farming	-57575,708*	8443,599	,000	-83378,4122	-31773,0032
	Hunting	-28160,019*	9174,387	,048	-56195,9327	-124,1044
	Livestock rearing	-12399,529	13781,17	,986	-54513,2634	29714,2053
	Paid labour	-103925,17*	19105,91	,000	-162310,7105	-45539,6297
	Trading	-93137,291*	11336,52	,000	-127780,4448	-58494,1377
	Others	-16448,980	13386,54,	923	-57356,7530	24458,7938
Farming	NTFP gathering	11896,152	8105,880	,824	-12874,5229	36666,8262
	Fishing	57575,708*	8443,599	,000	31773,0032	83378,4122
	Hunting	29415,689*	8707,445	,0192	806,7001	56024,6782
	Livestock rearing	45176,179*	13474,82	,020	3998,6066	86353,7507
	Paid labour	-46349,462	18886,13	,220-	104063,3874	11364,4627
	Trading	-35561,584*	10962,07	,029	-69060,4478	-2062,7193
	Others	41126,728*	13070,94	,038	1183,3714	81070,0848
Hunting	NTFP gathering	-17519,537	8864,554	,500	-44608,6356	9569,5606
	Fishing	28160,019*	9174,387	,048	124,1044	56195,9327
	Farming	-29415,689*	8707,445	,019	-56024,6782	-2806,7001
	Livestock rearing	15760,490	13944,39	,950	-26852,0128	58372,9919
	Paid labour	-75765,152*	19223,97	,003	-134511,4711	-17018,8319
	Trading	-64977,273*	11534,38	,000	-100225,0645	-29729,4810
	Others	11711,039	13554,50	,989	-29710,0265	53132,1044
Livestock rearing	NTFP gathering	-33280,027	13576,88	,222	-74769,4639	8209,4099
	Fishing	12399,529	13781,17	,986	-29714,2053	54513,2634
	Farning	-45176,179*	13474,82	,020	-86353,7507	-3998,6066
	Hunting	-15760,490	13944,39	,950	-58372,9919	26852,0128
	Paid labour	-91525,641*	21801,66	,001	-158149,0919	-24902,1901
	Trading	-80737,762*	15452,94	,000	-127960,2247	-33515,2997
	Others	-4049,4505	17013,99	1,000	-56042,3232	47943,4221
Paid labour	NTFP gathering	58245,614*	18959,08	,048	308,7684	116182,4597
	Fishing	103925,17*	19105,91	,000	45539,6297	162310,7105
	Farming	46349,462	18886,13	,220	-11364,4627	104063,3874
	Hunting	75765,152*	19223,97	,003	17018,8319	134511,4711
	Livestock rearing	91525,641*	21801,66	,001	24902,1901	158149,0919
	Trading	10787,879	20344,73	,999	-51383,3820	72959,1396
	Others	87476,190*	21554,37	,002	21608,4176	153343,9634
Trading	NTFP gathering	47457,735*	11087,27	,001	13576,2530	81339,2175
	Fishing	93137,291*	11336,52	,000	58494,1377	127780,4448
	Farming	35561,584*	10962,07	,029	2062,7193	69060,4478
	Hunting	64977,273*	11534,38	,000	29729,4810	100225,0645
	Livestock rearing	80737,762*	15452,94	,000	33515,2997	127960,2247
	Paid labour	-10787,879	20344,73	,999	-72959,1396	51383,3820
	Others	76688,312*	15102,05	,000	30538,1192	122838,5042
Others	NTFP gathering	-29230,576	13176,13	,344	-69495,3586	11034,2057
	Fishing	16448,980	13386,54	,923	-24458,7938	57356,7530
	Farming	-41126,728*	13070,94	,038	-81070,0848	-1183,3714
	Hunting	-11711,039	13554,50	,989	-53132,1044	29710,0265
	Livestock rearing	4049,45055	17013,99	1,000	-47943,4221	56042,3232
	Paid labour	-87476,190*	21554,37	,002	-153343,9634	-21608,4176
	Trading	-76688,312*	15102,05	,000	-122838,5042	-30538,1192

