

**Volume E –
Executive Summary
Conclusion**

FINAL REPORT

RioTinto

Social and Environmental Baseline Study

Simandou Project – Mine Component



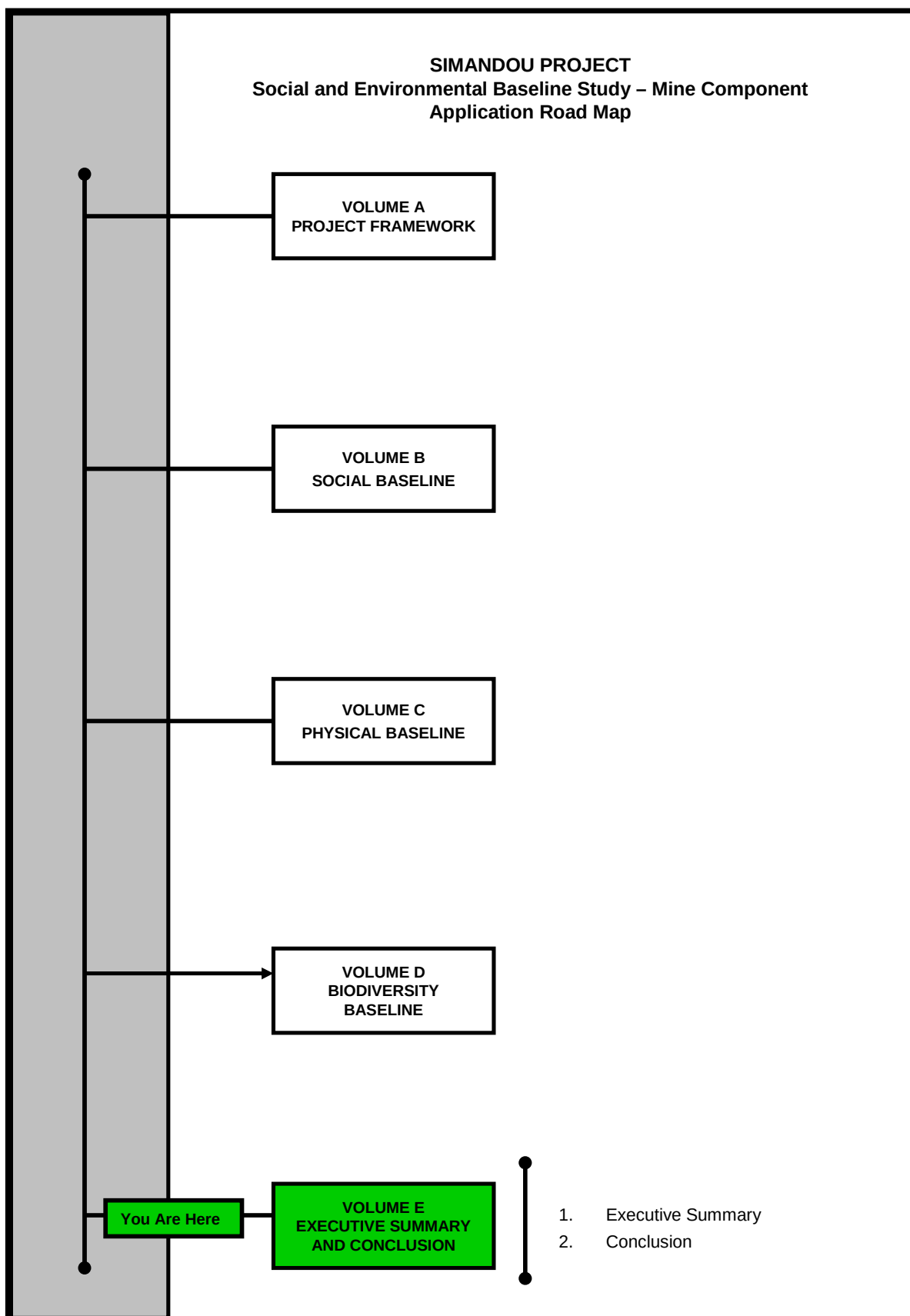
Project No.: 604917

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**SNC•LAVALIN
Environment**

REPORT ROAD MAP



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EXECUTIVE SUMMARY

Social and Environmental Baseline Study Simandou Project

1. PROJECT FRAMEWORK

1.1 PROJECT INTRODUCTION

Rio Tinto is currently carrying out an advanced exploration programme and project development studies on the Simandou Project, a large iron ore deposit located in the southern portion of the Simandou mountain range in the southeastern part of Guinea. It is within the context of the project development studies that an extensive Social and Environmental Baseline Study (SEBS) has been conducted for the mine component of the Simandou Project.

The Simandou Project includes three components:

- i) the mine site: the infrastructure required to operate the iron ore mine in the Simandou Range;
- ii) the port area: a deepwater port on the coast south of Conakry in the Forécariah Prefecture; and
- iii) the railway corridor: a Trans-Guinean railway to transport the ore from the concession to the Guinea coast.

The present SEBS concentrates on the mining concession of the Simandou Project located in

Forest Guinea region and on the southern end of the Simandou Range within the Pic de Fon Classified Forest (PdF CF). The concession is owned by Simfer S.A. a Guinean registered company owned at 95% by Rio Tinto, with the remaining 5% share owned by the International Finance Corporation (IFC).

Under the Mining Convention (a signed mining agreement between the Guinean Government and Simfer S.A.), the Government of Guinea has the option to acquire up to 20% of the share capital of Simfer S.A. at a commercial rate when a development decision is taken.

Project History - The high potential of the Simandou iron ore deposit was discovered in the 1950s. It is in 1996 that Rio Tinto was introduced to the project, and one year later, in 1997, that it was granted an exploration licence. The Simandou mining agreement between the Guinean Government and Simfer S.A., which includes terms and conditions for mining within the concession, was signed in February 2003, and the associated mining concession was granted in March 2006.

The work carried out so far within the mining concession includes an extensive exploration programme, the project engineering studies,

Location of the Simandou Project components



some social and environmental impact assessment for early works, the current SEBS and the ongoing implementation of Rio Tinto's Public Consultation and Disclosure Strategy (PCDS).

Drilling platforms on Pic de Fon



Rio Tinto

This executive summary provides an overview of the global SEBS carried out at mine site. It summarises the five volumes of the study, which include:

- Project Framework (Volume A)
- Social Baseline (Volume B)
- Physical Baseline (Volume C)
- Biodiversity Baseline (Volume D)
- The present Executive Summary and Conclusion (Volume E)

1.2 PROJECT DEFINITION

Since the outset of the project in 1997, many conceptual studies were carried out in order to determine the best strategic directions to adopt for the project development. Further to these studies one base case option was considered. The main features of the base case (or mine design) are:

- The ore resource consists of more than 2 billion tonnes in the two major deposits in the concession: Pic de Fon and Ouéléba.
- Mine plans and designs are based on a 70-95 Mtpa saleable ore product operation. Life mine is expected to be in excess of 30 years.
- The mining operation will involve conventional open-pit mining consisting of

drill, blast, load and haul methods with variations.

- A single sinter fines product of 10 mm will be achieved by means of a three-stage dry crushing and screening plant located at the mine site.
- There will be a primary crushing operation at the two mining areas.
- Ore will be conveyed overland from the edge-of-pits to processing facilities downhill at the secondary/tertiary crushing and screening plant.
- Waste, blend ore and low-grade materials will be trucked to dump and stockpile locations. The blend and low-grade will be stored in a manner that allows for future recovery and beneficiation.
- There will be conveyors to move the ore from the mine plant to the live stockyard area at the train load-out systems.
- Power requirements at mine site are 40-MW. Regenerative conveyors from the edge-of-pits to processing facilities downhill will contribute to this power demand.

The mine development comprises three distinct phases: i) the construction phase; ii) the operational phase; and iii) the closure phase.

Drilling rig on Pic de Fon



Rio Tinto

Construction Phase - The sequence of activities for the construction phase include: topsoil removal; access road construction; pre-stripping of the deposits; commissioning of the overland conveyor; early works associated with facilities, services and infrastructure; early works associated with water and

sedimentation control and treatment; and dump and stockpile base preparation.

Operational Phase – A strategic plan will be developed to provide direction for the sequence in which the Pic de Fon and Ouéléba deposits should be mined to optimize the resource and meet target quality parameters. The mining operations sequence includes: drilling and blasting; water management; primary crushing and conveying; ore processing; ore conveying, stockpiling and train load-out. Life of the mine is assumed to be in excess of 30 years.

Closure Phase - Once mining is completed, all pumps, pipe work and water management structures will be removed. A passive hydrogeological/hydrological system will be reinstated post mining.

Disturbed areas will be rehabilitated with the top soil removed from the infrastructure footprints during construction phase and revegetated with indigenous or native plant species.

1.3 SOCIAL AND ENVIRONMENTAL BASELINE STUDY (SEBS)

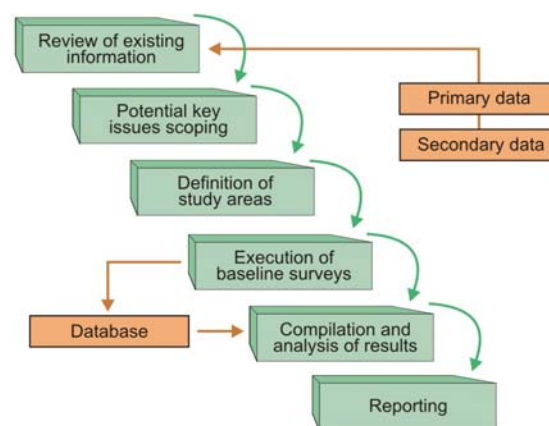
The SEBS report will be used as a reference for producing the project's Social and Environmental Impact Assessment (SEIA) at the Feasibility Stage (FS). Its main objectives are to:

- Identify the social and environmental legal and institutional frameworks applicable to the Simandou Project.
- Provide an overview of the project description in terms of mineable resources, mine base case, development phases, and equipments, infrastructure and utilities.
- Provide a description of the current socio-economic and cultural context and of the physical and biological environment in the project's areas of influence.
- Develop a comprehensive GIS database with all the information gathered during baseline surveys.
- Identify stakeholders who may have an interest in the project or who may be affected by the project at local, national or international levels.

- Identify the project's major findings, main concerns of the various parties affected, socio-economic and environmental issues, and risks and opportunities of the Simandou Project.

The overall general approach to conduct the SEBS included a series of steps, namely the review of existing information, data collection, analyses of results and preparation of a database. The methodological approach and various steps involved in the preparation of the SEBS are summarised in the figure below.

Methodological approach and steps for the SEBS



Since the start of the first exploration campaign in 1997, Rio Tinto has conducted several field investigations as well as a number of social and environmental studies for the purposes of the Simandou Project. These studies were analysed in order to align the scope of the SEBS surveys.

Two project areas of influence were identified for each discipline (social, physical and biodiversity): the Local Study Area (LSA) and the Regional Study Area (RSA). Typically, the LSA is based on the spatial extent of the project's footprint and related facilities as well as on the associated effects on the receiving environment. The RSA is a broader geographic area that allows for a better understanding of human activities and natural factors of the Simandou region.

Comprehensive baseline field surveys were conducted primarily within the project LSA between November 2007 and December 2008. Methods used to collect site-specific data included: interviews with key informants, village consultations and household surveys, sample-gathering programmes, monitoring programmes and comprehensive inventories of plant and wildlife species. In order to

compile and analyse the data collected, databases have been prepared for each discipline.

1.4 SOCIAL AND ENVIRONMENTAL LEGAL FRAMEWORK

The legal framework governing the Simandou Project is primarily defined by the Mining Convention granted by presidential decree in 2002 - and signed in 2003 - to SIMFER S.A., a subsidiary of the Rio Tinto group. The decree has the force of law in Guinea and defines the general and specific conditions related to the exploration and mining of the Simandou iron ore deposits.

However, the Convention takes precedence over the general provisions of Guinean laws including the *Mining Code*. In the Convention, the State has the commitment to provide all permits and authorisations required for the timely execution of the project.

A series of Guinean laws set out the legal, social and environmental frameworks of the project. An essential law is the *Mining Code* which defines the framework for all mining activities in Guinea, including investigating, operating, trade and transformation. The Code indirectly stipulates, among others things, that Guineans must be given priority, preferential treatment for employment if equally qualified for a position.

Parallel to the *Mining Code*, the legal framework is divided in two main categories: i) the Guinean Social Legal Framework; ii) the Guinean Environmental Legal Framework.

The main laws under the Guinean Social Legal Framework include:

- The *Constitution or Fundamental Law*, which protects the rights of ownership in Guinea.
- The *Labour Code*, which provides the legal framework for employment, contracts and working conditions.
- The *Domain and Land Tenure Code*, which further entrenches rights to private ownership of land.
- Other laws included in this category are the *Social Security Code*; the *Decentralisation Law*; the *Pastoral Code*; the *Rural Land Policy*.

The main laws under the Guinean Environmental Legal Framework are divided into two categories: first, the *environmental assessment authorisation process*, and secondly, the main *environmental legislation* applicable to the industrial facilities.

The *environmental assessment authorisation process* includes several presidential decrees and orders all related to the definitions, requirements, processes, methodology and procedures for carrying out an Environmental Impact Assessment (EIA).

The authorisation process includes a public enquiry in which a Review Commissioner is responsible for obtaining relevant comments from stakeholders, the public, the local leaders and the local representatives of the ministries interested or affected by the project. At the end of the 30-day public enquiry, the concerned ministries have 30 days to issue a Joint Ministerial Order (Arrêté) that either grants or refuse authorisation for the project to proceed, and determines the conditions to be met by the Proponents for the protection of the environment. This Ministerial Order is valid for a period of three years from the date of publication.

Guinean environmental legislation includes a series of laws, decrees, codes and regulations that are applicable to the Simandou Project. The most important of these environmental laws are:

- The *Decree 8113 on Pic de Fon Classified Forest* which classifies PdF as a state forest (1953).
- The *Code for Protection and Development of the Environment* which ensures that physical, natural and human environments are protected.
- The *Water Code* which sets out the overall framework for managing water resources.
- The *Forest Code*, designed to protect and develop Guinean forests.
- The *Guinean Biodiversity Policy*, adopted to promote the conservation and sustainable use of biological diversity through various policies and agencies.
- The *Legal and Institutional Framework for Foreign Trade and Investment*, which together with the *Investment Code*, defines the government policies for trade, industrial policy and foreign investment.

- The *Land Acquisition and Compensation Framework*, which tackles the expropriation process (according to the *Land Tenure Code* and the *Mining Code* process), and allows compensation for land owners and occupants.

Guinea is signatory to several environmental conventions, all aimed at protecting biological and human environments.

Rio Tinto endorses and supports several international agreements, in particular the global principles and values of social responsibility. The company is also strongly committed to the concept of sustainable development. This commitment is contained in a statement entitled “The Way We Work”, which ensures that Rio Tinto’s values and best practices are reflected in the day-to-day activities of all employees.

In addition, the Simandou Project complies with Rio Tinto’s corporate policies and guidelines related to:

- Health, Safety, Environmental and Community Policies (HSEC Policies);
- Corporate Standards;
- Communities Standard;
- Environmental Standards;
- Occupational Health Standards;
- Safety Standards;
- Closure Standards;
- Biodiversity Strategy (to reduce project footprints and minimise risk of impacts); and
- Product Stewardship Strategy.

The Republic of Guinea has no standards for discharges and emissions to the environment. In the absence of environmental standard, the Simandou Project will mainly use IFC and World Health Organisation (WHO) guidelines and site-specific criteria to be developed during the engineering phase.

The environmental discharge criteria concern: noise and vibration; water quality and water conservation; soils management; hazardous management and general waste management; energy conservation and greenhouses emissions.

2. SOCIAL BASELINE

2.1 INTRODUCTION

The objective of the Social Baseline Study (SBS) is to describe the social, socio-economic and cultural context of the areas affected by the project, and to identify potential socio-economic issues, potential risks and constraints presented by the Simandou Project.

2.2 STUDY AREAS

The social baseline encompasses the larger regional study area (RSA), but focuses primarily on the social, cultural and economic conditions and issues within the local study area (LSA). The later has been defined based on the latest revised stakeholder analysis undertaken by Rio Tinto – and presented in the 2010 Public Consultation and Disclosure Strategy (PCDS). This analysis re-assesses the levels of impact caused by the project on villages currently affected by the exploration work and those that will be impacted by future mining activities and infrastructure.

It was thus established, based on the PCDS, that the LSA includes the villages having the greatest potential levels of impact, i.e. levels 4 and 5 (5 being the highest and 1 the lowest).

In total, 27 communities surrounding the project site have been designated at levels of impact 4 and 5. They constitute the priority villages covered by the SBS. They include the town of Beyla, considered as a single impacted village, but subdivided into five distinct districts; and, 26 rural villages scattered around the region.

Villages with the highest potential impact (level 5) include the town of Beyla and the villages of Moribadou, Traoréla, and Lamandou. The other priority villages are classified at impact level 4, which also implies a high risk of being directly impacted by the project.

All priority villages are located within the environs of the Pic de Fon Classified Forest (PdF CF). The majority (15 villages or 58%) is situated on the east slope of the Simandou Range and the PdF CF, under the jurisdiction of Beyla Prefecture. The remainder (12 villages or 42%) is located on the west slope of the range in Macenta Prefecture.

In terms of local government, the LSA includes portions of the Urban Commune (*Commune urbaine* – CU) of Beyla and the Rural Development Communities (*Communautés Rurales de Développement* – CRD) of Nionsomoridou in the prefecture of Beyla and Kouankan in the prefecture of Macenta.

Distribution of priority villages in the LSA

Pref.	CU / CRD	No. villages	Pop.
Beyla	CU Beyla Urban area	1 (5 districts)	22,233
	CU Beyla Rural area	8	3,285
	CRD Nionsomoridou	7	8,285
Macenta	CRD Kouankan	11	7,066
Total		27	40,821

Apart from the 27 priority villages, the preparation of the SBS has included village consultations and household surveys in 28 other villages.

2.3 METHODOLOGY

The preparation of the SBS was based on a participatory process, involving government authorities, local populations, community leaders and household members.

The overall methodology relied on five major components:

- Literature review, including compilation and analysis of previous studies conducted within the framework of the Simandou Project and secondary data;
- Field investigation programme, including village consultations and household surveys in affected communities;
- Detailed mapping and land use analysis;
- Development of a social development index; and
- Development of a social baseline database.

Field Investigation Programme - The programme encompassed village consultations and household surveys that were designed to collect data and information on the

current demographic, social and economic conditions in the communities.

The programme was carried out in two phases: the initial fieldwork was conducted in 2007 and additional surveys were carried out in 2009 to ensure complete sets of village and household data for the 26 identified rural priority villages.

In total, 54 villages were surveyed, of which 37 (74%) are located on the east slope of the Simandou Range in Beyla Prefecture, reflecting the greater number of villages and the larger population in this prefecture. The meetings were held mostly with community leaders and elders, using a specifically prepared interview guide.

Households' surveys were also conducted in two phases (2007 and 2009) in 41 villages. A total of 410 households in 26 priority villages and 15 non-priority villages were surveyed by the team of social surveyors, with the help of a special household survey questionnaire. The survey collected the following categories of information, among others: demographic data, economic activities, educational attainment, living conditions, land use and land tenure, agricultural labour, household revenues, livelihood strategies, needs and priorities. Household surveys constitute the basis of information used to develop the social database.

Village meeting



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Mapping and Land Use Analysis - Detailed mapping of land uses and vegetation entails three steps including: i) the preparation of an interpretation key of land use types; ii) photo-interpretation of aerial photographs; and iii) fieldwork for data collection and validation of photo-interpretation.

Social Development Index - A Social Development Index (SDI) is a tool to synthesise an array of data and information about an element (country, region, city or village). Through the use of consistent parameters, which are assessed (using a logical scale) and given a weight, it is possible to measure the level of development in a manner that is objective and enables comparison.

The SDI requires data that are discriminatory to allow the identification of differences among villages. Five parameters based on data collected through the household surveys were chosen, that are closely linked to the features of the LSA: i) the living conditions (housing and equipment); ii) human capabilities (including health and education); iii) levels of wealth (revenue per capita, number of cattle, etc.); and iv) capacity to improve livelihoods (belonging to a founding family, access to market, etc.).

Social Baseline Database - The social database that has been developed integrates all the socio-economic data collected during village consultations and household surveys. It is built using Access software.