* The mean difference is significant at the .05 level.
a. country = Cameroon

Appendix 1b. Tukey test comparing means of non-mining income sources, Central African Republic

Multiple Comparisons[a]

Dependent Variable: amount
Tukey HSD

(I) activity	(J) activity	Mean Difference (I-J)	Std. Error	Sig.	95% Confidence Interval	
					Lower bound	Upper Bound
NTFP gathering	Fishing	-59221,212	31129,34	,326	-146421,3471	27978,9228
	Farming	-98316,614*	27768,97	,006	-176103,6300	-20529,5989
	Hunting	-28287,879	35247,04	,929	-127022,5890	70446,8314
	Livestock rearing	-21504,545	34264,03	,970	-117485,6536	74476,5627
Fishing	NTFP gathering	59221,212	31129,34	,326	-27978,9228	146421,3471
	Farming	-39095,402	24940,60	,523	-108959,5178	30768,7132
	Hunting	30933,333	33064,65	,882	-61688,0348	123554,7015
	Livestock rearing	37716,667	32014,71	,764	-51963,5874	127396,9207
Farming	NTFP gathering	98316,614*	27768,97	,006	20529,5989	176103,6300
	Fishing	39095,402	24940,60	,523	-30768,7132	108959,5178
	Hunting	70028,736	29922,42	,145	-13790,5586	153848,0299
	Livestock rearing	76812,069	28757,99	,069	-3745,3902	157369,5281
Hunting	NTFP gathering	28287,879	35247,04	,929	-70446,8314	127022,5890
	Fishing	-30933,333	33064,65	,882	-123554,7015	61688,0348
	Farming	-70028,736	29922,42	,145	-153848,0299	13790,5586
	Livestock rearing	6783,33333	36031,371	,000	-94148,4626	107715,1293
Livestock rearing	NTFP gathering	21504,545	34264,03	,970	-74476,5627	117485,6536
	Fishing	-37716,667	32014,71	,764	-127396,9207	51963,5874
	Farning	-76812,069	28757,99	,069	-157369,5281	3745,3902
	Hunting	-6783,3333	36031,371	,000	-107715,1293	94148,4626

* The mean difference is significant at the .05 level.
a. country = Central African Republic

Appendix 2a. Tukey test for multiple comparison of means of expenditures on basic needs, Cameroon

Multiple Comparisons[a]

Dependent Variable: percent
Tukey HSD

(I) items	(J) items	Mean Difference (I-J)	Std. Error	Sig.	95% Confidence Interval	
					Lower bound	Upper Bound
Education of children	Health, buy drugs	14,22711*	1,87579	,000	8,8595	19,5948
	Informations, radio/TV	16,06283*	2,18273	,000	9,8168	22,3088
	Buy food	-13,69271*	1,83363	,000	-18,9397	-8,4457
	Buy clothes	10,00822*	1,82985	,000	4,7720	15,2444
	Constructions/Others	14,54393*	1,88049	,000	9,1628	19,9250
Health, buy drugs	Education	-14,22711*	1,87579	,000	-19,5948	-8,8595
	Informations, radio/TV	1,835722	,06113	,949	-4,0623	7,7337
	Buy food	-27,91982*	1,68705	,000	-32,7474	-23,0922
	Buy clothes	-4,21889	1,68294	,124	-9,0347	,5969
	Constructions/Others	,316831	,737871	,000	-4,6562	5,2898
Informations, radio/TV	Education of children	-16,06283*	2,18273	,000	-22,3088	-9,8168
	Health, buy drugs	-1,83572	2,06113	,949	-7,7337	4,0623
	Buy food	-29,75554*	2,02284	,000	-35,5440	-23,9671
	Buy clothes	-6,05462*	2,01941	,034	-11,8332	-,2760
	Constructions/Others	-1,51890	2,06541	,977	-7,4292	4,3914
Buy food	Education of children	13,69271*	1,83363	,000	8,4457	18,9397
	Health, buy drugs	27,91982*	1,68705	,000	23,0922	32,7474
	Informations, radio/TV	29,75554*	2,02284	,000	23,9671	35,5440
	Buy clothes	23,70092*	1,63582	,000	19,0200	28,3819
	Constructions/Others	28,23664*	1,69228	,000	23,3941	33,0792
Buy clothes	Education of children	-10,00822*	1,82985	,000	-15,2444	-4,7720
	Health, buy drugs	4,21889	1,68294	,124	-,5969	9,0347
	Informations, radio/TV	6,05462*	2,01941	,034	,2760	11,8332
	Buy food	-23,70092*	1,63582	,000	-28,3819	-19,0200
	Constructions/Others	4,53572	1,68818	,080	-,2951	9,3665
Constructions/Others	Education of children	-14,54393*	1,88049	,000	-19,9250	-9,1628
	Health, buy drugs	-,31683	1,73787	1,000	-5,2898	4,6562
	Informations, radio/TV	1,51890	2,06541	,977	-4,3914	7,4292
	Buy food	-28,23664*	1,69228	,000	-33,0792	-23,3941
	Buy clothes	-4,53572	1,68818	,080	-9,3665	,2951