2.4 HISTORICAL AND CULTURAL CONTEXT

The Simandou region is situated along several historical trade routes that linked the Sub-Saharan region to the West African coast. The routes were used for transport of various goods including gold, kola nuts (an important trading product in the 14th century), ivory, iron, cloth, arms and slaves.

The intense trading that took place between the 14th and the 18th century brought Malinké and other clans from Mali into the region, who progressively settled alongside with the indigenous peoples. Migratory movements of Peul herders from central Guinea were prompted by the good grazing conditions in Forest Guinea region, leading some Peul to settle permanently in the Simandou area.

The trading alliances between the Malinké and the indigenous groups alternately prospered and faltered over the years, and finally came to an end at about the time that the French established a presence in the Forest Guinea region. Samoury Touré (1878-1898), a native of the Simandou region, was the last of the great leaders and conquerors in the region who established a kingdom that extended from

Niger to Guinea, and who fiercely resisted the colonial power.

Ethnicity and Religious Affiliations - Unlike the rest of the country, where each region has its dominant group, Forest Guinea region is characterised by ethnic diversity, with linkages forged from inter-ethnic marriages and population movements.

The majority group includes the Malinké or Konianké (over the years, the two groups have mingled so highly that they are now considered a single group). Other groups include indigenous groups such as Guerzé, Toma, Kissi, Kono, Mano, Bassari and a small population of Peul, many of whom have inter-married and assimilated with Konianké language and customs.

Among ethnic groups, some people have converted to Christianity while many continue to practice the traditional animism. The majority of the population, however, is Muslim. Nonetheless, animist beliefs and rituals remain important among both Christians and Muslims.

Indigenous People - The populations in the project area do not demonstrate characteristics of “indigenous peoples” as defined by the World Bank (OD 4.20) and the IFC. However understanding and recognising the historical and social context of the ethnic groups living in the region is a key factor in the development of the Simandou Project.

Settlements - The origins, founding families and key lineages are fundamental to understanding the social, cultural and political characteristics of the communities. The role of the founding family or lineage is the foundation of the traditional system of land allocation and management, as well as the social and political structure of villages.

A lineage is traditionally comprised of the people who are descended from the same patriarch, including blood relations, cousins on the father’s side and their children. The patriarch of the founding lineage is the man who settled the village. The founding family claims the entirety of the settled village lands as its property. This property right is passed from generation to generation through the head of the lineage.

There are generally between three and seven key family lineages in rural villages. In urbanising areas, such as Beyla and

Moribadou, however, the number of lineages is increasing. The traditional affiliation based on lineages is also gradually changing due to immigration and urbanisation.

Evolution of Villages - Population within the area has fluctuated over time. Although there are long-term trends that suggest a slow and progressive increase in the size of communities, there were also external shocks - epidemics, natural catastrophies or political upheavals - that have significantly and, often, suddenly reduced the number of people. The Simandou Project, in contrast, is contributing to a sudden increase of population in several communities.

Socio-spatial Organisation of Villages - A village is often sub-divided into different areas, each generally recognised as “belonging” to and occupied by the members of a single lineage.

Spatial organisation of a typical village



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The traditional family concession takes the physical form of a circle of circular huts with an open courtyard in the centre. This courtyard is used by all household members for social and cultural activities such as family councils and various ceremonies, as well as for animal pens and other shared facilities.

Huts serve different purposes for the men and women in the household. In cases of polygamy, each wife has a hut where she and her children will sleep and eat. The head of the household has his hut. Other huts are used for cooking, storing talismans’ or men’s hunting equipment or processing activities.

Traditionally, each village is encircled by a forested area. In addition to being a source of non-timber forest products that form an integral part of people’s livelihoods, these

forests are also places of great social, cultural and religious importance to people.

Cultural Heritage and Sacred Sites - Sacred forests and other natural resources are fundamental to people's social and cultural systems throughout the LSA. There have been varying degrees of integration of the traditional animist practices of indigenous peoples with Islam and Christianity over the years. But, as noted before, animistic beliefs and practices are common in the area.

In forests and fields around villages throughout the area, there are important sites where it is believed various types of spirits live and where important initiation rites are conducted. Altogether, 91 cultural sites have been identified within the LSA, including sacred sites, religious sites, initiation sites (including circumcision and excision sites) and historical sites.

Most communities continue to observe rituals related either with their spiritual beliefs (different types of spirits who co-habit with humans) or to the importance of their agricultural livelihoods. These customs and rituals stem from ancestral traditions and the long history of the region.

Village rituals



N'Zérékoré Forestry Centre

2.5 LOCAL GOVERNANCE

The death of Sekou Touré in 1984 was followed by a military coup that brought an end to the 25 years of socialism in Guinea that followed independence from French colonial rule in 1958. The new Constitution of 1991 established Guinea as a Republic with a civilian president and unicameral legislature, both elected by universal suffrage. Lansana

Conté held the presidency from 1993 up to his death in 2008. The country then entered a period of turmoil with the suspension of the Constitution and the replacement of government civilians by military personnel. The situation was stabilised by the end of 2009 and in early 2010 a new prime minister peacefully took office.

Territorial Organisation - Guinea is divided into seven administrative regions, 33 prefectures and 340 sub-prefectures. The city of Conakry has a special status equivalent to a prefecture. Below the level of the sub-prefecture, the district is the lowest level of territorial structure. In total, across the country, there are 1,700 rural districts and 270 urban districts.

Guinea was the first country in the region to institute a programme of decentralisation in the early 1990's. The decentralisation policies of the Government transferred responsibilities for decision making, finance and management to locally-elected entities. These are Rural Development Communities (*Communautés Rurales de Développement* - CRD) and Urban Communes (*Communes Urbaines* - CU).

Notwithstanding the formal structures of decentralisation, local governance in the rural villages and towns across Guinea and in the LSA stems primarily from traditional customs and political structures.

Administrative Structures - The area encompasses portions of the prefectures of Beyla and Macenta. It encompasses parts of two CRDs, namely Nionsomoridou and Kouankan and the CU of Beyla. The CRDs and CU are composed, respectively, of rural and urban districts. Each rural district is divided into sectors. The sectors are generally inclusive of a village or, as the case may be, a village and its hamlets.

Council of Elders - Each rural and urban district has a Council of Elders. This council is a traditional institution that is legally recognised. People living in the district elect council members from among the respected elders; they are named to the council for indefinite terms. By tradition the Council is headed by the oldest person who is a member of the "generation of the fathers".

The principal responsibility of the Council of Elders is the resolution of intra- and inter-family conflicts; the Council is also involved in

the distribution of land and the preservation and passing on tradition to young generations.

Sectors or Villages - Villages are headed by a Chief (*douti*), whose role is to represent the sector (or village) to higher levels of government administration, i.e., the district, sub-prefecture, etc. He is also charged with responsibilities to carry out an annual census of the village population and to collect taxes in the sector. The sector chief reports to the sector Council of Elders.

Sectors also have their Council of Elders, which bring together the elders in the community and is the primary decision-making body at the village level.

Local Governance Issues - Decentralisation and strengthening of local governance in Guinea has been a slow process and, as yet, one that has not been entirely able to overcome various obstacles. They include, at the central level: resistance to change and inability to transfer funds to meet recurrent costs at the local levels. It is mostly due to the lack of local institutional and organisational capacity of the authorities as well as insufficient budgets and poor management capacity. Low levels of education and literacy contribute to the poor performance of local governments.

2.6 SOCIO-DEMOGRAPHIC PROFILE

Data for the preparation of the socio-demographic profile are primarily based on the village consultations and the household surveys conducted within the affected communities, as well as on studies conducted in the LSA by other consultants.

Population - The 26 rural priority villages have a total population of 18,588, compared with 22,233 for the town of Beyla. The distribution of the population of priority villages is presented in the following table.

Among rural priority villages, Moribadou, Nionsomoridou and Dandano each have populations that range between 2,000 and 4,500 people. The population of Moribadou and Nionsomoridou, in particular, has grown significantly in recent years as a direct result of in-migration of people seeking work or other economic opportunities associated with the project.

The population of the town of Beyla has also grown rapidly in recent years due to the in-migration of population attracted by opportunities associated with the project.

Each of the five urban districts of Beyla has seen significant increases in population, although most newcomers have settled in the district of Kissibou where the population has grown from 470 in 1996 to 4,850 in 2008.

Households Characteristics - The composition of households includes nuclear and extended households, monogamous and polygamous households. The head of the household is the patriarch, the person with responsibility for and authority over the other members of the household. Two-thirds of the surveyed household heads indicated that theirs was a polygamous household.

The average household size is 10 people. In most cases, it encompasses an extended family or clan. In addition to the wives and children of the household head, the household may include his brothers and their wives and children.

The age distribution reflects a young population, with more than 48% of the population under the age of 15. The male/female ratio (1.01) indicates there are slightly more women than men in the population. The dependency ratio is high in most of the priority villages, meaning that there is a large number of dependents in relation to the population of working age people. This, however, is not surprising given the high proportion of children in the area.

During the 1990s, the refugee issue was a major source of economical and political destabilisation in the region. However, the situation has normalised in the past years, especially since 2007 when the refugees that were still in the region either went back to their home country on voluntary repatriation or integrated their local communities and obtained Guinean citizenship. Refugees no longer constitute an issue in the area at the present time.

Population in rural priority villages in the local study area

Prefecture	CU/CRD	District	Village	Population		
				2007	2008	2009
Beyla	CU Beyla	Morisangarédou	Morisangarédou	508	-	
			Kéoulendou	-	-	320
			Piyaro	508	-	-
		Banankoro	Banankoro	458	536	-
			Foma	464	636	-
			Goékoro	172	-	-
			Thia	203	-	-
			Koimoridou	402	-	-
	CRD Nionsomoridou	Nionsomoridou	Nionsomoridou	770	2,132	-
			Wataférédou II	131	279	-
		Yendédou	Traoréla	329	952	-
			Moribadou	768	3,806	-
		Mafindou	Mafindou	229	463	-
			Baladou	-	-	285
Macenta	CRD Kouankan	Banko	Kankoro	128	320	-
			Banko	558	-	-
			Lamandou	195	-	-
			Kotia	-	-	54
			Mandou	222	-	-
			Naouinzou	423	-	-
		Dandano	Tourela	261	-	-
			Orono	85	-	-
			Dandano	4,536	-	-
			Silafarala	225	-	-
		Bonodou	Korela	468	-	-
			Mamouroudou	-	-	39
Total approximate population				18,588		

It is the large in-migration influxes of workers attracted by the economic perspectives of the Simandou Project that now constitute the main source in population increase. The in-migration phenomenon is particularly affecting the town of Beyla and the villages in proximity to the Rio Tinto camps, i.e. the villages of Moribadou and Traoréla, and other villages to a smaller extent.

Education and Literacy - a large proportion of the population has no schooling throughout the area. Very few people reach post-secondary education, proportion varies between less than 1% (Nionsomoridou) to 2.4% (Kouankan).

There are only two secondary schools in the entirety of the LSA, both of which are located in the town of Beyla. School attendance is low, particularly at secondary school, as most children drop out at secondary level. Numerous reasons explain the fact: poverty – families' lack of funds to pay for school fees and other costs; lack of schooling premises and facilities, long walking distances for the children to the nearest school; lack of teachers; dilapidated state of schools and materials; overcrowding in classrooms, which

is widespread throughout the primary and secondary schools.

Financed school canteen from the World Food Programme



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Furthermore, the absence of a primary school in some villages (8 villages out of 26) has favoured religious instruction from the mosque and Islamic schools, over public schools.

Water - Thirty percent (30%) of the villages get their water for domestic uses from surface water sources, i.e. directly from rivers, streams and back waters. There are several watercourses crossing the project area, many

of which have their sources on the Simandou mountain chain. All of these rivers and streams are vital to the well-being and livelihoods of communities that use them, among other purposes: i) to meet household needs (drinking, cooking, washing and bathing); ii) to make bricks to construct housing; iii) to irrigate crops; iv) to water livestock; and v) for fishing.

In terms of access to potable water, most villages do not meet national standards which stipulate that villages accessible by road should be provided with one borehole for every 300-500 inhabitants. In fact, only 33% of the rural population and 27% of the urban population in the region have access to potable water.

In total, 17 out of the 26 rural priority villages, plus the town of Beyla, have access to groundwater. These communities have boreholes, although some have traditional wells or both. In many instances, these facilities are defective or have been abandoned due to malfunction or lack of maintenance. In the remaining rural villages, many communities rely entirely on rivers and streams as their access to water.

Hygiene - The proportions of the surveyed households with access to latrines are 46.6% in the CU of Beyla; 62% in Kouankan CRD; and 64.3% in Nionsomoridou CRD. With regards to solid waste management, most households dispose of their domestic waste around their houses or in forests surrounding the village.

Health - There is a prefectural hospital in the town of Beyla and each of the CU/CRD has a community health centre. The town of Beyla has three health centres.

However, the health coverage is low and does not meet the national standard for district-level integrated health stations; this standard stipulates that districts with populations greater than 3,000 people and located more than 10 km from the sub-prefecture community health centre should have an integrated health station.

Only three villages have an integrated health station: Moribadou (CRD Nionsomoridou), and Dandano and Naouinzou (CRD Kouankan). For these CRDs, the number of inhabitants per health center and/or health station is between 7,000 to 15,000 inhabitants. In addition, the existing health facilities are under-equipped

and suffer from lack of medication and trained personnel.

The main causes for medical consultations, in order of importance, are malaria, respiratory infections, diarrhoeal diseases and bilharzias. Among children, the most common illnesses are parasitic and diarrhoeal ailments and malaria, mainly caused by poverty, lack of food hygiene and limited financial resources of households. Traditional medicine is still very popular; one-third to one-half of people prefers to consult a traditional healer.

Living Conditions - Typically, a village is a small agglomeration of family concessions surrounded by forest land and scattered plantations. Each concession is a grouping of traditional mud-brick round huts with thatch roofs, sometimes supplemented with rectangular houses with tin roofs. Within a concession, several huts are arranged around a central courtyard. This is the most common form of housing in the priority villages.

Typical Guinean mud hut



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In the town of Beyla, 15% of households live in cement houses. In rural priority villages, durable house structures are increasingly being built in villages such as Traoréla, Nionsomoridou, Wataférédou, Moribadou and Banko.

The number of persons per dwelling is on average 1.94 for the CU of Beyla, 2.5 for the CRD of Nionsomoridou and 2.6 for the CRD of Kouankan. However, overcrowding occurs in the town of Beyla where, on average, there are 4.1 persons per dwelling.

In general, most households have very few durable goods. Access to electricity is very restricted and limited to 20% of all households. In rural villages, firewood is the main source of

domestic energy for cooking, heating and transformation of certain products (e.g. blacksmithing). For lighting, people use kerosene or other lamp oils. In the town of Beyla, 19% of households have access to electricity.

Poverty Incidence - Poverty incidence in Guinea is higher among agricultural households. In rural areas, where most households rely on subsistence agriculture and where most of them live in a state of destitution, the poverty incidence is high.

In Beyla Prefecture, the proportion of people living in poverty is higher compared with Macenta Prefecture. At the level of CU/CRD, the poverty level is lower in the CU of Beyla, as a result of the urban area of the town of Beyla, compared with the predominantly rural character of the CRDs of Nionsomoridou and Kouankan.

The causes of poverty are multiple and complex. They are reflected in the socio-demographic characteristics of the LSA. They include the lack of hygiene and the poor health status of the population, high rates of illiteracy, rudimentary housing and the lack of modern productive tools. Causes of poverty identified by the households are often linked to low agricultural techniques and lack of farming production means.

Furthermore, remoteness hindered by the lack of road infrastructure and access to information adds an isolation factor that does not foster integration and development planning.

Mutual Aid Networks - The organisation of networks of mutual aid is a livelihood strategy in poor rural areas. There are several mutual aid groups;. In each village there is a range of formal and informal organisations to which community members belong. These are most of the time organised by social group for instance, ethnic groups, men, women, elders and youth.

Gender Conditions - Women generally have low levels of social development when measured in terms of literacy, educational attainment or general health conditions.

They are highly involved in agricultural production. In fact, 80% of economically active women work in agriculture and are responsible for about 80% of food production in Guinea.

They cultivate their own land and, as well, work on their husbands' land. They collect non-timber forest products, convert palm oil and process crops to meet household needs and sell in local markets if there are surpluses.

Although sometimes participating in village councils and other traditional forums, women's position and power in village affairs and decision-making are still generally limited.

2.7 LAND TENURE AND USE RIGHTS

In Guinea, there are two systems of land administration and management:

- the statutory land tenure system; and
- the customary system of land tenure and use rights.

In rural areas, the legitimate and recognised system is the traditional system although recent influxes of populations and economic investment associated with the Simandou Project is creating a shift towards greater emphasis of statutory rights.

The statutory land tenure system is not widely implemented across Guinea, due in large measure to the lack of institutional capacity to implement the *Domain and Land Tenure Code* (*Code Foncier et Domanial* – CFD) and other legislation. In the LSA, Beyla is the only place where formal registration of land is taking place. The process is starting to take place in the village of Moribadou.

Customary Systems of Land Tenure and Use Rights - Under traditional land tenure, land is not considered a merchantable good. Land access and rights are largely determined by membership in social networks, and distinguish between the ownership rights of the founding family and recognised use rights of other lineages in the community and of individuals.

The founding family is considered to hold ownership rights to all village lands. Village lands are traditionally considered to be inalienable. The ownership rights of the founding family mean that they have been entrusted with the custodianship and management of the village lands on behalf of the community.

In spite of the precedence of lineage rights, individual rights, although limited, are nevertheless recognised in the sense that

everyone has access to the agricultural land required to meet his or her needs. As for the land rights, there are as well lineage land and community lands.

Access to Land and Land Transaction - Within this customary land tenure system, there are clear distinct opportunities for local people who are native to the community and in-migrants and newcomers. The most common access to land is mostly by inheritance, or by gifts made by the lineage head to families of the same lineage.

When people migrate to a community, they generally do not have any traditional land use rights based on their lineage. Therefore, new forms of land transactions are emerging in urban (Beyla) and peri-urban (Moribadou) areas, involving the exchange of money. Land rental and land sales are increasingly common as newcomers enter communities where they do not have traditional rights to land through their lineage.

Based on surveyed households, access to land, either for native people or newcomers, can be summarised as:

- inheritance and family agreement (65% to 90% of cases);
- gift or allocation - maybe temporary, on a annual basis or permanent (average of 14%);
- loans (mostly based on sharecropping) (5%); and
- land purchase (less than 1%).

Local government institutions dealing with land tenure are:

- Prefecture Land Tenure Commission;
- Prefecture Department of Urban Planning and Housing; and
- CRD Land Commission.

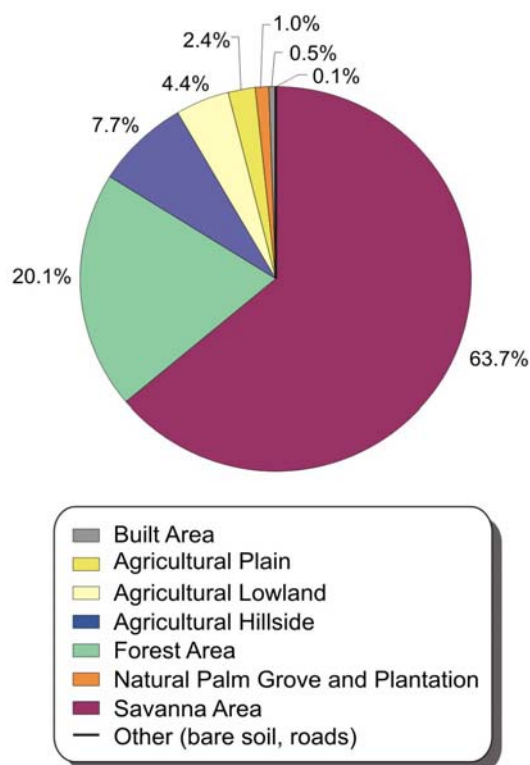
2.8 LAND USES AND URBAN DEVELOPMENT

The analysis of land uses is intended to define and assess how human activities are distributed on the ground. It contributes to the socio-economic analysis of the communities and helps determine the impact of land uses on the project. Based on the inventory carried out, the main characteristics of land uses can be summarised as follows:

- Predominance of agro-pastoral activities;
- Important regional urban center in the town of Beyla;
- Large block of dense forest within the PdF CF used by local populations for gathering of natural resources and hunting;
- Village forests encircling villages where various fruit plantations are found;
- Large areas of savanna grassland or woodland, or wooded savanna, used temporarily and/or permanently for various purposes;
- Large presence of livestock throughout the territory, but generally concentrated in the northeast and northwest of the LSA; and
- Large natural palm grove and plantations concentrated on the western slope of the Simandou ridge.

In total, seven main types of land uses have been identified. Their distribution is presented in the figure below.

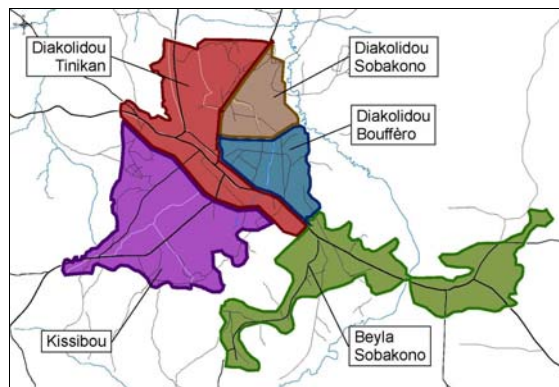
Distribution of land uses in priority village territory



Urban Development in Beyla Town - The town is organised into five districts (all ranked level 5), including fifteen sectors:

- Beyla Sobakono;
- Diakolidou Bouffèro;
- Diakolidou Sobakono;
- Diakolidou Tinikan; and
- Kissibou.

Existing districts of Beyla Town



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In addition to its dual administrative responsibilities (Prefecture and CU), Beyla is a major market town, including the sale of agricultural and livestock products produced throughout the prefectures of Beyla and, to a lesser degree, Macenta. The town has, however, very few local industries apart from a small soap manufacture.

There are many challenges that need to be addressed in the development of Beyla. They encompass the residential, commercial and institutional functions of the community, as well as the provision of a wide range of public and community services.

2.9 LIVELIHOOD SYSTEMS

Livelihood systems for households in rural villages, are driven by subsistence agriculture complemented by a wide array of other activities meant to generate income. These activities include animal husbandry, market gardening, oil palm and groundnuts production, fruit trees' plantations, trades and crafts, vending, small transformation units, hunting and fishing.

In Beyla, and in larger villages in the midst of becoming small towns (Dandano, Moribadou and Nionsomoridou) there are more diversified livelihood systems that include in addition to agriculture, salaried employment, service-based and small-scale transformation businesses.

Rural Occupations - Nearly all household heads (93% of respondents) report agriculture as their primary occupation. Other secondary occupations include: hunting (19%), animal husbandry (15%), trades and crafts (12%), oil palm production (11%) and vending and work as healers or priest (each 9%).

Subsistence agriculture is a labour-intensive activity, involving many male and female members of the household. Agriculture is the primary occupation for 84% of male and 86% of female of the households.

Household Income - Agricultural activities is the main source of income, including the sale of crops and/or the sale of animals and animal products for three-quarters, of households. Animal husbandry is the second most important income source in some but not all villages (the principals being located on the eastern slopes of the Simandou Range: Wataférédou II, Morisangarédou, Goékoro, Foma and Banankoro).

Trades, crafts, services and small businesses are more significant than agriculture for the villages of Kéoulendou, Traoréla, Moribadou, Mafindou, Baladou, Kankoro, Kotia, Mandou and Orono.

There is a clear distinction to be made in terms of households' incomes between two types of activities:

- Subsistence activities: mainly rice and tuber production, fishing and hunting and animal husbandry.
- Income-generating activities: mainly agriculture related services (i.e. trades and crafts), animal husbandry and market gardening but can include palm oil production, tree plantations and groundnuts production.

The income distribution is mostly determined by these two categories. Families within income-generating activities are better off than the others.

Although seemingly equalitarian, there are sizeable and noteworthy inequalities within households and villages of the LSA. Households' levels of income are low for the majority of surveyed households in rural villages and in Beyla, as indicated in the table below: 14.4% of the households did not report any income. The average annual income is:

2,486,100 GNF per household and 357 000 GNF per capita. However, there are households earning over 6 million GNF per year (13%).

Annual income distribution in priority villages

Annual income (GNF) (M=million)	No. of households	Distribution
0 M	59	14.4%
0 M – 1 M	112	27.4%
1 M – 2 M	83	20.3%
2 M – 3 M	36	8.8%
3 M – 4 M	29	7%
4 M – 5 M	24	5.9%
5 M – 6 M	13	3.2%
Above 6 M	53	13%
Average income per household	2,486,100 GNF	
Income per capita	357,000 GNF	

The highest per capita incomes are reported in the CRD of Kouankan. Overall, income levels are lower in the CU of Beyla and the CRD of Nionsomoridou. In villages close to the mine, such as Moribadou, Traoréla or Nionsomoridou, modest levels of employment and an active trading and service sector should produce higher income levels than what is being reported. However, at the same time, these communities have been affected by large influxes of migrants many of whom remain unemployed.

In Beyla, the livelihood strategies as per rural villages, also rely on agriculture. Households grow most of what they require to meet their own consumption needs. At the same time, a greater proportion of households than in villages are engaged in commercial activities.

Agricultural Land - There are three distinct types of agricultural land within the LSA:

- Lowlands, mostly concentrated in the CU of Beyla;
- Agricultural plains, mostly concentrated in the CRD of Nionsomoridou; and
- Hillside areas, scattered around the region mostly used for slash and burn agriculture.

Rice, as staple food, is the primary crop grown by most households followed by cassava, potatoes, groundnuts and corn.

There is a high diversity of crops grown by households, mostly due to agro-ecological conditions. Villages of the west slope of Simandou benefit from greater rainfall and can therefore engage in cash cropping such as coffee, cacao and fruit trees. Natural and cultivated palm groves are also found in this area. Natural palm groves are exploited to extract red oil used for cooking and palm oil that is processed to make soap.

The majority (61%) of surveyed households have landholdings that are less than four hectares.

Distribution of household agricultural land in the local study area

Type of land	LSA
Hills	31.5%
Plains	9.6%
Lowlands	39.3%
Forest	0.5%
Plantation	18.4%
Other	0.7%

Agricultural Labor - Two phenomena have brought major changes in ancestral agricultural patterns. First, artisanal mining activities have brought men away from to fields and communities, and more recently the monetisation of activities in what was traditionally a subsistence economy has resulted in an important increase in the number of young men in particular, who prefer to seek wage employment rather than take up or continue agricultural activities. It creates a situation of increasing labour shortage, and forces families to hire temporary or permanent farm workers. Twelve percent (12%) of surveyed households hire permanent employees to help in various agricultural tasks.

Agricultural Inputs and Irrigation - Agriculture does not involve use of large agricultural inputs nor irrigation. Most farmers use hand tools, animal traction and sometimes plough. There is little, if any use of other agricultural technologies as well as use of fertilizers. There is no irrigation cultivation apart from the annual flood of the lowlands.

Animal Husbandry - Two types of animal husbandry are practiced in the area:

- Sedentary animal husbandry: mainly small ruminants such as chickens, sheep and goat, sometimes cattle, which remain in

the vicinity of family's huts and near villages. Animals are tethered to protect crops during winter rainy seasons and roam freely in the dry season.

- Nomadic animal husbandry: livestock rising takes place mostly in the northern part of the area. Transhumant cattle herds stop or transit through the savanna region.

There is little animal husbandry activity on the west of Simandou Range (Macenta Prefecture). Cattle raising is widespread but relatively more important for households in the CU of Beyla.

Income for livestock breeding is an important livelihood strategy for many households. Income from livestock includes the sale of cattle; sale of milk, fat and butter; and, other activities such as renting out oxen or being hired to guard or herd animals.

Cattle herd in the local study area



N'Zérékoré Forestry Centre

Hunting - In areas such as villages close to the PdF CF where wild species are still abundant, population engage actively in hunting as a means of obtaining and/or reducing the costs for meat. Hunting activities are widely distributed throughout the PdF CF.

Traditional hunting for subsistence is authorised in the PdF CF but commercial hunting is banned. Hunting season extends from 15 December to 15 April but in fact people hunt throughout the year and more intensively in the dry season. Rifles and traps are the main hunting methods, but setting bushfires to scare game towards set traps is also used much too frequently.

Wild Plants, Wood and other Fibre Resource - The PdF CF is also used for harvesting various plants that are used for household consumption or sold in local markets, or for medical use, as traditional medicine remains an important custom in the region.

Wood resources harvested are used primarily to meet household energy needs, namely firewood for cooking and heating. All accessible dead wood is collected for fuel. Other wood resources are used, to a lesser extent, for making furniture and construction.

Men constructing a house in the local study area



N'Zérékoré Forestry Centre

Charcoal, which was not widely produced by the populations, is now becoming a lucrative activity due to increased demographic pressure.

Fishing - As the LSA also has many small rivers and streams and several major rivers with fishing potential, inland fishing is a major subsistence activity for villagers although it is marginal in terms of income-generation. Fish are consumed fresh or are smoked, but they are rarely traded. Most farmers fish in the dry season after the harvest is finished. There are no professional fishermen in the area.

Small Businesses, Trades and Crafts - In all villages, men or women exchange goods and services for money or in a barter exchange, as means of meeting their needs and generating income. Common services that are exchanged include transportation (moto taxis, drivers), agricultural labour, babysitting for young women, guarding facilities for young men, road sweeping, baking and cooking.

In some villages men have developed more specialised trades such as carpentry, mechanics, electricity, plumbing, tapestry, masonry, sculpture, husking services, blacksmithing and sheet metal work. Women's activities such as basket making and embroidery are also encountered.

Transporting goods on motorcycles



Claude Hamel

There is no major industry in the area. The town of Beyla has several small and medium enterprises such as vehicle garages, welding stations, a slaughterhouse and a butcher. In rural communities, small businesses consist of palm oil production; groundnuts paste production, and charcoal production.

Artisanal Mining - Guinea is renowned for the richness of its soil. Forest Guinea region in general and the Simandou area are rich in mineral resources. The area counts a concentration of many small-scale mining concessions where many farmers try their luck. Working conditions are often difficult.

Economic Support Systems - Elements of the economic support systems include:

Market: The size and availability of markets, and poor road networks are limiting factors to trading. The distance to a market is clearly an obstacle for development in some villages. On average, households living in priority villages have to travel nearly eight to ten kilometres to reach the closest market.

Trade routes: For specialised products or services, households must travel to the town of Beyla. For more basic products, they can generally find what they need in small nearby markets. The role of regional markets is vital for isolated village populations that have limited opportunities to sell their modest production and buy consumer goods. Regional markets are in Beyla, Bonodou, Macenta and Boola.

Energy: In Forest Guinea region, only 2.4% of households have access to electricity, compared with a national average of 19.3%

households. The use of electricity is marginal. Where it is available, it is because individual households generate electricity with diesel generators. In the 270 surveyed households, only five of them have their own diesel generator. In the town of Beyla, 19% of households have electricity, most of it supplied by individually owned generators.

Telecommunication: Access and coverage of telecommunication is possible through three telecommunication operators. Network is good although relatively unstable. Possibility of having a mobile phone is highly viewed although not accessible to many households. Only six households, out of 270, reported having access to a telephone.

Informal and formal credit: Access to informal credit is available in rural villages through mutual aids groups and associations. However, the most effective way observed to accumulate capital goods is to own cattle. Owning cattle is an effective form of savings account, as they can be sold readily to generate cash for unexpected events.

Formal credit is only available in Beyla through two credit institutions: Crédit Rural de Guinée (CRG) and the International Bank for Trade and Industry of Guinea (BICIGUI). The CRG has 4,000 clients mostly in the CU of Beyla. The BICIGUI had 1,500 clients (2008).

Borrowing and Debt: The vast majority of households (68%) surveyed have borrowed and accumulated significant amount of debt considering their income levels. Given the informal aspect of trade, computing debt is a challenging process. However, based on response to the social survey, households' average debt level represents 29.8% of their income.

The majority of borrowed money (51% of households) is for food or health spending; 19% spent for agricultural inputs and the remaining for diverse necessities.

Investment and Spending Profile - Households in the area do not save and invest on their land or on other activities since most of their surplus production is used to pay for basic expenses (food, clothing, school fees, health spending and basic agricultural inputs).

In spite of the poverty incidence, households have plans and priorities to improve their livelihood strategies when they are able to

generate sufficient surpluses to spend or invest. Priority needs expressed by households are as follows:

- 35% of households would like to improve their housing conditions;
- 20% would want to develop trade;
- 8% would like to improve or develop a plantation;
- 7% would like to improve animal husbandry.

Development Aid - Most of the development aid in the area is provided by Rio Tinto and by some international and national NGOs based in Beyla, namely:

- World Education Group, working in literacy;
- ONUSIDA, working on HIV/AIDS;
- GTZ, working in health;
- Institut für Internationale Zusammenarbeit des Deutschen Volkshochschul, working in education and literacy;
- EU and USAID, working in community development (Programme “Faisons Ensemble” (Working Together));
- Three national NGOs (ZALI AC, REFMAP, AAGC), working in various fields;
- Three local NGOs (ABID, ADCR, CADGIB), working respectively in education, health and socio-economic development.

2.10 SOCIAL AND ECONOMIC ISSUES AND INDICATORS

Socio-Economic Development Index (SDI) - An SDI provides a synthesis of the social and economic conditions in the surveyed communities, and allows a comparison of these conditions across the 26 surveyed priority villages. The developed SDI used the most robust quantitative parameters generated by the household surveys conducted in the communities, some related to social aspects, others to incomes and livelihoods. The purpose is to rate, according to a mathematical formula, the level of development of these parameters, and therefore of the villages.

Five parameters were retained: i) the living conditions of the household; ii) educational level; iii) health conditions; iv) income of the

households; and v) capacity to improve livelihood. Each village has a score on a scale of one to five, from the less developed to the more developed village as shown in the above table. The rating scale is defined as follows:

- Scores below are equal to 2.5 = low development rate;
- Scores from 2.6 to 3.5 = moderate development rate;
- Scores over 3.6 = high development rate.

SDI rating in priority villages

CU /CRD	Priority villages	Total index rate
Beyla CU	Morisangarédou	3.4
	Kéoulendou	4.1
	Piyaro	3.5
	Banankoro	3.0
	Foma	2.4
	Goékoro	2.4
	Thia	2.5
	Koimoridou	3.1
Average index rate		3.05
CRD	Nionsomoridou	3.4
Nionsomoridou	Wataférédou II	3.5
	Traoréla	3.0
	Moribadou	3.4
	Mafindou	3.4
	Baladou	2.4
	Kankoro	3.2
Average index rate		3.18
CRD	Banko	2.9
Kouankan	Lamandou	2.0
	Kotia	2.3
	Mandou	3.1
	Naouinzou	3.1
	Tourela	2.4
	Orono	2.5
	Dandano	3.7
	Silafarala	2.9
	Korela	2.5
	Mamouroudou	2.2
Average index rate		2.69

The main findings of the SDI are summarised as follows:

- Out of the 26 rural priority villages, two villages have a level of development considered as high, (Dandano and Keoulendou). The majority of villages (14) are in the moderate range of development, and 10 villages are rated as having a low level of development.

- Villages in the corridor between the town of Beyla and the Canga East camp, are somewhat more developed than elsewhere from a social point of view.
- From an economical point of view, villages in the CRD of Kouankan, have higher incomes per capita given the greater proportion of income-generating activities, such as plantations and artisanal mining.
- Lack of social infrastructure and physical isolation seem to harm the development of the region.

Needs and Issues Identified in the LSA - When consulted about their needs in terms of socio-economic development, households expressed a large array of needs, ranging from basic needs (food security, employment), to recreation and cultural needs. However, the number one priority need voiced by the majority of the households is their wish for improved housing. Other important priorities endorsed by nearly all groups are, in decreasing order, employment, food security and assistance to agricultural development. In the fifth place comes the desire for better access to health services and facilities.

Guinea Development Priorities - The Government of Guinea has strongly stated in its national Poverty Reduction Strategy its intention: i) to improve governance; ii) expedite growth and expand employment; and iii) improve access to social services. Addressing social and economic issues of the mine area can therefore be linked to larger governmental development priorities.

Key Social Issues - A series of important issues have been singled out while preparing the SBS. These issues identified and presented below, need to be monitored and assessed over the life cycle of the project in order to support the project decision-making, to define community engagement and strengthening activities, to integrate the priorities of communities into the project planning, and to focus on results and improve reporting and accountability. A series of indicators have been elaborated for monitoring these key issues that are:

- In-migration;
- Land management;
- Community well-being;
- Employment;

- Infrastructures; and
- Social structures and values.

In-Migration - It is among the most important impacts associated with the Simandou Project, which is why an *In-Migration Plan* was commissioned by Rio Tinto in 2008 to specifically address the issue. The phenomenon entails several potential risks, among which:

- Social disturbance/disruptions of social values and structures due to large influxes of migrants.
- Pressure on land use and agro-pastoral situation.
- Increase in the number of people looking for employment.
- Pressure on the existing infrastructures (school, health facilities, etc).
- Potential increase of poverty level and in the development of adverse effects (alcoholism, prostitution, drugs, violence, larceny, vandalism).

Land Management - Issues related to land management include increased land pressure caused by many factors associated with the Simandou Project: changes in land ownership and land use rights; increasing monetization of land acquisition; transformations in the organic ties that have traditionally bound local populations to their land.

Among the risks associated with the issue of land management are:

- Rapid changes in ancestral and secular land management traditions.
- Increased pressures on land uses and on agricultural land and production.
- Rapid and progressive increase in land values; gradual introduction of land speculation which in turn gives rise to inflation and increased costs of living.
- More intensive and wicked exploitation of the land resulting in potential adverse effects such as degradation of the soil, deforestation, reduced yields, degradation of water sources, etc.
- Acceleration of the urbanization process of some communities, thus creating increasing concern for food security.

Community Well-being - As the project is located in an area of high poverty incidence and underdevelopment, the level of well-being in communities is generally low. Community economic development conditions are limited and most households live in precarious conditions. As a consequence, people that are likely to be affected in diverse ways by the project, have few of the basic necessities they need to deal independently and effectively with the changes occurring in their lives, including potential opportunities as well as adverse impacts. The risks associated with this issue are among others:

- Deterioration of already poor housing conditions.
- Increased number of young men abandoning agricultural for salaried employment, thus affecting agricultural activities and household food sources.
- Increased lack of access to potable water and sanitation.
- Increased cases of illnesses and introduction of new diseases.
- Restricted access to land for migrants may create social tension.

Employment - Wage employment is relatively new in the area, and is closely linked to the Simandou Project. Traditionally, livelihoods in the area were based on subsistence agriculture. The arrival of Rio Tinto has gradually modified this situation. As a consequence, there has been an increased monetization of exchanges that, in turn, has introduced new social patterns in communities. Households are now looking for new livelihood strategies, including wage employment as well as the establishment of new income-generating activities.

These transformations are increasingly changing the social as well as the economic structures of communities. Employment is always a central issue, especially in the context of a large-scale project. Some of the potential risks associated with employment are as follows:

- Livelihood strategies traditionally based on subsistence agriculture are rapidly shifting towards wage employment.
- Rio Tinto is the only important employer of the region. Level of expectations for employment remains too high and unrealistic in relation to the requirements

of the project for different types of workers (skilled, semi and non-skilled).

- There is little support from Guinean authorities in terms of labour coordination and agreements.
- As the project progresses, pressure on Rio Tinto for employment is likely to increase mainly due to in-migration and changes in livelihood strategies.

Village meeting in Bonodou



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Infrastructure - A feature that characterised the Simandou Project area is the lack of public services and the poorly maintained and deficient infrastructure networks in most sectors: education, health, water distribution, transportation and energy.

The potential risks associated with the paucity of infrastructures can be summarised as follows:

- The poor conditions of the educational system (low percentage of people having secondary and post-secondary education), makes it difficult for local recruitment.
- Lack of health facilities; poor conditions of existing ones and general poor health situation exposes Simandou Project staff to health risks.
- Poor water distribution and limited access to good quality water (potable water) are a hindrance for local communities and for the project in general.
- Sparse and poorly maintained road networks are impediments to social mobility, to access and circulation of information and to overall socio-economic development.

- Deficient energy supply system contributes to the stagnation of local economic development.