* The mean difference is significant at the .05 level.
a. country = Cameroon

Appendix 2b. Tukey test for multiple comparison of means of expenditures on basic needs, CAR

Multiple Comparisons[a]

Dependent Variable: percent
Tukey HSD

(I) items	(J) items	Mean Difference (I-J)	Std. Error	Sig.	95% Confidence Interval	
					Lower bound	Upper Bound
Education of children	Health, buy drugs	7,46999	3,45705	,263	-2,5205	17,4605
	Informations, radio/TV	7,63300	4,62388	,567	-5,7295	20,9954
	Buy food	-25,57228*	3,40286	,000	-35,4061	-15,7384
	Buy clothes	-1,12067	3,40286	,999	-10,9545	8,7132
	Constructions/Others	1,25231	4,07836	1,000	-10,5336	13,0383
Health, buy drugs	Education	-7,46999	3,45705	,263	-17,4605	2,5205
	Informations, radio/TV	,16301	4,577491	,000	-13,0654	13,3914
	Buy food	-33,04227*	3,33956	,000	-42,6932	-23,3914
	Buy clothes	-8,59066	3,33956	,111	-18,2416	1,0603
	Constructions/Others	-6,21767	4,02569	,636	-17,8514	5,4161
Informations, radio/TV	Education of children	-7,63300	4,62388	,567	-20,9954	5,7295
	Health, buy drugs	-,16301	4,57749	1,000	-13,3914	13,0654
	Buy food	-33,20528*	4,53671	,000	-46,3158	-20,0948
	Buy clothes	-8,75367	4,53671	,389	-21,8642	4,3569
	Constructions/Others	-6,38068	5,06313	,806	-21,0125	8,2511
Buy food	Education of children	25,57228*	3,40286	,000	15,7384	35,4061
	Health, buy drugs	33,04227*	3,33956	,000	23,3914	42,6932
	Informations, radio/TV	33,20528*	4,53671	,000	20,0948	46,3158
	Buy clothes	24,45161*	3,28343	,000	14,9629	33,9403
	Constructions/Others	26,82460*	3,97925	,000	15,3251	38,3241
Buy clothes	Education of children	1,12067	3,40286	,999	-8,7132	10,9545
	Health, buy drugs	8,59066	3,33956	,111	-1,0603	18,2416
	Informations, radio/TV	8,75367	4,53671	,389	-4,3569	21,8642
	Buy food	-24,45161*	3,28343	,000	-33,9403	-14,9629
	Constructions/Others	2,37298	3,97925	,991	-9,1266	13,8725
Constructions/Others	Education of children	-1,25231	4,078361	,000	-13,0383	10,5336
	Health, buy drugs	6,21767	4,02569	,636	-5,4161	17,8514
	Informations, radio/TV	6,38068	5,06313	,806	-8,2511	21,0125
	Buy food	-26,82460*	3,97925	,000	-38,3241	-15,3251
	Buy clothes	-2,37298	3,97925	,991	-13,8725	9,1266

* The mean difference is significant at the .05 level.
a. country = Central African Republic