Changes in Social Structures and Values - It is not easy to grasp the reality of a society that is undergoing a process of major and, in some respects, fundamental change. Transformations currently taking place will have long-lasting effects on communities, for instance, family life, traditional social hierarchies, livelihood strategies, the changing role and status of women and segregation of men and women.

Normally, social transformations occur naturally, but over long periods of time. The distinctiveness of a large project such as the Simandou Project is that it provokes an accelerated rate of social changes. And as with all rapid changes in social structures and values, there are risks of social disorder, hence the need to assess and monitor the evolution of these changes.

The potential risks and with regards to changes in social structures and values are:

- Progressive dissolution of traditional social structure and emergence of a more contemporary rural society.
- Of traditional societies rather homogenous and equalitarian are emerging more stratified micro-societies based on class structures resulting from the rapid economic growth taking place.
- Gradual monetization of society is likely to create disparities of income per capita and become a source of social inequalities.
- Greater recognizance that education is of critical importance for economic and social advancement makes a larger number of parents wanting a better education for their children.
- Roles, responsibilities and status of women, which were definite and unquestionable not that far back, are now more diffused and balanced out. However this change may eventually entail other potential issues such as domestic violence, etc.
- The youth (young women and men) see their roles as being different from those of their parents. They tend to seek employment to have access to wages either from employment or through income-generating activities.

3. PHYSICAL BASELINE

3.1 INTRODUCTION

The objective of the physical baseline study is to characterise the initial conditions of the various physical components against which to assess the project implementation and operation phases.

Considering that the PdF CF presents some unique physical characteristics in terms of geology, topography and climatic conditions that themselves are related to hydrology, hydrogeology and livelihoods in villages, the sensitivity of the region has been recognised since the early stage of the exploration programme.

To provide relevant information to address the concerns related to this context, extensive surveys were conducted in the Simandou region.

Over the last decade, a set of important studies on the climate, hydrology and hydrogeology were performed to provide basic knowledge on the physical context of PdF CF.

Measurements and monitoring activities are ongoing in order to continue the baseline work for some of the physical components (hydrology, hydrogeology and climate).

3.2 STUDY AREAS

Two study areas have been defined to characterise the physical components of the Simandou Project.

The RSA encompasses a large portion of the Forest Guinea region which exhibits homogeneous physical characteristics in terms of physiographic units, rainfall pattern and geological formations associated to the Simandou Range and also hydrological characteristics of the regional watersheds which drain the range.

The LSA is related mainly to the spatial extent of the potential effects of the project on the receiving environment. The baseline surveys and monitoring activities were conducted within the LSA, mostly within PdF CF.

3.3 PHYSIOGRAPHY

The analysis of physiographic features, such as geomorphological units and topography,

provides information on the nature and properties of the soils and surface geological deposits. The understanding of landform formation provides additional information on the formation of soils and the characteristics of surface and ground water flow systems in the study area.

Physiographic Regions - The study area is located in the Forest Guinea physiographical region. It is a vast area dominated by an important forested cover that forms the habitat of distinct ecosystems, specific to southeastern Guinea. The important forested cover results from the typical rainy conditions encountered in southeastern Guinea, which influence topography, vegetation, soils, and surface and ground water flow systems.

Geomorphological Units - The Forest Guinea region is characterised by four distinct geomorphological units according to topography, nature of the soils and surface deposits, and geology. Only two of them, the Guinean Dorsal and the N'Zérékoré Notch, are found in the study area.

The Guinean Dorsal consists in a group of disjointed high elevation mountain ranges, such as the Simandou Range, parallel to the Atlantic coast. The Dorsal terrain is characterised by a crystalline rock basement, part of the West African Craton, composed primarily of granitic igneous rocks. The N'Zérékoré Notch is similar in nature to the Guinean Dorsal, but is characterised by gneissic metamorphic rocks.

The Guinean Dorsal and the N'Zérékoré Notch are located, respectively to the east and west of the Simandou Range. The plains in the Guinean Dorsal region presents typically lower elevations than the plains in the N'Zérékoré Notch region.

Topography - The topography is mountainous and undulating. It consists in steeply-sloped hills, separated by deep depressions (ravines) gradually changing into foothills, and then into same elevation plains. The ravines often contain small dry streams in inland valleys, known as *bas fonds*; and alluvial plains along rivers and creeks.

Typical landscape of the Simandou Range



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The Simandou Range presents a north-south axis, with an altitude exceeding 1,000 m over a distance of 25 km, and an average ridge width varying between 1 and 2 km. The two main mountain peaks are Pic de Fon and Ouéléba, which respectively have altitudes of 1,650 m and 1,255 m.

3.4 CLIMATE

The data collected from the meteorological stations of the *Direction Nationale de la Météorologie* (DNM) have been used to characterise the regional climate. The Rio Tinto meteorological network, which includes five automatic weather stations, 15 automatic rain gauges, ten manual rain gauges, three fog gauges and four cameras, has provided the data entry for the characterisation of the local climate.

As a supplement to the basic climatic data, the UK Met Office undertook a three-phase climatological study. Phase 1 characterises the local and regional climate and establishes the dominant rainfall mechanisms.

Regional Climatic Context - The climate of southeast Guinea is a seasonal humid tropical climate dominated by the West African monsoon. There is an important south to north decrease in annual rainfall (1,200 mm in Sigiri compared to 2,600 mm in Macenta) as well as in the duration of the wet season. The wet season is longest in the south of the country and shortest in the north. The wet season is also the cooler season with the lowest daytime maxima in August (27.5 °C). The highest daily maxima occur in March (32-34 °C). Daily minima are highest in the later part of the wet season (August to November) and lowest in December but vary only between 16 °C and 20 °C.

In southeast Guinea and in the RSA, approximately 90-95% of the annual rainfall occurs in the wet season with an annual mean precipitation higher at the Macenta station (2,800 mm) compared to the Kérouané and Beyla stations which are located along the Simandou Range (1,700 and 1,900 mm respectively) reflecting a west to east rainfall gradient typical of southeast Guinea.

In summary, there are two different seasons in the RSA, the wet season and the dry season. The seasons are distinguished by the rainfall regime rather than by the temperature.

Results in the LSA - The major influences on the climate are the following:

- Climate is governed by annual northward advance, then southward retreat of the West African south westerly monsoon;
- Topography is not the fundamental driver of the climate regime but it does modulate rainfall;
- Heavy rainfall occur irrespective of topography.

The climate characterisation includes the following parameters: atmospheric pressure, solar radiation, temperature, wind, humidity, evaporation, and precipitation.

There is only a slight seasonal variation in atmospheric pressure which is typical of tropical regions. This is closely linked to the low variation in temperature. The period of high pressure coincides with the period of lowest temperature in the wet season. The weather stations located at the base of the Simandou Range (Foko West, Mafindou and Mandou) registered an average atmospheric pressure of 922-935 mbar while the stations at the top of the ridge (above 1,300 m) registered an average atmospheric pressure of 838-870 mbar.

In terms of solar radiation, there is considerable variation throughout the year mainly related to cloudiness, in particular at the end of the wet season. The monthly mean radiation at all the weather stations varies from 11-16 MJ/m²/day in the wet season to a maximum of 19-20 MJ/m²/day in the dry season. The stations located on the west side of the Simandou ridge receive annually less solar radiation than the stations located on the east side of the ridge, a consequence of

greater cloud cover and fog on the west side compared to the east side.

Temperature variations are associated to seasons (clouds and rain) and altitude. The seasonal temperature values are quite similar at all stations (see figure below).

The monthly mean temperature is lowest during the wet season (between 16 and 22.5 °C) and reaches a maximum of 26 °C in February. Temperatures also vary with altitude. The coldest temperature is at Dabatini (annual mean of 18.3 °C at 1,650 m and the warmest is at Mandou (annual mean of 23.9 °C at 710 m).

The wind speed and direction vary significantly during the year depending on site and elevation. The exposed ridge of the PdF CF registered winds of 19.8 km/h and 14.4 km/h (at Dabatini and Ouéléba stations) compared to values that do not exceed 5.8 km/h at other lowland stations. Most of the time, at high altitudes, the wind comes either from the east (mostly during the dry season) or the west (mostly during the wet season).

The relative humidity, i.e. the vapor content of the air, is strongly related to the direction of the wind. Northeasterly and easterly winds (harmattan) bring drier air while southerly and southwesterly winds (monsoon) bring air of higher humidity. Consequently, there is a strong seasonal variation in humidity and rainfall which is closely related to seasonal variation in wind direction. Daily mean relative humidity in dry season reaches low of 20% with maxima of 90-98% during the wet season.

Evaporation occurs from water surfaces, bare ground surfaces, and transpiration from plant leaves (called evapotranspiration). At all weather stations, monthly trends show the dry season as having the highest rates of evaporation, whilst the June to August period records the lowest.

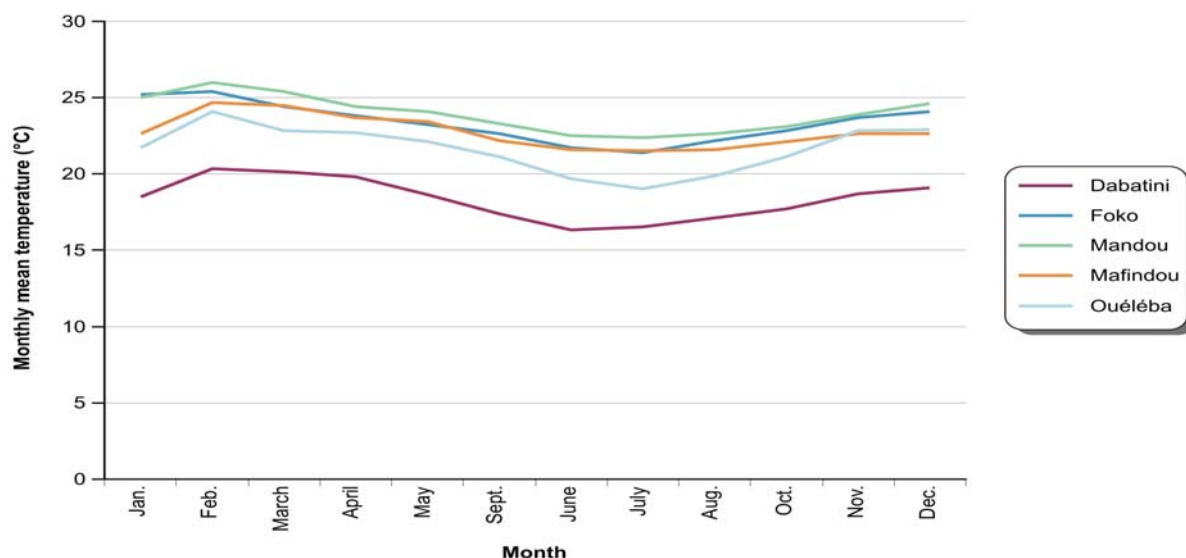
Precipitation - Rainfall is the dominant form of precipitation and fog occurs frequently.

The general rain mechanisms at the Simandou Range are:

- High moisture content air from the Gulf of Guinea;
- Large scale rising air motion in mid-troposphere (mid-wet season);
- Strong sun leading to intense convection (dominant in early and late wet season);
- Westward moving atmospheric disturbances intensifying the rainfall; and
- Modulation of the rainfall by topography (orographic enhancement).

For the rainfall distribution there is a zone of high rainfall (2,300 mm/yr) over the northern end of the Pic de Fon area near Dabatini. The rainfall contour is oriented north-south and broadly centred over the ridge. A second zone of high rainfall (over 2,000 mm/yr) is apparent in the southeast part of the Foko West ridge. Rainfall over the lowlands is higher on the west of the ridge compared to the east.

Monthly mean ambient temperature in the local study



There is also a strong seasonality to the rainfall distribution (see figure below). On average, around 90% of the annual rainfall falls in an eight-month period (March to October) and follows an annual cycle, rising slowly from January to July with a peak in August then decreases rapidly from September.

Rainfall within the study area also appears to increase with altitude on both sides of the ridge. The highest sites (Dabatini and Ouéléba) receive respectively 2,356 mm and 1,928 mm. The fact that Canga East and Mafindou stations receive less rain than Foko and Mandou suggests that the west side of the ridge receives more rainfall than the east.

Rainfall distribution can be summarised as follows:

- Rainfall distribution is more related to exposure than elevation;
- Centre of mass of rainfall lies to the west of the range, i.e. rainfall is higher to the west than to the east;
- Rainfall decreases from the south to the north;
- Rainfall rises with altitude;
- During the dry season, the orography exerts little influence on rainfall.

In terms of rainfall diurnal variability in the wet season, maximum rainfall is in the afternoon

and overnight and minimum rainfall in the morning. Rainfall can be intense, daily rainfall as high as 179 mm was recorded during the SEBS.

Fog - Fog occurs where the dewpoint temperature is reached for any specific level of atmosphere humidity. Fog is a common phenomenon on the west side of the Pic de Fon ridge on most mornings during the wet season (see photo). The fog usually dissipates by late morning with the increase of the temperature.

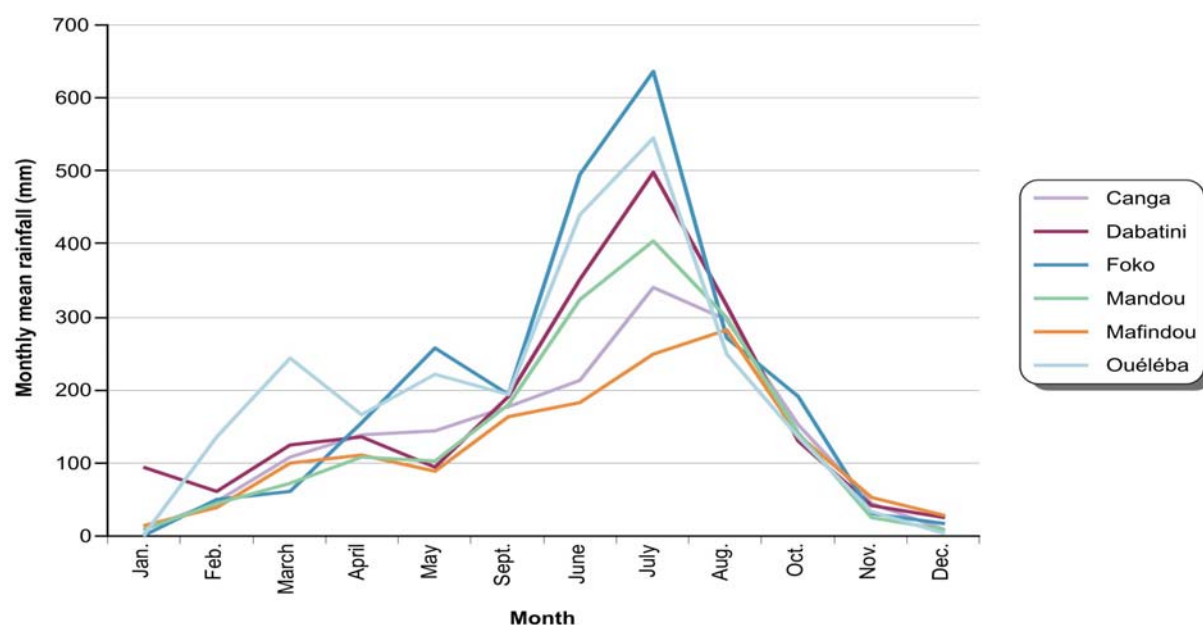
Fog on the western side of Pic de Fon



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Climate Change in Guinea - The data collected at the five DNM weather stations were analysed (from 1930 to present) with the objective to detect climate change on a decadal timescale and in the long term. In general the records are too short to make valuable inference on climate change.

Monthly mean rainfall in the local study area



However, the records suggests a long term downward trend in rainfall at Kérouané, Kissidougou and N'Zérékoré.

3.5 AIR QUALITY

The air quality baseline was required to identify current local sources contributing to the presence of contaminants in the atmosphere in order to assess the project's impacts on air quality. Currently there is no industry within the the study area. The major sources that can generate pollutants and dust are:

- the dry harmattan wind, often loaded with suspended particulate matter; and
- agriculture related slash and burn activities.

Two ambient air monitoring stations are currently in operation, one near the Mandou village on the west side of the ridge, and the other one near the village of Moribadou on the eastern side. Monthly determinations of gaseous contaminants (passive samplers) are conducted at both stations for nitrogen dioxide (NO₂), sulphur dioxide (SO₂), and ozone (O₃), as well as continuous monitoring of particulate matter (PM). Particulate matter includes dust, smoke, soot, pollen, soil particles, etc. suspended in the atmosphere. Depending on their size and their concentration, PM can cause environmental and health damages.

The results of the air quality characterisation, based on the data collected at these two stations from mid-February 2008 to mid-March 2009, indicate that the monthly concentrations of NO₂, SO₂, and O₃ are low, and are in line with the usual concentrations present in rural areas with no industrial activities.

For the ozone levels, the maximum monthly value is found in Moribadou which reflects the higher level of human activities in this area.

With regards to PM, air quality is poor during the dry season due to slash and burn activities and the harmattan wind loaded with particulate matter, but is generally good the rest of the year when rainfall cleans the atmosphere.

3.6 NOISE CLIMATE

The objective of the baseline noise characterisation is to establish noise levels at sensitive locations, which will serve as the pre-project reference point against which future

changes can be measured and compared with the WHO Guidelines for Community Noise.

The baseline noise environment was established using noise measurements data collected in eight villages surrounding the PdF CF and at Canga East camp. An autonomous noise monitoring station was used to measure the ambient noise on a continuous basis over 24-hour periods (in 5 second intervals) at each sampling site. The noise survey was undertaken from 13 to 23 February 2008.

The results of the noise records collected for each of the monitoring stations indicate that ambient noise characteristics differ between villages. The main features of the survey can be summarised as follows:

- The measured noise levels are compatible with the noise guidelines recommended by IFC and WHO for a residential area.
- Insect sounds are an important source of noise. It is the predominant source in Traoréla, which is the only village for which the daily noise level is equal to that of the WHO Guidelines (WHO's daily noise guideline is 55 dBA).
- During night-time, when insect sounds are not a significant source, typical noise levels are, for the most part, slightly below 40 dBA (ambient noise decibel rate).
- There is a larger fluctuating noise level during daytime which reflect human activities.
- Average hourly noise levels recorded during calm periods of day and night are lower than the WHO Guidelines at all measurement points.

3.7 GEOLOGY

Guinea is a country very rich in mineral resources. Major iron ore deposits have been identified along the Simandou Range. The geological formations associated with the iron ore deposits have been investigated in detail for mining exploration purposes, more specifically in the zones located in the vicinity of the two proposed mining sites: Pic de Fon and Ouéléba. A good understanding of the geology is needed in order to define the zone that may be affected by mining activities; evaluate the geotechnical conditions for mine development; and assess the potential impacts of the tailings and waste rock disposal and management.

The data used for the analysis of the geology was collected primarily through intensive mineral exploration work carried out at the project site. It consisted in more than 1,118 boreholes drilled in order to define the resource geometry and properties; core samples collected during drilling for laboratory analyses; and a geochemical test work programme on 154 rock samples to characterise materials (waste or exposed rock) with regard to their acid rock drainage (ARD) generation and metal leaching potential.

Regional Geology and Structure - Rocks in the LSA consist in crystalline Precambrian rocks of the southwestern part of the West African Craton, which is encountered in the Forest Guinea region. The Craton contains Archean rocks, some of the oldest rocks on Earth.

As discussed earlier, the Guinean Dorsal corresponds to a convexity of the crystalline Precambrian basement overlying the older Craton rocks. It forms a geological domain dominated by granitic rocks. This geological domain also includes the N'Zérékoré Notch dominated by gneiss rocks.

The Simandou Range is a younger metasedimentary rock sequence (Lower Proterozoic). It is composed of greenstone volcanic rocks with banded iron formations, which occur as linear belts and small relics throughout the Archean domain.

A series of tectonic events of varying ages have affected the basement rocks. They have all contributed to the regional fabric of the rocks. More specifically, the regional Simandou fabric is characterised by the development of a large-scale north-south sinistral shear system; and a second order northeast-southwest trending shear system. These shear zones are typically oriented northeast – southwest in Pic de Fon, and east – west in Ouéléba.

Local Geology - The older and lowest member of the Simandou Group rocks consists in a phyllite series of rock that overlies the Archean basement. Phyllite is a foliated metamorphic rock primarily composed of quartz, sericite mica, and chlorite minerals. The texture of the phyllite varies from very weathered and goethitised at the surface, to fresh and pyritic at depth.

An itabirite series is encountered above the basal phyllite. Itabirite is a rock that consists in laminated, metamorphosed, oxide-facies iron

formation that contains large grains of quartz; and in which the iron is present as thin layers of hematite, magnetite, goethite, or martite minerals. The texture of the itabirite varies from friable to hard.

Iron ore mineralisation is generally located on the top of the ridge, overlying the itabirite series, and has been encountered to a depth of more than 300 m. The primary iron ore minerals consist of oxide-hydroxides minerals that have a composition that varies, although hematite is the dominant mineral. Hematite is a black to silver-gray, brown to reddish brown or red mineral. It is harder than pure iron, but much more brittle. Goethite is another iron oxide-hydroxides mineral.

In Pic de Fon and Ouéléba, a carapace, or a weathered crust, is encountered over the iron ore formations as a result of weathering and associated hydration of the mineralisation.

Finally, numerous debris flows have deposited, typically in perpendicular valleys to the Simadou Range, iron rich poorly-sorted detrital materials, referred to as cangas. The cangas overlie the phyllite and basement rock with thicknesses ranging from a few metres up to 40 m.

Rock samples collected during mineral exploration drilling



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Geochemical Characterisation - The results of the geochemical test work programme suggest that geochemical hazard from mining activities is low on the basis of the geochemistry of most of the rocks that will be exposed as pit wall, or stored in the waste facilities. Typically, these rocks present low sulfur and trace metal contents. Water in contact with these rocks should be neutral or weakly acidic, with extremely low concentrations in sulphates and dissolved metals. Consequently, the vast

majority of the waste rock and ore produced by the project will essentially be geochemically inert.

However, although little fresh phyllite will be affected by mining activities, the analysis of fresh phyllite samples has indicated that a low acid rock drainage or metal leaching risk (As, Sb, Cu, Ni, Zn) exists with this specific lithological unit.

3.8 PEDOLOGY

The determination of soil characteristics has been performed in the study area. The evaluation of the soil properties is required primarily in order to evaluate the value of the land that will potentially be affected by the project; and to obtain background soil quality value prior to mining development.

For the purpose of this study, soil data has been collected in the zones located in the vicinity of the Pic de Fon and Ouéléba proposed mining sites. Twenty-four soil samples have been collected in these areas at representative sites. The soil profile characteristics at each sampling site has been noted and compiled in a log. The soil samples have been sent to be analysed in a laboratory for metals (arsenic, beryllium, cadmium, chromium, cobalt, copper, iron, manganese, mercury, nickel, lead); sulfur; total cyanides; and petroleum hydrocarbons (C10-C50).

Soil Profile and Agricultural Value - The results from the soil survey have confirmed the occurrence of the soils typically encountered in southeastern Guinea. The texture of the soils in Pic de Fon consists mainly in brown to dark reddish brown silty and gravely fine sand. The texture of the soils in the Ouéléba area are composed of silty brown fine sand with gravel or trace of gravel, or silt with some or trace of sand and gravel.

The soil profile found along the Simandou Range consists in lithic soils developed over the carapace and bedrock. These soils are typical of steep slope environments; or typical of environments lacking weatherable minerals in the parent rock material. Lithic soils are known for presenting no significant value for agriculture uses.

In the piedmont area, the soils that have developed and accumulated have been rejuvenated by bedrock erosion. They contain laterite soils and rock particles in various proportions, sometimes with clay material.

They represent typically a good value for agriculture uses.

Ferralitic soils dominate the study area. These soils are extremely weathered soils and typical of tropical climate. They are usually thick and generally display yellowish or reddish colours. Ferralitic soils usually offer a low value for agriculture uses.

Some hydromorphic soils are locally encountered in the valleys of small intermittent streams (*bas fonds*), and along perennial streams under poor drainage conditions. They are subject to occasional flooding. Hydromorphic soils typically exhibit a medium value for agriculture use.

Typical soil and surficial deposits exposed near a drilling pad located on Pic de Fon



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Chemical Characteristics of Soils - The results of the chemical analyses of the soil samples have described initial soil chemistry prior to the mining development. Chemical element content in the samples reflects typical soil background concentrations. Sulphur, as a common element, is largely present. Iron and manganese are the most abundant metal elements. With a few exceptions, the rest of the metals analysed in all samples present concentrations below detection limit, or slightly above.

3.9 HYDROLOGY

Potential impacts of mining operations on the flow and quality of surface waters is an important issue in the project since many people depend on these waters for drinking, bathing, washing, farming, etc. Moreover, hydrological processes in mountainous regions are complex and have to be examined closely in order to evaluate potential impacts on the the local and regional hydrology.

The hydrological monitoring programme implemented for this study has focused on the characterisation of the stream flow regime of the main regional tributaries that could be affected by the project, as well as on the hydrological regime of the local streams in Pic de Fon and Ouéléba areas.

The data have been collected from government-operated river gauging stations; and the Rio Tinto local hydrometric network consisting in 6 weirs and 20 manual streamflow monitoring stations. In addition, two spring surveys were carried out on the flanks of Pic de Fon and Ouéléba.

Weir parts of the local hydrometric monitoring network



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Hydrological Features - The project is located in the headwaters area of four major regional rivers (Dion, Milo, Loffa and Diani rivers) and part of the Niger River watershed in southeastern Guinea. The Simandou Range ridge forms the north-south divide between eastern and western watersheds. Locally, the main streams draining Ouéléba and Pic de Fon are:

- the Mala and Kinyeko rivers which drain the northwestern flank of Ouéléba;
- the Miya River, which drains the eastern flank of Ouéléba and flows towards the Dion River;

- the Loffa River, which drains the southeastern side of Ouéléba and the eastern flank of Pic de Fon;
- the Woron River, which drains the western flank of Ouéléba and the northern and western flanks of Pic de Fon; and
- the Fokou West which drains the southwestern flank of Pic de Fon.

Hydrological Regime - Although difficult to interpret, long-term trends have been observed in the government-operated river gauging stations, as well as annual stream flow fluctuations. Short-term hydrological processes in local watersheds have been examined with the data from the local hydrometric network, more specifically at the weirs installed at Whisky 1, 2 and 5 monitoring stations.

Characteristics of Whisky 1, 2 and 5 watersheds

Characteristic	Pic de Fon		Ouéléba
	Whisky 1	Whisky 2	Whisky 5
Watershed area	0.49 km ²	0.41 km ²	0.40 km ²
Proportion of area covered by grassland	60%	80%	43%
Proportion of area covered by forest	40%	20%	57%
Description	Canga East camp water supply abstraction upstream of weir	Assumed natural but presence of drill pads and tracks since 2007	Natural

In the local watersheds investigated in the Simandou Range, daily instantaneous flow measurements in comparison with daily rainfall records display a clear seasonal distribution of flow in response to the wet season.

Typically, stream flow begins to increase only in early July, despite the fact that the wet season rainfalls start earlier in March. Seasonal flow remains high, as long as rainfall continues, and declines in September/October. The flow recession continues through the dry season, fed primarily by the groundwater flow system. The hydrological regimes are therefore perennial and dominated by groundwater discharge, but with a significant storm flow component

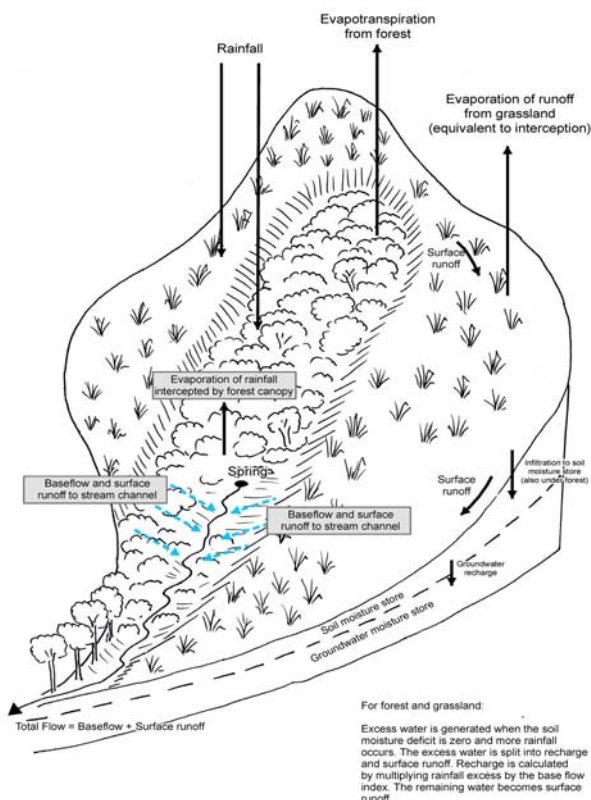
superimposed on the perennial flow in the wet season.

The results also suggest that in the first period of the wet season, the runoff is generated by rainfall falling primarily along the stream channels with limited or no contribution from other areas in the watershed. During the middle part of the wet season a different mechanism appears to be producing the storm flow runoff, with recession curves that last for considerable periods. It is assumed that water at this stage is discharged from storage that has been filled in the surficial deposits and the unsaturated zones during the wet season.

It is assumed that similar conclusions can be drawn from these observations for other watersheds originating from Pic de Fon and Ouéléba. The main factor distinguishing watersheds seems to be the proportion of their areas under forest and grassland. Indeed, grassland and impermeable laterite cover tend to increase runoff, and result in a smaller groundwater recharge (base flow) feeding the stream flow.

A simplified conceptual hydrological model, representative of local watersheds is presented hereafter.

Conceptual hydrological model of Whisky 1 and 2 watersheds



Water Management Consultants

The model displays the physical hydrological system and the typical land cover in the Pic de Fon and Ouéléba watersheds. Results from a preliminary water balance estimate using the data collected suggest that annual storm runoff for the watersheds studied are in the order of 8 to 9% of rainfall; between 13% and 22% of rainfall recharges the groundwater system; and interception losses are about 49% to 61%. This variation is assumed to result from the different proportions of grassland and underlying laterite in the watersheds, which limits infiltration. It also suggests variability in water balance components between mountain watersheds.

The spring surveys carried out in Pic de Fon and Ouéléba has allowed the identification of a total of 149 springs in the wet season survey, and 278 springs in the dry season survey. The dry season survey was assumed to be more representative because of the use of more accurate instruments for the survey and less vegetation. The results indicate that the most distinctive pattern in the data collected is that there are between 3 to 4 times as much springs drained to the west as flow drained to the east on both mountains, probably as a result of higher rainfall rates on the western sides of the Simandou Range. Under this assumption, spring flow is estimated approximately between 3% and 5% of estimated mean annual rainfall in Pic de Fon and Ouéléba.

3.10 HYDROGEOLOGY

It has been essential in this study to identify the characteristics and extent of the main water-bearing geological formations; examine the groundwater flow components; and assess the relationship between groundwater and natural surface water regimes in the surrounding areas.

The primary source of hydrogeological data used in this study has been collected during mineral exploration drilling conducted by Rio Tinto; and pre-feasibility study investigations. Additional information on groundwater level and hydraulic properties has been obtained from a number of piezometers; mineral exploration boreholes; laboratory tests on rock samples; springs and accretion flow surveys; and through the results of a village wells survey.

Typical piezometer head installed in mineral exploration boreholes



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Hydrostratigraphy - The interpretation of the available geological data has provided the information needed in order to establish hydrostratigraphic units, i.e. typical water-bearing and impermeable geological units, within the geological formation sequence in the vicinity of both deposits.

From the surface, the hydrostratigraphic units consist in:

Weathered carapace and transitional zone: This unit is an extended surficial feature, 5 to 20 m thick, composed of clay, goethite and limonite minerals that form a blanket over iron ore formations. The hydraulic properties of this layer are typically poor, which limits rainfall infiltration in depth from the surface, and increases the potential for surface runoff.

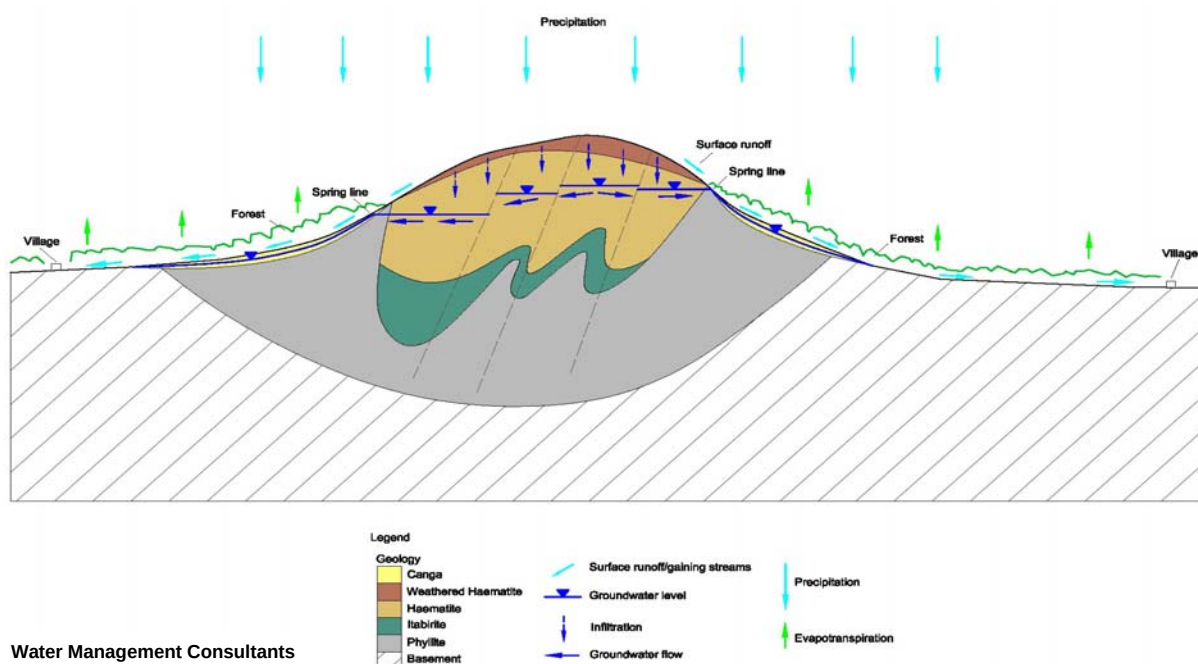
Hematite: This unit is located below the carapace and transitional zone. It occurs in distinct forms (friable hematite; biscuit-like hematite; and hard) characterised by different hydraulic properties that will affect the ability to transmit groundwater. Friable and biscuit-like hematites form the bulk of the ore body and groundwater flow within these units occurs mainly via inter-granular flow mechanisms, whereas the predominant flow mechanism in hard hematite is via the fracture network.

Itabirite: The following unit located below the hematite consists in the itabirite unit. The hydraulic properties of the itabirite are primarily controlled by the degree of fracturation of the unit. The permeability is either extremely low in fresh compact itabirite, where fracture density is generally very low. As opposed, weathered itabirite will provide numerous fracture flow paths.

Phyllite: The phyllite hydrostratigraphic unit is encountered beneath the itabirite. Fresh compact phyllite is generally massive and characterised as hard competent rock with low to very low porosity and permeability. As phyllite is increasingly weathered, observations suggest that the phyllite may also allow some groundwater flow.

Basement: The phyllites are confined in depth by crystalline basement rocks. These rocks are typically unfractured with negligible matrix porosity, and generally considered as impermeable rocks.

Schematic cross-section of the hydrogeological setting in the Pic de Fon deposit



Water Management Consultants

Hydraulic Properties - Laboratory tests on rock samples have allowed the estimation of hydraulic properties. The typical coarser texture and the low clay content measured in the samples suggest that some primary matrix porosity and permeability may be present. As expected, the results indicate that the weathering process tends to increase significantly the porosity of the rock (capacity for water storage): highly-weathered rocks can display porosity of more than 30%; as opposed, compact rock presents typically little porosity, from very tight matrix to 10 % of porosity.

The laboratory estimates of hydraulic conductivity (permeability) suggest that there is a significant variation in values within the various rock lithologies. Furthermore, the high degree of variation in lithology with depth suggest that bulk-rock hydraulic conductivity could be higher, due to the occurrence of permeable layers, and may also explain the formation of perched-water tables over impermeable lithologies.

The field estimates of hydraulic conductivity (permeability) measured in piezometers are in the same range as the laboratory estimates of hydraulic conductivity for compact core samples. Field hydraulic conductivity display however slightly higher values than hydraulic conductivity measured in core samples. This is assumed to result from the occurrence of friable mineralisation, which in the laboratory tests exhibited much higher hydraulic conductivity; the occurrence of permeable layers at depth within the lithological sequence; and the presence of secondary permeability in the fracture network.

Groundwater Levels - Groundwater level is critical information for the characterisation of the groundwater flow components, and the analysis of surface water and groundwater interaction. In addition to groundwater elevation monitoring, the spring surveys have been extremely useful in evaluating geological controls on groundwater flow and determining the elevation of groundwater on hill slopes at Pic de Fon and Ouéléba.

Groundwater elevations vary from over 1,400 m beneath Pic de Fon itself, and decrease to about 1,230 m beneath the Western Spur Valley. In the central and southern zones of Pic de Fon, groundwater levels are lower, and are typically in the range of 1,050 to 1,200 m. Groundwater levels in the northern and central part of Ouéléba are

mainly in the range of 950 to 1,050 m. For the southern part of Ouéléba, groundwater levels have been measured at elevations of around 1,150 m, and decreasing to below 1,000 m in the southwestern part of the area.

In the deposit areas, groundwater elevations decline rapidly with falling topography. The break in slope and occurrence of impermeable geological unit explain in part the numerous springs observed in Pic de Fon and Ouéléba. The groundwater level depths at the Pic de Fon deposit are generally encountered 75 to 175 m below ground level. At the Ouéléba deposit, groundwater levels are generally 100 to 150 m below ground level. At the base of the range, the depth to groundwater in the basement rocks may vary typically between streams from 5 to 30 m.

Long-term groundwater level monitoring clearly demonstrates the seasonal fluctuations, as a result of the wet season recharge. Detailed short-term continuous monitoring dataset currently available for many piezometers is unfortunately of too short duration for interpretation, although some distinct groundwater levels fluctuations have been observed according to the location of the piezometers. More analysis is planned later following the collection of additional data.

Quantification of Groundwater Discharge - Groundwater discharge has been examined with the results of a series of spring and flow accretion surveys. More specifically, the accretion surveys have been very useful in the evaluation of the main groundwater discharge areas. The latter have been identified as the Miya and Kinyeko streams local watersheds draining the northern tip of Ouéléba; the Woron stream watershed draining the central ridgeline and southwest of Ouéléba; and the Western Spur and Fokou West stream watersheds draining Pic de Fon.

The results of the accretion surveys have also been analysed with the objective to evaluate the extent to which flows from the Simandou Range contribute to the regional hydrologic network and the potential for impacts as a result of mining activities. The analysis of regional flow measurements suggest that the streams flowing away from the Simandou ridgeline are the most significant contribution to regional river flows. This contribution decreases moving downstream, as a greater part of flow is derived from offhill watersheds. Baseflow contributions from the less permeable basement rocks is, as expected,

considerably lower than base flow from the range, as flow rates on several streams are seen to stabilise away from the mountain indicating that baseflow is negligible in these areas.

Groundwater Flow Systems - Groundwater recharge at the regional scale is high within all watersheds in the Simandou Range, as a result of the typically high annual rainfall rates. However, significant local variations in recharge rates may occur since hydrogeological properties in mountainous terrain can vary significantly according to the topography, rainfall patterns, soils, vegetation covers, underlying geology, etc.

The recharge has been estimated in Pic de Fon to 600 mm/year, and in Ouéléba to 400 to 500 mm/yr. Recharge rates further away from the range are substantially lower as a result of lower mean annual precipitation.

Most groundwater recharge occurs in the mid to later phases of the wet season, after the removal of the soil moisture deficit, which builds up throughout the dry season. On the hill slopes and on the basement plains, where unsaturated zones are thinner, rainfall infiltrates relatively rapidly to recharge the water table. Conversely, below the ridgeline, groundwater recharge is delayed significantly due to the very thick unsaturated zones and the large number of perched water tables within that unsaturated zone.