Appendix 3. Resource persons contacted August 2008 – February 2009

Contacts	Organisation	Address
Senior Divisional Officer		Sangha Mbaere Division
Divisional officer	SDO	Ouesso, Congo
Divisional officer	SDO	Nola, Central African Republic
First Assistant	ASDO I	Yokadouma, Cameroon
Ntep Gweth Paul	CAPAM Yaounde	Coordinator Yaounde Tel: 99641821
Fobisin Godlove	MINEP Yaounde	Chief of Service Training and Partnership. Email: fabsisingoddy@yahoo.com
Emanga Emanga	MINEP	Delegate of MINEP, Boumba et Ngoko Division Tel: 96166355 / 79426499. Email: emangas2001@yahoo.fr
Lahandi Yetnang Prosper	MINIMIDT Yokadouma	Delegate of MINES, MINIMIDT, Boumba et Ngoko Division Tel: 99824145
Amougou Victor	CEFAID	Coordinator, Tel: 99290212 Email: cefaid@yahoo.fr
Louis Defo	WWF	WWF-Jengi, Yokadouma B.P: 6776 Yaoundé ; Tel: 99 93 09 69 Email: ldefo@wwfcarpo.org
Zackary Nzooh	WWF	WWF-Jengi, Yokadouma
Albert Mounga Abana	MINFOF	Conservator, Lobeke National Park. Tel: 96197727
Bilandi Marot Jean-Baptiste	MINFOF	Ecogarde Lobeke Naional park, Forestry and Wildlife Office, Kika
Alfred Bagueka Assobo	MINIFI Yaounde	EITI National Coordinator Tel: 9913615 Email: abaguekaassobo@yahoo.fr
Kamis Ami	GTZ-Bayanga	Responsable programme socio-economique, PDS/ GTZEmail: kamissami@yahoo.fr
Philippe Roth	GTZ-Bayanga	Yedaki76@web.de
Bruno Brachka	WCS-Bayanga	Email: brunobrachka2005@yahoo.fr
Mathias Heinze	GTZ-Bayanga	Coordinator, Email: matsheinze@aol.com
Ngwerium Japhael.		
SEMBOUNG Bertrant	MINEP / DDBN	MINEP, Boumba and Ngoko Division. Tel: 96144964 Email:semboungbertrant@yahoo.fr
Lahandi Yetnang Prosper	MINEP	Divisional Delegate of Environment
Ali Lavabandi	Chief	Ngola Village
Singa Barthelemy		
	Chief	Nguingueli
	Chief	Zega
Mondigi Pierre	Chief	Mboy
Kondji Appolinaire	CES representative	Mboy
Modigui Keneye Guy Simplice	President of Federation	FEDAMINE-Mobilong, Mboy
Emanga Emanga	Federation of miners FEDAMINE	FEDAMINE, President
Moupen Joseph	CAPAM Delegate	Mboy
Djenda Eloi K.	Rural counsellor	Mouloundou Rural Council
Ngwerium Japhael	Coordinator	GIC/MINEUR de Boumba, Kika
Albert Mounga Abana;	MINIMIDT	Divisional Delegate of Mines
Ayessi Joseph	MINIMIDT	Department of Mines

Appendix 4. Miners Questionnaire

Research Questionnaire

This questionnaire is to elicit information on the problems, functioning and prospects of artisan mining arrangements. Feel free to express your feelings and ideas. Your opinion may go a long way to providing solutions that meet the future needs for an equitable and environmentally friendly small-scale mining sector. Ideally, all artisan miners would have equitable access to natural resources in an organised marketing system.