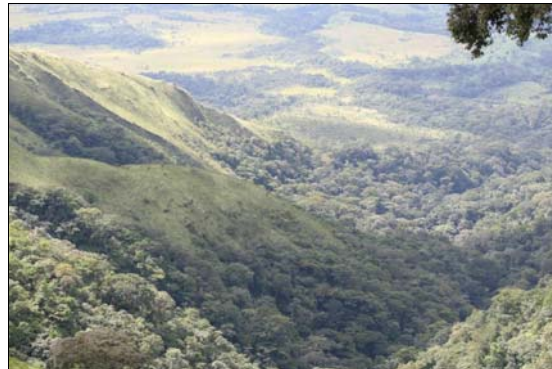
Two separate groundwater systems are present in the Pic de Fon area, the northern system dominated by groundwater flow from Pic de Fon towards Western Spur, and the central-southern system in which groundwater flows south within hematite and fractured itaberite towards Fokou West.

Groundwater levels and flow in Pic de Fon are primarily controlled by the occurrence of the low permeability phyllite; and large geological structures, more specifically the phyllite shear, which bisects the area and creates a boundary between the two groundwater systems. Groundwater flow to the east of Pic de Fon is limited by this phyllite shear.

Consequently, discharge to watersheds on the east central and southern zones is from localised groundwater flow within the itabirites and phyllites. As a result, groundwater flow is mainly to the west via subsurface cascading over poorly permeable itabirites into deeper hematites in the Western Spur Valley area,

where water levels are significantly lower. The Western Spur Valley is the final discharge area for most of the groundwater in the northern Pic de Fon groundwater system.

Western Spur Valley



Tim Wacher

Groundwater flow in Ouéléba is limited to the east and west by the occurrence of low permeability phyllite. The primary groundwater discharge area in Ouéléba is located at the northern tip and flow towards this area is directed into one of two north-south trending troughs of ore, which are separated by a phyllite shear.

The cross-cutting phyllite shear appears to isolate these two bodies of groundwater as the groundwater level data indicate a lower water table to the east of the shear. . A structural control is present in the southern zone of Ouéléba and separates it from the groundwater system to the north. The majority of groundwater discharge in the southern area is towards the west into the Woron stream watershed. All other watersheds along the eastern and western hill slopes are draining localised groundwater systems with little or no discharge from the main Ouéléba groundwater system.

Groundwater flow in watersheds on the basement plain will typically be localised and concentrated in shallow structurally controlled weathered zones in the basement rock. The basement unit has comparatively low storage and permeability.

The results of the hydrogeological investigations have suggested that groundwater discharge from the mountain core is primarily controlled by overspill of groundwater at the contact with underlying low-permeability compact itaberite or phyllite, or via permeable pathways presented by faulting or more dense fracture networks in the geology that surrounding the ore body.

Overspill type discharge areas are observed in the Fokou West watershed, and are also likely to account for the major discharge areas in the north of Ouéléba. The Western Spur Valley is the only location where groundwater discharges through hematites and permeable itabirites in the absence of a low permeability underlying barrier to flow. There are also numerous occurrences of springs and base flow discharging from shallow localised groundwater systems along the hill slopes of Pic de Fon and Ouéléba.

The groundwater system in the study area is entirely local, which means that all water originates from rainfall, with the majority of groundwater leaving the area as stream flow rather than groundwater flow. The local groundwater flow systems hence play a major role in the regional surface water system, maintaining perennial stream flows.

3.11 WATER QUALITY

The Simandou Range is the headwaters of many large western African rivers. Several villages depend of surface and groundwaters for various purposes, such as drinking, bathing, washing, irrigation, etc. Furthermore, groundwater discharge from the range supports perennial base flow in streams originating from the mountains, and where sensitive ecosystems are often encountered. Consequently, a main concern in the project is the potential impacts of mining operations on surface and groundwater quality.

Typical village well



SNC-Lavalin Environment

Detailed analysis has been carried out locally in the vicinity of the proposed mining sites. Surface water and groundwater quality sampling has been undertaken with the objective of defining natural pre-mining water quality. Water samples have been collected in the course of six sampling campaigns in

13 springs, 24 streams and 25 piezometers. Water samples have also been collected in a total of 36 village wells. All water samples have been analysed in a laboratory for a series of physico-chemical parameters. Field measurements for pH, temperature, conductivity, oxidation-reduction potential and dissolved oxygen have also been performed with portable equipment.

Surface Water - The surface water samples collected in the course of the sampling campaigns have exhibited typically very low ionic concentrations.

The spring water samples have displayed the characteristics of water with very little mineralisation. Most of the parameters, including major anions and cations, and trace metals are below detection limit; or present at very low concentrations.

Low pH values have been measured in some water samples. The values were attributed to the pH effect of carbonic acid generation. The small increase in pH observed from spring samples to stream samples is expected, as a result from the small increase in buffer capacity likely occurring through dissolution of base components and the degassing of dissolved atmospheric CO₂.

The results of the stream water samples have exhibited slightly higher solute contents in comparison with upstream spring samples. The major ion and trace element concentrations for stream samples are similar to the spring samples with values measured below detection; or present at very low concentrations.

The concentrations for all physico-chemical parameters of the spring and stream water samples are below the WHO drinking water guidelines (2006).

Short-term variations in surface water quality have been observed in the course of this study. Turbidity data presents the most variability among the parameters monitored continuously in surface waters. Variability reflects changes in a stream's capacity to transport sediments due to an increase in stream flow. Natural variability typically occurs over the course of single storm events.

Spatial variations in surface water quality have also been observed in the results, notably upstream and downstream of the location of villages. Records for the upstream sampling

sites are assumed representative of the flow as it arrives at the point of use and the records for the downstream sampling point are representative of the water as it leaves the point of use. Differences would be associated to activities carried in the villages.

Groundwater - Groundwater samples have also exhibited the characteristics of very low mineralised waters. The results display very low dissolved solids concentrations in the groundwater samples. The low ionic concentrations measured in the samples suggest that groundwater has a relatively short residence time following infiltration.

Sample pH is also typically low in groundwater indicating acidic water. These results are consistent with the pH effect of carbonic acid generation, which can decrease the pH of water to 5.5-6. The low ionic strength of the water favours carbonic acid generation. This pH range could also be obtained when more acidic water is buffered by FeOH_3 or FeOOH .

Major ions are typically measured at similar small concentrations, i.e. less than 1 mg/l; or often below detection limit. Iron and manganese concentrations are generally low, although slightly elevated in some piezometers, which is not surprising in an iron ore geological environment. Several heavy metals detected in the groundwater samples are close to, or below the method detection limit. However, they can be considered as background values of the natural groundwater geochemistry.

Very few groundwater samples have displayed concentration above the WHO drinking water guidelines (2006). It was the case only for manganese and lead (eight samples).

Village Well Water - The water sampled in the village wells has generally displayed a larger dissolved content than the water from the spring, stream and piezometer samples. Despite these higher conductivity values, the dissolved content measured in the water still indicates freshwater characteristics.

Village wells can exhibit signs of groundwater pollution that can originate from latrines, surface spills and other effects of human activity performed in the surroundings of the wells. Thus, the construction of the well has a large control on the extent to which sources of contamination can impact the well water quality.

According to the previous assumption, it is not surprising that nitrate is present in much larger concentrations in the village well water than in the other water samples. Furthermore, during the hydrocensus, well sample water has been tested for the presence of faecal coliforms. Samples with high levels of faecal coliforms are measured in open dug wells; and there is almost a complete absence of coliforms in boreholes with handpumps.

Water Quality - Surface water and groundwater are generally of good quality, with a few exceptions. The spring samples have presented the lowest solute concentrations among all water samples collected in the course of this study. However, the results from the sampling campaigns suggest that quality is already affected by human activities near some villages and in the vicinity of roads.

3.12 NATURAL HAZARDS

Knowledge of natural hazards can assist in the identification of potential risks on mine infrastructure integrity, mining operations, local transportation. Among potential natural hazards, the most important, landslide, seismicity, and flooding, have been examined in this study.

Landslide - The steep natural slopes on the flanks of the Simandou Range, weak geological conditions and seasonal tropical environment represent favourable conditions for landslide hazards. This is confirmed by the occurrence of debris flows (canga), and unstable ground observed near drilling pads and new roads.

However, there is very little evidence of current, natural, active landslide instability, and landslides that may have developed in the past have largely been stabilised. Despite this observation, these ancient features represent a hazard to pit planning and operations where such buried features remain. These potential hazards areas should be taken into account in defining mine infrastructure.

Regional Seismicity - Existing data indicate that seismicity risk is low. Guinean territory lies on very ancient rocks of the West African Craton, which are typically relatively stable. These geological formations have not been affected by recent tectonic phenomena.

The most important earthquakes that occurred recently in Guinea were in the area of Koumbia in 1983 and Boffa 1986 (magnitude

of 4.5 and 5.0 on the Richter scale, which typically produces limited damages).

Floodable Areas - The zones that are sensitive to flooding during periods of heavy rainfall are primarily the *bas fonds*. These valleys, often encountered at the base of Pic de Fon and Ouéléba, are sometimes used by local people. However, all villages are located outside these potential flooding areas.

Although some traces of floods have been observed at road crossings, no information is available on the occurrence or duration of flooding events.

Example of natural landslides on Pic de Fon



Rio Tinto

4. BIODIVERSITY BASELINE

4.1 INTRODUCTION

The Simandou Project is driven by two biodiversity policies: Rio Tinto's Biodiversity Strategy and IFC's Performance Standard 6.

To meet the requirements of these policies, a baseline study was carried out in order to assess the biodiversity values of the mine site environment. The main objectives of the biodiversity baseline study were; i) to identify priority biodiversity values and determine conservation priority species (CPS) as well as important ecosystem services requiring particular management attention; and ii) to provide a baseline against which progress towards the requirements of the two biodiversity policies driving the Simandou Project can be measured.

4.2 BIODIVERSITY STUDY AREAS

The biodiversity baseline study encompasses two study areas:

- A local study area (LSA) centered on the Pic de Fon Classified Forest (PdF CF) and where direct biological impacts of the mine are expected.
- A regional study area (RSA) designed to capture similar conditions and habitats to those of the PdF CF. Surveys within the RSA targeted conservation priority species identified within the LSA.

4.3 REGIONAL CONTEXT

The RSA lies within the Guinea Highlands, a densely forested mountainous plateau, and is included in the Loma-Man Highlands. The region is internationally known for its biological richness. It is part of the Upper Guinea Forests Endemic Bird Area and the Guinean Forests of West Africa Biodiversity Hotspot.

The region encompasses three Important Bird Areas, four Key Biodiversity Areas, one Alliance for Zero Extinction site, as well as five areas that were identified as Priority Conservation Zones in a regional study conducted by Conservation International. It also contains four different types of protected areas (one strict nature reserve, one world heritage site, one biosphere reserve and 17 classified forests).

As for the LSA, it is part of the Fon-Tibé Priority Conservation Zone and it includes the PdF CF. This Classified Forest covers 252 km² and was established by a decree in November 1953 mainly to protect water, forests and soil against erosion. The PdF CF is designated by Conservation International as a Key Biodiversity Area. It is currently managed by the N'Zérékoré Forestry Centre (CFZ).

4.4 METHODOLOGY

The execution of the biodiversity baseline involved four main steps:

- Review of previous studies and preliminary biodiversity assessment
- Execution of baseline surveys
- Compilation, analysis and presentation of results
- Identification of priority biodiversity values, including CPS and important ecosystem services.

The baseline findings also provided the basis for the assessment of critical habitats. This step is however covered in a separate document produced by The Biodiversity Consultancy Ltd.

i) Review of Previous Studies - The studies conducted as part of the Simandou Project or independently of the project were reviewed to prepare a preliminary assessment of the LSA's biodiversity, define taxonomic groups to be studied in the baseline study and guide field inventories.

ii) Execution of Baseline Surveys - In order to extend the breadth of available data and knowledge on fauna and flora of the LSA, field surveys were undertaken as part of the baseline study.

From November 2007 to December 2008, baseline field surveys were carried out for six groups of species (flora, large mammals, small mammals, birds, amphibians and reptiles,

freshwater fish) as well as for four classes of ecosystem services (provisioning, cultural, regulating and supporting services). For each taxonomic group, international experts and qualified Guinean specialists were hired to coordinate and/or participate in the field studies.

Two types of surveys took place as part of the baseline study:

- General surveys: exhaustive surveys undertaken to characterise the flora and fauna of the LSA and identify CPS.
- Targeted surveys: specific surveys undertaken within the RSA and LSA to better document the distribution and habitat preferences of the CPS.

Royal Botanic Gardens, Kew field team



Royal Botanic Gardens, Kew

iii) Compilation, Analysis and Presentation of Results - All results from previous studies were analysed for validation before their inclusion in the baseline study. Some of these previous studies showed limitations and discrepancies in comparison to the baseline study data. Consequently, some previous studies done by generalists rather than specialists were not included in the biodiversity baseline, where subsequent expert review as part of the baseline study indicated that their results were unreliable.

For each taxonomic group, results were compiled to produce validated lists of species known to occur within the LSA. These lists were then screened for identification of species with special status or features, including threatened species according to the 2008 IUCN Red List of Threatened Species and the *National Monograph on the Biological Diversity of Guinea*; endemic or restricted-

range species; species new to science; and invasive species.

All the data considered in the biodiversity baseline study were gathered into a central database and different maps were produced to illustrate the sampling sites, the vegetation types and species distribution as well as other results.

iv) Identification of Priority Biodiversity Values - The biodiversity values of greatest significance to local communities, global conservation communities or international institutions were identified to facilitate the management effort of the project stakeholders and prioritise investments.

A custom-built methodology, the Biodiversity Values Matrix, was used to identify priority biodiversity values in line with IFC's Performance Standard 6 and Rio Tinto's Biodiversity Strategy.

Biodiversity Values Matrix

	Species	Habitats	Ecosystem processes
Existence values	Category 1	Category 2	Category 3
Service values	Category 4	Category 5	Category 6

The Biodiversity Values Matrix is a simple tool to help identify the main biodiversity issues relevant to the operation on site, whether at the species, habitat or ecosystem levels. The matrix considers the existence values of species (e.g. rare species) as well as their utilitarian sense (e.g. service values). This results in six categories of biodiversity value:

Category 1: is based on vulnerability (threat) and irreplaceability (endemism) of species.

Under the vulnerability principle, Critically Endangered and Endangered species, according to the IUCN Red List as well as the *National Monograph on the Biological Diversity of Guinea*, were classified as CPS.

Under the irreplaceability principle, species were considered as CPS if they are endemic to the LSA, restricted to the Simandou Range (flora species), to the Loma-Man Highlands (large and small mammal, amphibian, reptile and fish species) or restricted to an area of less than 50,000 km² (bird species).

Migratory and congregatory species also fall within this first category.

Category 2: refers to uniqueness of a habitat and/or associated species assemblage which is generally associated with the rarity of a habitat or particular landscape feature.

Category 3: concerns particular ecosystem or landscape features which led to distinct evolutionary processes.

Categories 4 and 5: include species and habitats valued for the goods, products and services they provide to local communities. The provisioning and cultural services fall within these categories.

Category 6: consists of supporting and regulating ecosystem services which operate over a relatively large spatial scale (e.g. erosion control, water flow).

The methodology used to identify the ecosystem services of relevance to the Simandou Project was based on the spatial scale and importance of the ecosystem services for the beneficiaries.

4.5 VEGETATION TYPES

Different vegetation types characterise the PdF CF. Throughout the biodiversity baseline, these vegetation types are considered as the main different habitats for the flora and fauna in question.

Methods - Three main steps led to the identification, description and mapping of the PdF CF vegetation types.

First, a vegetation classification scheme was determined using standard terminology and discriminating classification units which are ecologically meaningful and easily discernible in the field.

Second, the vegetation types were delineated by interpreting available data from satellite images and high resolution aerial photos.

Third, field vegetation sampling (ground-truthing) was undertaken to identify and characterise each vegetation type, validate their distribution within the PdF CF and confirm the data interpretation.

Results - Seven main vegetation types were identified within the PdF CF including two vegetation types dictated by altitude and considered to be rare in Western Africa:

submontane grassland and evergreen submontane forest.

Submontane grassland and forest in the Pic de Fon Classified Forest



Royal Botanic Gardens, Kew

Submontane grassland, including rock outcrops and seasonal swamps, occupies the top of the ridge (mostly >1000 m altitude), an area totaling 25 km² (10% of the PdF CF).

Primary forests (lowland and submontane forests) make up c. 44% of total surface area of the CF, located mainly on the western slopes of the ridge. The submontane forest mostly occupies the belt from >800 m altitude and the lowland forest lies below this altitude. On the eastern side, primary forest is mainly restricted to narrow ravines and galleries which intersect the savanna matrix.

Vegetation types within the Pic de Fon Classified Forest

Vegetation type	% of the PdF CF
Submontane grassland	9.7
Evergreen submontane forest	16.0
Semi-deciduous lowland forest	27.9
Secondary forest	7.7
Savanna woodland and wooded grassland	20.2
Savanna grassland	16.5
Cultivated areas, plantations and fallow land	1.9
Other land uses	0.1

In between the two submontane vegetation types, a thin transition zone whose structure and plant composition differs from either of two is found. Despite the fact that this zone is not considered as a distinct vegetation type, it is nevertheless an important habitat for some species.

Secondary habitats (secondary forests, savannas) and cultivated areas make up 46% of the CF surface area.

Overall, the PdF CF is covered 55% by natural habitats while the other 45% has been modified by anthropogenic activities. Modified habitats are mostly distributed in the peripheral areas of the PdF CF, near villages.

4.6 FLORA

Although botanical work in the Loma-Man Highlands was initiated many years ago, the PdF CF flora was still unknown until recently. The main objectives of the baseline botanical surveys were thus to provide a comprehensive understanding of the floral diversity of the PdF CF, identify flora CPS and expand the known distribution of these CPS at the regional level.

Methods - As part of the baseline surveys, a total of 13 flora campaigns was conducted within the LSA (294 man-days) and RSA (102 man-days) by a team of 12 international experts and nine local specialists. The campaigns were carried out at different sampling periods to cover all vegetative stages and collect fertile material.

Two field sampling methods were used: i) general field sampling using different plot sizes in which all flora species were recorded; and ii) targeted field sampling in suitable CPS habitats. In this case, no specific technique was used other than visual surveys.

The flora sampling effort was mainly deployed in habitats known for their high floral diversity as well as in habitats most likely to be affected by future mining activities, such as the submontane habitats and lowland forest.

Over all flora campaigns, specimens were gathered along with plot vouchers for identification by experts from RBG Kew and other institutions.

Results - Within the LSA, 1,204 vascular plant species representing 149 families have been identified and 345 specimens still need to be identified to species level. The floral diversity was greatest within submontane habitats and lowland forest.

Among the species whose presence has been confirmed:

- three are listed as Endangered on the IUCN Red List of Threatened Species

(*Brachystephanus oreacanthus*, *Dorstenia astyanactis*, *Tieghemella heckelii*), 16 as Vulnerable and one as Conservation Dependent;

- one is new to science (*Brachystephanus oreacanthus*) and eight are possibly new but require further research to clarify their status;
- none are endemic to the LSA nor to the Simandou Range; and
- two are invasive species and 89 are weed species.

Brachystephanus oreacanthus



Royal Botanic Gardens, Kew

Level of Confidence and Representativity of Flora Surveys - Leveling trend of the species curve for surveys above 1,000 m altitude indicates that the confidence level in these surveys is relatively high. RBG Kew estimates that about 99% of the LSA submontane grassland species and 90-95% of the submontane forest species have been recorded.

On the other hand, the still increasing accumulation curve for surveys below 1,000 m altitude suggests that additional species might be found. Consequently, RBG Kew evaluates that 20-30% of the lower grassland species have not been recorded yet.

The baseline flora campaigns covered about 35% of the PdF CF area.

4.7 LARGE MAMMALS

The LSA falls within a region known for its overall mammalian diversity and particularly for its primate richness.

The objectives of the large mammal baseline surveys were to document the large mammal diversity of the PdF CF, provide a population estimate or distribution range for each large

mammal species recorded (when possible) and identify large mammal CPS.

Methods - The large mammal surveys were scheduled for a full 13-month period in order to account for changes in seasonal movements and distribution of species. This field effort translated into 1,649 km walked and 3,686 camera trapping days in addition to the 44 man-days deployed during an earlier survey, the RAP-35.

A combination of five field techniques was used by the international and local team members:

- a network of 34 systematic transects (c. 2 km each) covering the entire PdF CF and surveyed every six weeks;
- 21 reconnaissance walks surveyed every six weeks to provide supplemental information on important habitats, such as gallery forests;
- 53 exploration tracks to explore newly discovered zones of interest;
- sound recording of primate calls to identify the presence of elusive species; and
- camera trapping at 71 different sites throughout the PdF CF to monitor elusive and nocturnal species.

It should be noted that no large mammal surveys were conducted at the regional level as the regional distribution of the large mammal CPS was already well known.

Results - A total of 35 large mammal species, representing 13 families, were recorded within the PdF CF. This number includes 11 primate species and 24 other large mammal species.

Among the 35 species, one is listed as Endangered on the 2008 IUCN Red List (West African Chimpanzee), one is Vulnerable (Western Black-and-White Colobus) and five are Near Threatened.

No large mammal species surveyed within the PdF CF are endemic or restricted to the Loma-Man Highlands, but three species are restricted to the Upper Guinea Forests (Sooty Mangabey, Bourlon's Genet and Common Cusimanse).

The data analysis revealed that the preferred habitats of the large mammal species, including the Chimpanzees, are generally the

dense forests and particularly the gallery forests. While the primate species mostly occur between 800 and 1,100 m altitude, the other large mammals occur at a wide range of altitudes.

With a distribution rate of 76 and 61%, the Red River Hog and the Bushbuck are the most widespread large mammal species within the PdF CF, while the Chimpanzee and Campbell's Monkey exhibited the widest distributions among primate species.

Regarding Chimpanzees, 874 observations were recorded, including 10 sightings, 48 camera trap events and 728 nests. Nest analysis, together with all information collected during the baseline surveys, provided a range for the PdF CF Chimpanzee population of 15-49 individuals.

Chimpanzee camera trap photo



Tim Wachter

In the PdF CF, Chimpanzees show a clear preference for submontane forests and gallery forests at higher altitudes. They are concentrated on the west side of the ridge and, as with the other primate species, are mainly found in the vicinity of the PdF proposed mining area and, to a lesser degree, of the Ouéléba one.

It should be noted that the primate species seem to be absent from the southwestern lowland forest block of the PdF CF.

Level of Confidence and Representativity of Large Mammal Surveys - The baseline large mammal surveys were exhaustive, extending over a whole year and covering 78% of the area of PdF CF.

The large mammal accumulation curves indicate that no new large mammal species were added after 142 days of fieldwork and 69 days of camera trapping confirming the high confidence level of the baseline surveys.

4.8 SMALL MAMMALS

The small mammal group includes species in the orders of Rodentia (rodents), Chiroptera (bats) and Soricomorpha (shrews). The small mammal baseline surveys were intended to obtain comprehensive knowledge of the PdF CF small mammal fauna and identify CPS.

Methods - Two small mammal campaigns were undertaken during the baseline study; one covering the dry season and one covering the end of wet season.

The team of international experts and local field guides applied various sampling methods. For the terrestrial small mammals (rodents and shrews), trapping was done using Sherman traps, Museum Special traps, Victor Rat traps, Tomahawk live traps and pitfall bucket traps. Tethered snap traps were also used to access difficult areas and camera traps were deployed to capture elusive small mammal species.

For sampling bats, the team used a “triple high forest filter mist net” system of three stacked 12-metre nets, as well as one 18-metre and three to five 6-metre ground level mist nets.

Including the RAP-35, a sampling effort of 209 man-days was spent in the PdF CF. The total trapping effort added up to 4,585 trap-nights for terrestrial small mammals while for bats, the capture effort amounted to 1,873 net-hours in addition to 112 harp trap-hours.

No small mammal surveys took place at the regional scale as no small mammal CPS have been identified within the LSA.

Results - Including the RAP-35 and baseline study results, 71 small mammal species (33 bats, 12 shrews and 26 rodent species representing 14 families) were recorded within the PdF CF. Muridae is the largest family represented with 15 species.

The bat captures were most diversified in the semi-deciduous lowland forest and submontane forest while the most species-rich habitat for terrestrial small mammals was the submontane grassland.

Among the small mammal species recorded some show special features:

- five bat species (15%) depend strictly on caves for day roosts and eight species (24%) are partially dependant on caves;

- none are classified as Endangered according to IUCN Red List, but one is Vulnerable (*Rhinolophus guineensis*), four Near Threatened and four Data Deficient;
- one bat species may constitute a new species for Guinea or to science (*Neromicia* cf. *grandidieri*) and one shrew species warrants full species status (*Crociodura nimbasilvanus* currently classified as a subspecies of *Crociodura goliath*); and
- one species is considered to be restricted to the Guinea Highlands (*Rhinolophus guineensis*), one might be restricted to the Loma-Man Highlands once described as a separate species (*Crociodura [goliath] nimbasilvanus*) and eight are endemic to the Upper Guinea Forests.

Level of Confidence and Representativity of Small Mammal Surveys - Considering the two baseline campaigns as well as the camera trapping, the small mammal surveys covered 25% of the area of the PdF CF.

Both terrestrial small mammal and bat accumulation curves show a long plateau for about 20 days before rising again after 45-48 days of fieldwork, suggesting that many days were required before finding new species.

Crociodura [goliath] nimbasilvanus and *Micropteropus pusillus*



Jan Decher

4.9 BIRDS

The PdF CF overlaps the Upper Guinea Forests Endemic Bird Area as well as two vegetation zones of importance for birds: the Guinea-Congo Forests biome and the Sudan-Guinea Savanna biome.

Birds are good indicators of the biodiversity of a site. Therefore, the baseline study objective was to list the birds occurring in the PdF CF, but also to identify bird CPS and document their regional distribution.

Methods - During the baseline survey, three campaigns dedicated to birds were carried out by international and local specialists. The first two campaigns were undertaken at two distinct periods (dry season and end of wet season) within the LSA in order to improve the initial bird list of the RAP-35. During the third campaign, the LSA and RSA were visited by the field team to conduct targeted surveys on bird CPS.

Overall, and including the RAP-35, a sampling effort of 153 man-days (71 field-days) was devoted to the avifauna of the PdF CF.

The methodology followed consisted of visual observations with binoculars and listening to birds while walking in the different vegetation types. Because birds are more active early morning, the fieldwork began just before dawn and lasted until late afternoon. Night inventories also took place in order to survey nocturnal birds.

During the targeted surveys, the field team especially looked for Sierra Leone Prinia (*Schistolaia leontica*). This species is highly restricted to the transition zone between submontane forest and submontane grassland, a rare habitat in West Africa. In this specific case, the team replayed vocalisations of the species in favorable habitats.

Results - Within the LSA, 353 bird species, representing 60 families, were recorded during the RAP-35 and the baseline surveys (142 non-passerines and 211 passerines). This number represents over half of Guinea's known avifauna species, currently comprising 660 species.

Among the bird species recorded, some have particular status:

- no Endangered species but six Vulnerable species, five Near Threatened and one Data Deficient, according to the IUCN Red List;
- nine restricted-range species with a breeding range of less than 50,000 km²;
- 12 species endemic to the Upper Guinea Forests; and

- 121 species confined to the Guinea-Congo Forests biome and 13 confined to the Sudan-Guinea Savanna biome.

As a result of its great avifaunal diversity, the presence of species of global conservation concern and the assemblage of restricted-range and biome-restricted species, the PdF CF would likely qualify as an Important Bird Area (IBA) if it were to be assessed against the IBA criteria.

Level of Confidence and Representativity of Bird Surveys - The three avifauna campaigns undertaken as part of the baseline study covered 41% of the PdF CF area. All vegetation types were sampled and all results were reviewed by international experts.

The bird accumulation curve, which only starts to flatten after about 70 field days, suggests that other bird species could be found within the LSA. However, according to Demey, the total number of species inventoried indicates that the confidence level of the avifauna study is relatively high.

Anthus similis



Tim Wacher

4.10 AMPHIBIANS AND REPTILES

The PdF CF offers many different habitat types suitable to amphibian and reptile species. The purpose of the amphibian and reptile baseline surveys was therefore to describe this herpetofaunal diversity, identify CPS within the PdF CF and document their regional distribution.

Methods - The results of three different surveys undertaken within the LSA were considered in the amphibian and reptile baseline study: the RAP-35, the survey carried out by M.A. Bangoura as part of his DEA and the baseline survey including two distinct field campaigns.

While the first baseline campaign was designed to characterise the LSA's general amphibian and reptile diversity, the second

campaign targeted CPS, both within the LSA and the RSA. A total sampling effort of 331 man-days was deployed in the LSA, covering all vegetation types of the PdF CF.

Because the wet season is the most active period for amphibians (period of reproduction and calling), the two baseline campaigns were undertaken within this season. Each time, the semi-deciduous lowland and evergreen submontane forests were the most surveyed vegetation types as it has been demonstrated that amphibian biodiversity is much greater in primary forests than in savanna habitats.

The baseline team, composed of international experts and national specialists, used three different techniques to survey amphibians and reptiles: i) opportunistic visual and acoustic observation of available habitats; ii) examination of shelters; and iii) standardised exhaustive collection method for quantitative inventories in submontane grassland habitats and primary forests (using quadrants).

Genetic analyses were also performed to determine species with uncertain taxonomic status.

Results - With 58 amphibian species, belonging to 11 families, the PdF CF proved to be one of the most diverse sites for amphibians in the Upper Guinea Forests region. As for reptiles, 35 species belonging to 14 families were inventoried.

Amnirana fonensis* and *Botrophthalmus lineatus



Annika Hillers, M. Alhassane Bangoura

As expected, the amphibian and reptile diversity is highest in the PdF CF primary forests (evergreen submontane forest and semi-deciduous lowland forest) followed by submontane grasslands and savannas.

Among the species recorded, some are classified as of particular status, such as:

- three Endangered amphibian species (*Arthroleptis cruscum*, *Hylarana*

occidentalis, *Phrynobatrachus annulatus*), nine Near Threatened and three Data Deficient, according to the IUCN Red List;

- one Vulnerable reptile species (*Osteolaemus tetraspis*) according to the IUCN Red List;
- two confirmed new amphibian species to science (*Conraua* nov. sp., *Petroedetes* nov. sp.);
- one amphibian species endemic to the Guinean Highlands (*Hylarana fonensis*) and four to the Loma-Man Highlands; and
- two invasive species (*Hoplobatrachus occipitalis* and *Bufo maculatus*).

Level of Confidence and Representativity of Amphibian and Reptile Surveys - The leveling-off of the amphibian species accumulation curve after 89 field days suggests that the level of confidence associated with amphibian surveys is high. However, the still increasing species accumulation curve for reptiles indicates that additional reptile species are still likely to be found in the PdF CF.

The amphibian and reptile baseline surveys covered 22% of the PdF CF area.

4.11 FRESHWATER FISH

Prior to the baseline study, no freshwater fish surveys had been conducted within the PdF CF. Therefore, a biological assessment of freshwater fish was necessary to characterise the PdF CF fish populations and to identify fish CPS.

Methods - Based on their accessibility, utilisation by local communities and permanent flow, 26 sampling sites were selected by the local field team following an inception visit in the riverine villages of the PdF CF. The sites, located on different watercourses, were representative of the four watersheds covering the PdF CF: the Milo, Dion, Loffa and Diani watersheds.

To analyse the seasonal variations of the freshwater fish captures, the same sites were sampled during the two distinct hydrological seasons (wet and dry seasons). These two campaigns totalled 46 fishing days.

In order to sample all varieties of fish and explore various aquatic microhabitats, two fishing techniques were used:

- Nocturnal passive fishing using gillnets in watercourses with minimum water depth of 0.5 to 1.5 m. Gillnets of various mesh sizes were set at night and removed in the morning.
- Diurnal active fishing using short nets and dipnets in shallow water and cast nets in the same locations as the gillnets.

All surveyed species were photographed and their identification was validated by international specialist.

Active fishing using cast net



Mambi Magassouba and Sékou Camara

Results - Baseline surveys revealed a diversity of 36 freshwater fish species in the watercourses draining the PdF CF. The number of species surveyed during the wet season (29) was very similar to the 30 species captured in the dry season.

Among the 14 families represented, the Cyprinidae and Alestidae seem to dominate the PdF CF watercourses. The Diani River watershed, located on the west side of the ridge, appears to have the greatest diversity in terms of fish species (28), followed by the Dion watershed (18), the Loffa (12) and the Milo (7).

According to the fish expert and to the IUCN Red List provisional status:

- three species are considered as Endangered (*Barbus lauzannei*, *Epiplatys njalaensis* and *Epiplatys roloffii*), four as Vulnerable, and two as Near Threatened;
- six species are endemic to the Upper Guinea Forests zone, two are endemic to the Guinean Highlands and three to the Loma-Man Highlands (*Amphilius platycheilum*, *Epiplatys lamottei*, *Epiplatys roloffii*); and
- one species is invasive (*Oreochromis niloticus*).

Level of Confidence and Representativity of Freshwater Fish Surveys - The fishing sampling effort within the LSA was representative of the size of the different watersheds draining the territory. Moreover, the flattening of the species accumulation curve indicates that no new freshwater fish species were captured during the last six days of inventories.

4.12 PRIORITY BIODIVERSITY VALUES

The multiple surveys undertaken as part of the baseline study led to a comprehensive knowledge of the flora and fauna diversity within the PdF CF.

Some components of this biodiversity, known as priority biodiversity values, are particularly relevant to the operation on site as they present important existence values or utilitarian values. These priority biodiversity values have been identified according to the six biodiversity values matrix categories.

Category 1 - Existence Values of Species - In this category fall species threatened with extinction (according to the vulnerability principle), endemic or restricted-range species (according to the irreplaceability principle), and also migratory and congregatory species.

While no species recorded within the PdF CF are Critically Endangered, 11 are classified as Endangered at the international level (2008 IUCN Red List) or at the national level (*National Monograph on the Biological Diversity of Guinea*). These species are therefore classified as CPS.

Regarding the irreplaceability of species surveyed within the PdF CF, none are endemic to this area, but 16 are known to have localised geographical distribution and therefore are also classified as CPS. These restricted-range species include nine bird species with a breeding range of less than 50,000 km² as well as four amphibian and three fish species restricted to the Loma-Man Highlands.

Overall, the area harbours 24 conservation priority species as listed in the following table.

Conservation priority species recorded within the local study area

Species	EN	RR
Flora CPS (<1% of total species)		
<i>Dorstenia astyanactis</i>	X	-
<i>Tieghemella heckelii</i> (Cherry Mahogany)	X	-
<i>Brachystephanus oreacanthus</i>	X	-
Large mammal CPS (5.7% of total species)		
<i>Pan troglodytes verus</i> (West African Chimpanzee)	X	-
<i>Colobus polykomos polykomos</i> (Western Black-and-White Colobus)	X	-
Bird CPS (2.5% of total species)		
<i>Lobotos lobatus</i> (Western Wattled Cuckoo-Shrike)	-	X
<i>Criniger olivaceus</i> (Yellow-bearded Greenbul)	-	X
<i>Bathmocercus cerviniventris</i> (Black-headed Rufous Warbler)	-	X
<i>Schistolais leontica</i> (Sierra Leone Prinia)	-	X
<i>Apalis sharpii</i> (Sharpe's Apalis)	-	X
<i>Melaenornis annamarulae</i> (Nimba Flycatcher)	-	X
<i>Picathartes gymnocephalus</i> (Yellow-headed Picathartes)	-	X
<i>Illadopsis rufescens</i> (Rufous-winged Illadopsis)	-	X
<i>Parmoptila rubifrons</i> (Red-fronted Antpecker)	-	X
Amphibian CPS (10% of total species)		
<i>Hylarana occidentalis</i>	X	
<i>Arthroleptis cruscum</i>	X	X
<i>Conraua</i> nov. sp.	-	X
<i>Petropedetes</i> nov. sp.	-	X
<i>Phrynobatrachus annulatus</i>	X	-
<i>Ptychadena submascareniensis</i>	-	X
Freshwater fish CPS (11% of total species)		
<i>Barbus lauzannei</i>	X	X
<i>Epiplatys njalaensis</i>	X	-
<i>Epiplatys lamottei</i> (Redspotted Panchax)	-	X
<i>Epiplatys roloffii</i>	X	X

EN: Endangered species
RR: Restricted-range species

As for migratory species, four bat species surveyed in the PdF CF are known to migrate within Africa while 39 bird species are either Intra-African migrants or Palearctic migrants.

Finally, 11 bat species found in the PdF CF are known to form large colonies of hundreds or thousands of individuals (within their broader global distribution) and six bird species have congregatory behaviour.

Despite the presence of these migrants and congregatory species, there are currently no indications that the PdF CF constitutes a major flyway where migratory or congregatory bats or birds concentrate in significant numbers. Consequently, no migratory or congregatory species were identified as CPS as the PdF CF does not hold globally significant numbers of any such species.

Category 2 - Existence Values of Habitats

The PdF CF holds a rich assemblage of flora and fauna. Its highland vegetation types (submontane forest, submontane grassland and transition zone), rock outcrops and seasonal swamps offer rare flora and fauna habitats.

The species assemblages found within each of these habitats are differentiated from the surrounding habitats and have a high concentration of species of conservation interest. However, these flora and fauna assemblages are not unique to the PdF CF as similar species compositions are found throughout southeast Guinea.

Furthermore, no plant species assemblage specifically linked to hematite is known to occur within the PdF CF.

Category 3 - Existence Values of Ecosystems

Unique evolutionary processes, influenced by the particular attributes of a region, gave rise to specific species configurations in southeastern Guinean areas such as Mount Nimba and Ziama CF.

Even though the PdF CF shelters a rich fauna and flora diversity, such evolutionary processes do not seem to have occurred in this area as suggested by the absence of locally endemic species.

Categories 4 and 5 - Services Values of Species and Habitats

Field surveys showed that the LSA's biodiversity components provide local communities with provisioning services (goods, products) as well as cultural services. Consequently, many common species, which have not been prioritised as of biodiversity conservation concern, are of high importance to the economic livelihoods or subsistence of local communities.

In terms of provisioning services, six sub-categories were assessed to be essential or of high importance for beneficiaries:

Wild food - plants: some 36 species of the PdF CF are currently harvested by local communities for consumption or selling on the local market.

Wild food - bushmeat: 31 wildlife species (including Chimpanzee) are known to be hunted in the village territories of the PdF CF and provide an important source of proteins to villagers. Current levels of hunting are unsustainable and constitute a significant threat to large mammal species in the PdF CF.

Timber and other wood fibres: local communities use 47 tree species for household construction, furniture, fencing, cooking utensils, etc.

Biomass fuel: local communities depend on fuel wood and charcoal for domestic energy. Some 31 species are used to satisfy this energy need.

Water supply: surface and groundwater is used by local communities for drinking, washing, bathing, domestic purposes, subsistence fishing and small-scale agriculture irrigation.

Natural medicine: from the 55 species recorded within the PdF CF and identified as having medicinal value, 46 seem to be harvested by local communities to treat various diseases.

Among the species providing provisioning services, only the Chimpanzee (hunted species) meets the CPS criteria, but several others are protected under Article 78 of the Forest Code.

Goods and products of the local study area



N'Zérékoré Forestry Centre; Jan Decher

In terms of cultural services, 91 cultural-spiritual sites have been recorded within the LSA. Among these sites, 20 are both related to biodiversity and considered of high importance for the beneficiaries. These sites are mainly located outside the PdF CF.

Category 6 - Service Values of Ecosystems -

The ecosystem processes occurring within the PdF CF provide many regulating and supporting services. While no supporting services are considered of high importance in the context of the Simandou Project, four sub-categories of regulating services were assessed as being essential or of high importance:

Regional and local climate: the local-scale orography of the Simandou ridge influences local distribution, quantity and timing of precipitation and fog as well as temperature and wind. The climate patterns and the hydrological patterns also influence the distribution and density of vegetation types and plant species within the PdF CF.

Water regulation: the Simandou ridge plays an important role in water regulation. Within the PdF CF, all groundwater recharge occurs due to infiltration of rainfall into the substrate along ridge crests and upper slopes. There is a very strong surface and groundwater inter-connection throughout much of the study area.

Erosion regulation: the vegetation cover protects soil from erosion by rain drop impact, and root systems bind soil and prevent soil loss. This is particularly of high importance within the PdF CF where very steep slopes are found. Of the different vegetation types, the role of submontane grasslands is the most important as it is found on the highest and steepest slopes.