Section I: Biodata of Respondent

1) Country	☐	1=Cameroon, 2=CAR, 3=Congo
2) Village	☐	1=Zega, 2=Mboy, 3=Nguenguili, 4=Ngola
3) Chantier	☐☐	1=Cola, 2=Bandengue, 3=Ngola, 4=Mobilong, 5=Houho, 6=Johvah Jire, 7=Mokopaka, 8=Bougoli, 9=Boto, 10=Motokobilo, 11=Mabauli, 12=Nompenda, 13=Papam, 14=Montsombe, 15=Lingui, 16=Momekok, 17=Kolongo
4) Mineral mined	☐	1=Gold, 2=Diamond
5) Mining type	☐	1=Digger, 2=Diver
6)Miner's name		
7) Gender		1=Male, 2=Female
8) Number of children	☐	
9) Age	☐☐	
10) Ethnic group	☐☐ ☐☐	1=Banda, 2=Bamoun, 3=Bassa, 4=Manzah, 5=Kako, 6=Bimo, 7=Mezimi, 8=Ngondi, 9=Bangando, 10=Mpiemo, 11=Ngombe, 12=Yakoma, 13=Foulbe/Haousa, 14=Bakare, 15=Beti, 16=Bambara, 17=Bororo, 18=Voko, 19=Baya, 20=Baka, 21=Mvongmvong, 22=Badjoue, 23=Ashanti, 24=Yamba, 25=Baaka, 26=Bilo, 27=Sangha-Sangha, 28=Bossangoa, 29=Bogongo, 30=Baya
11) Education	☐	0=No formal education/SIL/CP/CE1, 1=Primary (CE2,CM1,CM2), 2=Secondary, 3=High school, 4=University
12) Marital status	☐	1=Married, 2=Single, 3=Divorced, 4=Widowed
13) Number of wives	☐	
14) Total number of dependents	☐☐	
14) Number of years as miner	☐☐	
15) Nationality	☐	1=Cameroonian, 2=CAR, 3=Congolese, 4=Ghanaian, 5=Malian
16) Occupation as miner	☐	1=Full-time, 2=Part-time

Section II: Mining Activity

1) Is mining your principal activity?	☐	1=Yes, 2=No
2) Who initiated you into mining?	☐	1=Parent, 2=Local friend, 3=Outsiders
3) How long have you been mining?	☐☐	
4) Do you work for yourself?	☐	1=Yes, 2=No (if yes, go to 6)
5) If no, whom are you working for?	☐	1=Parent, 2=Friend, 3=Sponsor
6) Where do you normally do your mining?	☐	1=Inside the reserve, 2=Outside the reserve, 3=Both
7) How many workers assist you?	☐☐	
7.1) Family labourers	☐☐	
7.2) Hired labourers	☐☐	
7.3) Children (less than 15 years old)	☐☐	
7.4) Adults	☐☐	
7.5) Men	☐☐	
7.6) Women	☐☐	
8) How many trips do you make to the mining site per month?	☐☐	
9) What quantity of gold/diamonds do you typically get per trip?	☐☐	
10) Where do your buyers come from?	☐	1= Within the village, 2= From the town/city, 3= From other villages
10.1) If town/city, specify its name	☐	1=Kika, 2=Yokadouma, 3=Nola, 4=Salo, 5=Yaounde
11) On average how much do you spend per month to get your minerals to the market?	☐☐☐☐☐	
12) On average how much do you earn per month from selling your minerals?	☐☐☐☐☐☐	
13) Does anybody ever disturb you when mining?	☐	1=Yes, 2=No
13.1) If yes, who does it?	☐	1=Government agent, 2=Conservation agent, 3=Individual buyer/collector
14) What is usually your reaction?	☐	1=Run away, 2=Bribe them, 3=Speak to them angrily, 4=Do nothing, 5=Show legal papers
15) Availability of minerals	☐	1=All seasons, 2=Dry season, 3=Rainy season
16) How do you foresee mining in the next 10-20 years?	☐	1=Better, 2=Same, 3=Worse
17) Distance to mining area (km)	☐☐	
18) Main means of transport	☐	1=By foot, 2=By car/canoe, 3=By motorbike
19) Source of capital	☐	1=Self-financed, 2= Village sponsor, 3= External sponsor, 4= Borrowed money

20) Specify amount you pay and lifespan of the following items		
Item	Amount / Price	Lifespan
Pele		
Polyane		
Bate/tamis		
Baramine		
Canoe		
Matchet		
Pots		
Gicque		
Motorised pump		
Food		
Medicines		
Bucket/plates/bidon		

Section III: Functioning of Market

1) To whom do you sell?	☐	1=Individual collector, 2=Organisation, 3=Sponsor
2) and where?	☐	1=In the village, 2=In town/city, 3=In another village
3) Current price per unit	☐☐	
4) Price per unit 5 years ago	☐☐	
5) What was your capital when you started business?	☐☐☐☐☐☐	
6) And what is it now?	☐☐☐☐☐☐	
7) How do you transport your mineral to market?	☐	1=By foot, 2=By car/canoe, 3=By motorbike
8) What is your transport cost?	☐☐☐☐	
9) If you hire a labourer, how much do you pay per day?	☐☐☐☐	
10) What problems do you face in transit?	☐	1=Government agent, 2=Conservation agent, 3=Thieves/robbers, 4=No problem
11) Do you pay any tax?	☐	1=Yes, 2=No
11.1) If yes, what type of tax?	☐	1=Labourers' tax, 2=Head of chantier's tax, 3=Collector tax
11.2) And how much?	☐☐☐☐☐☐	
12) How many selling trips do you make per month?	☐☐	
13) Market organisation: How do you sell the product? Do you pay any tax?	☐	1=Individually, 2=Group, 3=Cooperative
14) About how much profit do you currently make per month?	☐☐☐☐☐☐	
15) How much did you make per month in the past?	☐☐☐☐☐☐	
16) How does the present situation compare to the past?	☐	1=Better, 2=Worse, 3=Same
17) What are the reasons responsible for an increase/decrease in the profits you make?	☐☐☐	1=More experience, 2=Good price, 3=Help from family/hired labourer, 4=New site discovered, 5=Fall in price, 6=Gov't suspension/no sales office, 7=Impoverishment of site, 8=Mishaps, 9=Lack of materials, 10=Fetish/sacrifice, 11=New materials bought, 12=Overexploitation

Section IV: Conservation of Environment

1) Have you ever thought that one day these minerals could be exhausted?	☐	1=Yes, 2=No
2) Are you getting more gold/diamonds now than 5-10 years ago?	☐	1=More, 2=Less, 3=The same as before
3) What do you think is the reason for the increase or decrease?	☐☐☐	1=Increasing income, 2=Decreasing income, 3=Confrontation with agencies, 4=More support from gov't agencies, 5=Lack of support, 6= Fetish/ sacrifice, 7=Impoverishment of site, 8= New materials bought/new site, 9=Too much water and rain, 10= Help from family/hired labour, 11=Have more experience, 12=No buyers
4) How do you see the mining business in the next 10-20 years?	☐	1=Better, 2=Same, 3=Worse
5) Do you think mining has some negative environmental impacts?	☐	1=Yes, 2=No
6) If 'Yes', please tick possible impacts	☐☐☐	1= Water contamination, 2= Air contamination, 3= biodiversity loss, 4= Soil contamination, 5= Open mines
7) How do you protect yourself from harmful elements, such as wild animals or falling branches?	☐	1=No protection, 2=Build strong hut, 3=Use mosquito net
8) How do you treat yourself when sick?	☐	1= Drug store, 2= Forest herbs, 3=Both
9) Do you use cyanide or mercury in your extraction activities?	☐	1= Yes, 2= No
10) If yes, explain how you protect yourself	☐	

Section V: Processing of Minerals

1) In what form do you sell your gold/diamonds?	☐	1=Cleaned/polished, 2= Unprocessed
2) How do you process your mineral? Briefly describe	☐	
3) List the equipment you use		
4) Do you think the equipment is good enough for your activity?	☐	1= Yes, 2= No
5) If no, list other equipment you know could be more efficient	☐	
6) Have you always used the same extraction or processing methods, or have they changed?	☐	1=Changed, 2=Same
7) If they have changed, what are some of the reasons for the change?	☐☐☐	1=Gov't/sponsor support, 2=Conservation support, 3= Increase in capital, 4= Outside sponsor

Section VI: Alternatives to Mining

1) Apart from the sale of minerals. is there any other work you do? ☐ 1=Yes, 2= No

2) If yes, what other activities do you do apart from mining? About how much do you earn from each activity per week, per month or per year?

Gathering NTFPs
Fishing
Farming
Hunting
Raising livestock
Paid labour
Trading
Other

3) According to you what is the best alternative activity to mining: ☐ 1= Gathering NTFPs, 2= Fishing, 3= Farming, 4= Hunting, 5= Raising livestock, 6= Paid labour, 7= Trading, 8= Other

4) Has money from gold/diamond sales helped you achieve any of the following?