Water purification and waste treatment: vegetation cover and soils of the PdF CF play an important role in water purification. This regulating service is of high significance to beneficiaries using surface water for domestic purposes.

4.13 SPECIES DIVERSITY

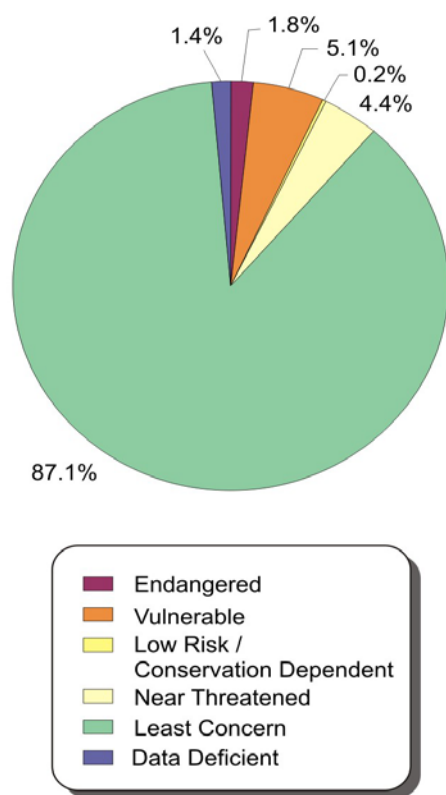
As part of the baseline study, the species diversity of the PdF CF has been analysed in regards to the number of species, vegetation types and the species' habitat preferences.

Species Diversity - Overall, the biodiversity baseline study has confirmed the presence of 1,792 species within the PdF CF, including 588 fauna species and 1,204 flora species. The presence of a great diversity of indicator species, such as amphibians, suggests that the PdF CF is an environment of high quality for fauna and flora.

Results show that the PdF CF harbours about 39% of the known flora species occurring in Guinea, 65% of the primates, 56% of the small mammals, 53% of the birds, 76% of the amphibians and 25% of the known reptiles.

Among the 1,792 species surveyed, 564 are listed on the IUCN Red List of Threatened Species either as Endangered (10 sp.), Vulnerable (29 sp.), Lower Risk/Conservation Dependent (1 sp.), Near Threatened (25 sp.), Least Concern (491 sp.) or Data Deficient (8 sp.). Those classed as Endangered and Vulnerable are considered to be threatened.

IUCN Red List status of the species recorded within the local study area



Moreover, a total of 24 species have been classified as CPS, including relatively high proportions of primates (18%), freshwater fish (11%) and amphibians (10%).

Species Diversity by Vegetation Type - Each habitat type is characterised by a combination of features which are suitable to certain species. The baseline surveys showed that among the vegetation types of the PdF CF, the evergreen submontane forest holds the greatest species diversity with 741 species, followed by submontane grassland (580 species) and lowland forest (515 species). These figures should however

be interpreted with caution as sampling effort was lower in lowland forest.

Most of the CPS recorded occurrences lie within these three vegetation types and, more specifically, on the west side of the Pic de Fon ridge.

Overall, the submontane habitats and primary forests of the PdF CF are the most diverse in terms of biodiversity.

Species diversity by vegetation type

Vegetation type	% of total flora species	% of total fauna species
Submontane grassland	41	42
Evergreen submontane forest	53	51
Semi-deciduous lowland forest	34	54
Secondary forest	1	17
Savanna woodland, wooded grassland	6	27
Savanna grassland	22	13

Habitat preferences - Some species are dependent on a particular habitat, landscape feature or ecosystem function without which their viability is threatened.

Such ecological dependencies have been analysed for primary forest (evergreen submontane forest and lowland forest), and submontane grassland, as well as the submontane forest / grassland transition zone.

Among the species recorded within the PdF CF, two flora CPS, four amphibian CPS and eight bird CPS are primary forest dependent. Their presence was mostly recorded in the primary forest block surrounding Banko and Western Spur Valley. The occurrence of these species indicates good quality primary forest habitat.

Although the submontane grassland supports smaller overall species diversity than the primary forest, it holds two amphibian CPS strictly dependent on this rare habitat (*Arthroleptis cruscum* and *Ptychadena submascareniensis*).

As for the submontane forest and grassland transition zone, it holds one bird CPS (Sierra Leone Prinia) which may occur exclusively

within this zone. It should be noted that this transition zone covers a maximum area of 3 km² within the PdF CF.

Additionally, some species recorded seem to depend on particular landscape features. This is the case of many bat species depending strictly or partly on caves, and the Yellow-headed Picathartes (bird CPS) requiring rocks, caves or cliffs for nesting. In the PdF CF, these kinds of landscape features are especially prevalent on the mid to high elevation slopes.

Finally, the presence of good quality water/streams is important for all species, but is essential for strictly aquatic species such as freshwater fish and stream-living frogs (e.g. *Amnirana occidentalis*, *Conraua* nov. sp.).

Stream of the Pic de Fon Classified Forest



Jan Decher

Hunting is also among the greatest threats to fauna. During the baseline surveys, evidence of hunting was recorded all over the PdF CF. The large body size of large mammals and the low reproduction rate of some species such as Chimpanzees increase their vulnerability to hunting.

Hunters' camp in the Pic de Fon Classified Forest



Janis Carter

4.14 CURRENT THREATS TO BIODIVERSITY

The PdF CF biodiversity currently faces threats, independent of the Simandou Project, which are directly or indirectly attributable to anthropogenic pressure.

As it is the case throughout Guinea, habitat loss, fragmentation and degradation is the main threat to biodiversity in the study area. The inhabitants of villages surrounding the PdF CF directly impact natural habitats by clearing lands for agriculture. Among other activities contributing to habitat loss or degradation are cattle grazing, charcoal-burning, artisanal mining as well as uncontrolled use of bushfires.

The fact that the primary forest of the PdF CF is isolated from the other forested areas of southeastern Guinea increases habitat loss/degradation impacts on species as they lack alternatives. There are no ecological corridors leading to other classified forests, farms exist in direct proximity to the CF boundaries, and bushfires burn across extensive areas of the savanna every year.

CONCLUSION

Social and Environmental Baseline Study Simandou Project

1. CONCLUSION

The Social and Environmental Baseline Study contributed to a better understanding of the current social, physical, and biological conditions that the mine component of the Simandou Project will need to contend with. Given that the description of each of the three disciplines (Social, Physical and Biodiversity) is presented in separate volumes, each having its respective and specific components and features, the following section seeks to bring to light the interdisciplinarity of certain features and systems that are specific to the Simandou region. Understanding the relationships between social, physical and biological features will help to better define the specific project-related issues, risks and challenges that the project will be facing.

The objective of this Conclusion is to summarise the essence of the major findings, issues, risks and challenges that emerge from all the surveys and studies carried out within the framework of the Social and Environmental Baseline Study. In addition, a focus is given to the various opportunities that the project can bring to the overall socio-economic and environmental development of the Simandou region. Finally, the last section tackles the next steps foreseen for the project development.

1.1 MAJOR FINDINGS

The analysis and synthesis of all the data collected for the preparation of the Social and Environmental Baseline Study make it possible to draw several broad conclusions that summarise the main socio-economic, physical and environmental features and characteristics of the region and its population.

Essentially, the Simandou Project is dealing with traditional self-sufficient societies that, despite historical population movements linked to trade and migration caused by political and economical upheaval, are still living in relative isolation. The project is located in an undeveloped area where socio-economic conditions and opportunities are very limited for several reasons: low agricultural productivity; economic trade limited to basic necessities; limited road network which hinders expansion of trade; absence of any form of industry; deficient energy supply; and limited local institutional capacity.

Development needs are numerous in all facets of household and community activities. With regards to population, there are multiple needs affecting different aspects of people's lives, but many only address the principal source of their livelihoods, namely agriculture. However, the top priority need expressed by the majority of the surveyed households, is their desire for improved housing. Other important priorities endorsed by nearly all are, in decreasing order, employment, food security and assistance to agricultural development and better access to health services and facilities. At the institutional level, capacity strengthening is the foremost important need for all local institutions, groupings and/or organisations.

The Simandou Range plays a role in the climate and water regulation of the region. Rainfall increases with altitude but topography is not the fundamental driver of the

climate even if it influences rainfall. The geology of the ridge governs the infiltration of rainfall as well as the recharge and discharge of the groundwater that contributes to the base flow throughout the year. There is a very strong surface and groundwater inter-connection; the most substantial volumes of groundwater discharged have been identified in two major groundwater systems: the Pic de Foko West and Western Spur systems, respectively located in the southern and northern parts of the Pic de Fon deposit. The Pic de Fon Classified Forest is drained by a dense network of perennial streams which act as the headwaters of four major rivers: Dion, Milo, Loffa and Diani rivers.

Vegetation cover in the Pic de Fon Classified Forest consists of seven main vegetation types. Among the most important in terms of biodiversity values (existence and service values) are: i) submontane habitats (grassland and forest) on the ridge (summit above 1,000 m altitude) - which are relatively unusual in West Africa; and ii) closed evergreen forest which occupies the western slope of the Simandou ridge.

The biodiversity baseline study has confirmed the presence of some 1,800 species within the Pic de Fon Classified Forest, including approximately 600 fauna species and 1,200 flora species. Among all of these, 24 species were identified as conservation priority species based on the vulnerability and irreplaceability criteria (threatened status, endemic or restricted-range species). The primary forest habitat, which includes evergreen submontane forest and semi-deciduous lowland forest, harbours the highest species diversity. Most conservation priority species are found in the primary forest on the west side of the ridge and in the submontane habitats which make them very valuable from a conservation point of view. The presence of a great diversity of indicator species, such as amphibians, suggests that the Pic de Fon Classified Forest is an environment of high quality for fauna and flora.

The natural resources of the Pic de Fon Classified Forest provide a subsistence base for traditional livelihoods (water supply, wood gathering, harvesting of plants, fruits and medicinal plants, hunting, fishing, etc.) for most of the surrounding local communities, in particular during the lean months of the year when food stocks are low and households must find other strategies to feed and trade. Furthermore, some natural resource locations such as sacred forests and initiation sites near watercourses have high cultural and spiritual values for local communities.

1.2 KEY ISSUES, RISKS AND CHALLENGES FOR THE PROJECT

A series of important issues, potential risks and challenges have been identified in relation to the development of the mine component of the Simandou Project. The most important issues, risks and challenges raised by the project are presented below.

1.2.1 Social Aspect

In-migration - Influxes of population is an inevitable consequence of large projects where future prospects, economic benefits and livelihood opportunities attract interest. It brings profound transformation of the social fabric of the host communities, upsets the traditional structures and introduces ruptures in the old social order. While the

phenomenon of in-migration cannot be prevented, attempts must be made to control the adverse effects of this demographic growth, particularly in the most affected communities of the town of Beyla and the villages of Moribadou and Traoréla. An in-migration management plan for the Simandou Project is actually at the implementation phase.

Employment: Wage employment is relatively new in the local study area, and is closely linked to the Simandou Project, as exchanges prior to the project were mostly based on barter. Rio Tinto's arrival at the end of the 1990s has gradually modified this situation. Livelihood strategies traditionally based on subsistence agriculture are rapidly shifting towards wage employment. The majority of men (and women to some extent), although most without any skills, would like to work for Rio Tinto, who is practically the only employer in the region along with its project suppliers and contractors. Rio Tinto has in place well-defined policies, transparent procedures and good communication plans.

Land management - This issue, with the arrival of migrants attracted by the Simandou Project among other aspects, involves increasing monetization of land acquisition, changes in land ownership and land use rights and transformations in the organic ties that have traditionally bound local populations to their land. Land management is often complex as it intermingles ancestral customary rules and modern and more logical ways of managing land uses. Introducing a new land management system is breaking with the past, and resistance to change is generally strong with such a deep-rooted matter.

Community well-being: Affected households and communities have few of the basic necessities they need to deal effectively and independently with the anticipated changes arising from the project. Education level and literacy rate are very low, vocational training nonexistent; populations live in precarious conditions, starting with generally poor housing and limited access to many basic elements such as potable water, sanitation and decent hygiene and health services. Since the outset of the exploration activities, Rio Tinto has actively worked to build constructive relationships and alliances with communities, building capacity and undertaking actions that contribute to poverty reduction and sustainable development, at both community and country levels.

Infrastructure: A feature that characterises the Simandou Project area is the inadequacy of public services and the poorly maintained and deficient infrastructure networks in most sectors: education, health, water distribution, transportation, and energy. The paucity and poor conditions of the infrastructures, as well as the state of dilapidation of the existing ones, is both a cause and a consequence of the underdevelopment of the region. Defining the social responsibilities of Rio Tinto and exhorting Guinean authorities to play an active role in the regional development of the region also constitutes a challenge for the project in a context where local and regional institutional capacities are highly deficient.

Changes in social structures and values: Social transformations currently taking place will have long-lasting effects on communities, for instance, family life, traditional social hierarchies, livelihood strategies and the role and status of women. As part of these changes, Rio Tinto and the Simandou Project bear social responsibilities with the Guinean authorities in addressing these societal challenges and in ensuring that these changes lead to a smart, sustainable and inclusive growth.

1.2.2 Physical Aspect

Climate and water regulation: The operation phase will affect both these inter-related systems by altering the natural hydrological cycle. While lowering of the ridge may affect local weather patterns by modifying rainfall distribution, dewatering could possibly change the water balance regime (volume, rate and seasonality of stream flow). These potential changes could also induce effects on downstream communities and biodiversity components (vegetation and water dependent species). Water management and access to quality water (potable) have been identified as key environmental risks for the project as well as a major social issue for local populations.

Erosion regulation: The steep topography of the Simandou Range with high rainfall intensities and erodible soils make managing erosion and sediment control a significant challenge facing the project. This phenomenon has already been experienced during exploration activities. Degradation of downstream water quality due to increased total suspended solids will in turn induce indirect impacts on downstream communities and biodiversity components (water dependent species). A water management plan will be required to address these issues at all phases of the project (development, operation and closure phases). This will include management of storm runoff and construction of sediment control structures downstream of all sites to allow settlement of suspended sediment prior to discharge into the drainage systems.

1.2.3 Biodiversity Aspect

The Baseline Study confirms that the Pic de Fon Classified Forest is an area of high biodiversity value that presents several challenges for the Simandou Project:

- A large proportion of the conservation priority species (c. 60%), including the West African Chimpanzee, occurring in the primary forest located on the west side of the ridge might impose serious constraints on project design if their habitat, which overlaps a section of the ore body, is considered important habitat. This could result in habitat loss or significant habitat disturbance and fragmentation.
- The submontane habitats (grassland and forest), including their transition zone, will be particularly vulnerable to the Simandou Project development given that they are overlapping the ore body. Consequently, some species that are specific to these habitats will also be vulnerable to habitat loss, disturbance and fragmentation. This is the case of two submontane grassland dependent amphibian species: *Arthroleptis crusculum*, *Ptychadena submascarensis*; one submontane forest dependent flora species: *Dorstenia astyanactis*; and one transition zone dependent bird species: *Prinia leontica* (Sierra Leone *Prinia*).

- Reduction in stream flows and alteration of water quality will possibly affect water dependent species (e.g. *Amnirana occidentalis*, *Conraua* nov. sp.); specific attention to water management will be required to preserve, as much as possible, discharge and water quality in the primary forest block on the western slope of the ridge (in particular for Pic de Foko West and Western Spur Valley systems).
- Increased threats on habitats and species due to in-migration including hunting pressure, habitat alteration, intentional burning, increased harvesting of wild food, medicines and wood, encroachment of clearing and farming practices.

Biodiversity including species, habitats and ecosystem services derived from biodiversity itself will be a key issue for the project and the presence of conservation priority species in particular, such as the West African Chimpanzee, will need to be managed carefully and will continue to influence the mine design and implementation of the project through the Rio Tinto mitigation processes (including avoidance, minimisation, rehabilitation-restoration, and offsets).

1.3 OPPORTUNITIES

1.3.1 Social Opportunities

While the Simandou Project poses some social risks, it also represents a tremendous opportunity for socio-economic development in the Simandou region as a whole and, more specifically, for the most affected communities, including the town of Beyla and the villages near the mine site such as Moribadou, Traoréla and Nionsomoridou. The baseline study has already identified positive development opportunities; the major one being that the project has the potential to stimulate significant social and economic development at both national and local levels. Development priorities and expected opportunities include job creation, stimulation of secondary economies (new business opportunities – formal and informal sectors; increased annual income and market accessibility, etc.), improved land management, creation of trade, construction of social infrastructure (schools, health facilities, water supply, sanitation, etc.) and rehabilitation of transport infrastructure.

Local Guinean authorities are well aware of the development possibilities offered by the project. The development of the project through the feasibility stage will require concerted efforts with regional and local authorities to promote long-term sustainability of the project.

1.3.2 Biodiversity Opportunities

As biodiversity is increasingly recognised as a serious business challenge for the Simandou Project because ecosystems have declined extensively over the past 50 years and this degradation jeopardises the world's biodiversity, it also represents an opportunity for Rio Tinto to demonstrate good biodiversity performance and risk handling for reputational benefits throughout a Biodiversity Action Plan. Biodiversity management is supported by Rio Tinto's Biodiversity Strategy which entails a key statement to have a Net Positive Impact on biodiversity.

The Simandou Project is an opportunity for Rio Tinto to constructively engage in the enhanced management of the Pic de Fon Classified Forest in partnership with communities and government groups. The Biodiversity Management Plan can provide long term benefits through mitigating impacts caused by the mining operations (e.g. management program to improve the habitat for conservation priority species or production of key livelihoods). Moreover, the Biodiversity Management Plan can also be an opportunity to halt current environmental degradation and threat on chimpanzees and other conservation priority species caused by clearing for agriculture, frequent bushfires and overexploitation through hunting.

1.4 NEXT STEPS

Following this Social and Environmental Baseline Study the next step is to launch the Social and Environmental Impact Assessment phase of the project. Studies and assessments that will be undertaken in the next phase must build on the understanding and findings described in the present Baseline Study and address the key issues that have been defined herein.

The main steps to be undertaken within the framework of the Social and Environmental Impact Assessment are:

Project description and option analysis: Once the detailed engineering will have been defined, the major components of the project will be described (project locations, proposed technologies, raw materials, alternative options, project schedule, etc.). Then the evaluation of technically and financially feasible alternatives will be undertaken (project location and project design alternatives) and the rationale for selected option documented.

Risks and impacts assessment of the selected option: Potential risks and impacts related to the Simandou Project will be identified and quantified based on the interactions between the proposed infrastructures (including construction, operation and maintenance activities) and their effects on the socio-economic, physical and biological components of the affected areas. The assessment will consider the direct and indirect impacts (positive or negative). The potential for cumulative impacts will also be assessed, i.e. the environmental and social impacts of the project may combine with those of other activities or prior, current or future projects in the same territory.

Social and Environmental Management Plan: The Social and Environmental Management Plan will be developed to provide a structured framework for appropriately and proactively managing the relevant social and environmental risks and impacts that will be identified, in order to reduce adverse effects on the receiving environment. The measures and actions will range from a description of routine mitigation measures to a series of specific plans (e.g. Land Acquisition and Compensation Plan, In-migration Plan, Biodiversity Action Plan, etc.), following the Rio Tinto mitigation processes (including avoidance, prevention, minimization, mitigation, rehabilitation, restoration, and compensation).

Monitoring Programme: Following the Social and Environmental Management Plan, a Monitoring Programme will be implemented. This programme aims to verify the implementation and effectiveness of the Social and Environmental Management Plan and to ensure the project's compliance to applicable regulations and standards. The Monitoring Programme will define desired outcomes as measurable events to the extent possible, with elements such as performance indicators, targets, or acceptance criteria that can be tracked over defined time periods.

Public Consultation and Information Disclosure: Consultation of affected communities and disclosure of project-related information in compliance with Rio Tinto's policies and procedures and IFC's requirements should be part of the SEIA steps.

Permits and authorisations: According to the Guinean environmental legislation, the Social and Environmental Impact Assessment requires approval from the Ministry of Environment as well as some activities and works that require special permits before construction.

It should be mentioned that, even though the formal impact assessment phase has not yet started, Rio Tinto has already undertaken or is currently conducting studies/work that will be part of the risks and impacts assessment phase (e.g. studies and modelling on climatological and hydrological impacts) and Social and Environmental Management Plan phase (e.g. in-migration plan, water management, biodiversity management plan).



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