Item	Mark each applicable item	Proportion used*	Remarks
Education of children			
Health, buy medicine			
Information, buy radio/TV			
Buy food			
Buy clothes			
House construction			

Use ten stones to represent the total amount of money from gold/diamonds that you spend per month and divide it among the items listed above.

Section VII: Problems and opportunities associated with mining (production, processing, trade, legal)

1) In your own opinion, what are the major problems faced in mining?	☐☐☐	1=Low production, 2=Harsh government law, 3=Lack of detecting/exploiting equipment, 4=Fall in prices, 5=Lack of organisation, 6=Closure of buying offices, 7=Lack of capital
2) How do you think these problems can be resolved?	☐☐☐	1=Assistance to get working materials, 2=All miners should have legal papers, 3=Assistance to get legal papers/materials, 4=Open sales office in village, 5=Train in modern mining techniques, 6=Stabilize prices, 7=Create cooperative
3) What do you think the government can do to solve these problems?	☐☐☐	1=Sensitise miners on code, 2=Reduce cost of mining papers, 3=Assist miners to get legal papers/materials, 4=Open transparent sales office in village, 5=Train in modern mining techniques, 6=Stabilize prices, 7=Create cooperative
4) Are there national laws that govern mining practices?	☐	1=Yes, 2= No, 3=Unaware
5) If there are laws, are they properly enforced?	☐	1=Yes, 2= No, 3= I don't know
6) What kinds of government support or programs are available for you as a miner in the formal sector?	☐	1= Education, 2= Technical training, 3= Exploration equipment, 4= Marketing of products, 5= No support
7) Is it easy to obtain all government papers for mining operations?	☐	1=Yes, 2= No
8) If 'Yes', do you have legal mining documents?	☐	1=Yes, 2= No
9) If you have legal papers, what are the benefits you receive from having them?	☐	1=Freedom to exploit and sell, 2=Support from government, 3=Support from conservation agencies, 4=No benefits
10) Who have been the leaders of efforts to improve the gold mining sector?	☐	1=Government, 2=Development agencies, 3=Conservation agencies, 4=Individual sponsors, 5=No improvements
11) Is there any other information you would like to share with me today?		

Appendix 5. Organisations and Partners Questionnaire

Research Questionnaire

This questionnaire is to elicit information on the problems, functioning and prospects of artisan mining arrangements in the Sangha region. Feel free to express your feelings and ideas. Your opinion may go a long way to providing solutions that meet the future needs for an environmentally sustainable and socio-economically equitable small-scale mining sector. Ideally, all artisan miners would be more environmentally responsible and have equitable access to natural resources in an organised marketing system.

Section I
1). Organisation…… 2). Country segment…… 3). Mineral mined……

Section II
Problems and Possibilities Associated with Production & Trade of Minerals

3). In your own opinion, what are the major problems/obstacles faced in artisan mining (social, economic, environmental, legal/regulatory, institutional, technical)?
……
……

4). How do you think these problems can be resolved? ……
……
……...

5). What do you think the government can do to help solve these problems? ……
……
……

6). Your experience in the gold/diamond mining sector: high, low, medium

7). Do you know any projects or programs that have helped the ASM sector to become more efficient socially and environmentally? Yes…… or No……..

8). If 'Yes' to question 7, please list the projects and their contributions
……
……..

9). Are these projects/programs effective? Please explain how: ……
……
……

10. What local measures are used to encourage/enforce efficient mining? ……
……
……

11. What equipment do local miners use?……
……

12. Is there a clear government policy for the ASM sector, or are small-scale miners incorporated into the formal sector? a)Yes…… b) No……

13. Briefly explain how miners are organised ……
……
……

14. Do you think miners are conscious of the negative impacts of their activities? How has this process evolved?
……
……

15. Are legislation and regulations effective in the small-scale mining sector? What is your opinion about the application of existing laws? ……
……

16. Are regulations being properly enforced? Yes…… No……

17. Which actors drive possible improvements in the mining sector? ……
……

18. If 'Yes' to question 12, what type of support, education, or incentives have miners received after incorporation?

19. What entails a successful formalisation of the artisanal mining sector? ……
……

20. What are the necessary conditions for achieving success? ……
……

21. What is your long-term vision for a sustainable artisanal and small-scale mining sector? ……
……
……

22. Suggestions to other people who want to formalise and improve the artisanal and small-scale mining sector in other communities or other countries in the region and beyond? ……
……
……

23. Are thereviable alternative livelihoods for miners? Are they being sought out? ……
……

24. Can you share statistics pertaining to the artisanal and small-scale mining? ……
……

25. Is there any other information you would like to share with me today? ……
……
……

26. Please, tick the possible environmental impacts of small scale mining
a) biodiversity loss …… b) water pollution …… c) disruption of logging …… d) soil depression ……
e) air pollution …… f). other (please specify ……)

Appendix 6. Terms of Reference

LLS CIFOR-IUCN Impacts of artisanal gold and diamond mining on livelihoods and the environment in the Sangha Tri-National Park (TNS), Congo Basin

Aim
Research the impacts of artisanal gold and diamond mining on livelihoods and the environment in the Sangha Tri-National Park (TNS) areas, as part of the IUCN-led LLS « Programme Paysages et Moyens d'Existence de l'UICN- PACO » whose aim is to « Contribuer à la gestion durable du paysage et à la réduction de la pauvreté à travers la mise en œuvre des activités de LLS dans le Tri-national de la Sangha (TNS) ».

Time scale
2.5 months; 10 October – 31 December 2008

Methodology
In consultation with the CIFOR team leader:
- Literature review of artisanal and large-scale mining permits and impacts in zone approx 50 km wide bordering the TNS area
- Field visits (each country) to current mines
- Guidelines for developing interview questionnaires (input from focus groups and individuals)
- Consultation meetings with local stakeholders in all three TNS countries (communities, miners/ government, local administration, TNS park officials, etc)
- Consultation with stakeholders (national government in Cameroon, World Bank, international environmental/mining/conservation organisations, NGOs, etc)
- Reporting (draft for comments within CIFOR and to IUCN, followed by final)

Activities
- Literature review Case studies to be referred to: Zega & Mboy II in Cameroon; Nguenguili & Nola in CAR; and Souanké in Congo
- Plan and conduct field visits (Cameroon, DRC, CAR), working closely with partners and wherever possible using their assistance
- Guidelines for developing interview questionnaires (input from focus groups and individuals)
- Consultation meetings with local stakeholders in all three TNS countries (communities, miners/ government, local administration, TNS park officials, etc)
- stakeholders Consultation (national government in Cameroon, World Bank, international environmental/ mining/conservation organisations, NGOs, etc)
- Reporting

Indicators
- number of villagers and networks involved, and their profiles, are defined,
- income generated by locals is estimated
- exploitation areas are mapped
- environmental and livelihood considerations are better understood.

Partners
World Bank
TNS partners – particularly WWF, GTZ and Wildlife Conservation Society (WCS), CED for local transport arrangements
Local NGOs
Extractive Industries Transparency International (EITI)
Local miners and authorities

Output Verifications

- List of partners and stakeholders identified and contacts made (provided in Annexes)
- Typology of actors specified
- Guidelines for developing interview questionnaires (input from focus groups and individuals) in consultation with CIFOR team leader
- Baseline quantitative information is generated about:
  - Location (mapping), number, type of current artisanal mines in the TNS area
  - Socio-economic baseline information: Name and number of communities involved, numbers of people directly and indirectly employed (detailing gender, ethnicity, age and occupations) and average monthly and annual incomes (detailing % of average incomes, frequency and reliability) PSM=Professional stranger methodology to be adopted with locals
  - Mapping of location, number, type of proposed or potential artisanal and large-scale mines in the TNS area
  - Assessment of current direct and cumulative environmental and social (livelihood) impacts from small-scale and large-scale mining in TNS Park (from community and stakeholder reports, observation and assessment)
  - Prediction of future direct and cumulative environmental and social (livelihood) impacts
  - Recommendation for mitigation measures, actions/points of attention
- Draft Table of Contents (consultation with the CIFOR team leader)
- Draft report
- Incorporation of comments from stakeholders and LLS partners, particularly IUCN
- Final Report

Center for International Forestry Research

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