RANOBE MINE PROJECT, SOUTHWEST REGION, MADAGASCAR

VOLUME 11: LAND AND NATURAL RESOURCE USE

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EXECUTIVE SUMMARY

World Titanium Resources Ltd (WTR - formerly Madagascar Resources NL), through its Malagasy subsidiaries, currently owns the Ranobe Mine Project (TSP), which includes the Ranobe mineral sand deposit and other zones of mineralised sand to the north. The Ranobe deposit is located north of the Port of Toliara in south-west Madagascar where a large mineral sands resource containing the valuable heavy minerals ilmenite, rutile, zircon and leucoxene has been identified.

This report forms part of a series of biophysical specialist studies for the Ranobe Mine Project, ESIA, in the Toliara Province of Madagascar. As part of the ESIA this report describes the land & natural resource use in the project affected area.

OBJECTIVES

A land and natural resource use study was undertaken in response to this important issue as part of the Ranobe Mine Project ESIA. The specific objectives of the study are to:

- Determine the suite of natural resources that are most important to the livelihoods of the directly-affected population of the proposed project;
- Examine concerns around natural resources that emerged from local stakeholders during the public participation process;
- Assess the impacts of the proposed development on natural resources;
- Gauge the importance of the suite of natural resources to the livelihoods of the directly-affected population; and
- Determine whether any rare and irreplaceable natural resources exist within the proposed mine footprint and describe the location of those natural resources.

OVERVIEW

Natural resources provided by the Ranobe Forest, Ifaty and Toliara Lagoons and rivers and lakes surrounding the proposed development site are an important component of the livelihoods of the potentially affected communities of the proposed Ranobe Mine Project. As in many parts of Africa, the local communities around these forests rely heavily on the resources offered by the natural environment for their livelihoods and survival. Consequently, any developments that might impact on the resource base could potentially threaten food security and livelihood strategies. The Ranobe Forest is known for its multitude of resources including, but not limited to, fuelwood, wild fruit and vegetables, medicinal plants, wild bird and animal meat, fuel for slash and burn agriculture, wood for charcoal, and timber. The Ifaty and Toliara Lagoons provide an abundance of fishing resources. The rivers, lakes and wetlands provide thatch grass and are used for fishing, bathing and drinking water for livestock. The proposed Ranobe Mine Project intends to develop an area of the Ranobe forest, and is anticipated to construct a causeway on the Fiherenana River and a jetty in the Toliara Lagoon. It should however be noted that even though the proposed mine will affect a large area (approximately 455 ha) over its lifespan, only a limited area (approximately 35 ha) will be impacted upon at any given time due to progressive rehabilitation. Demand for natural resources in the already stressed and over utilized Ranobe Forest is likely to increase, and supply decrease, as a direct result of the proposed project due to the required clearing of extensive areas of natural indigenous forest, much of which is considered to be endangered. This could affect natural resource availability and the lives of communities living nearby the proposed mine.

Consequently, the main objective of this study is to gain a clear understanding of local community's reliance on the natural resources in and around the study area. This included an investigation of the extent to which natural resources are used for basic household needs such as food, medicines, shelter, and household utensils, to gain an understanding of the levels of community knowledge and dependence on natural resource use, and also to determine current levels of exploitation of potentially endangered species. This dependence on natural resources also needed to be understood in the context of the diversity of other agricultural land uses and (off and on-farm) livelihood strategies which local households combine to reduce their vulnerability to risk, ensure

their survival and meet their needs. This information should also be used to inform the investigation of appropriate rehabilitation strategies for the concession area and how these could be integrated with existing land uses.

WATER RESOURCES

The cultivation of crops is probably the most significant livelihood activity in the study area. However, given the nature of the soils in this area and the dry climate, there are very limited areas suitable for the cultivation of dryland crops, and cultivation is largely restricted to those areas which are supplied with irrigation water. Irrigated cultivation is a livelihood activity that residents of the study site appear to have been engaged in since the 1920s. According to respondents the dam on the Manombo River and its associated 17 km of irrigation canal were apparently developed by the French authorities in the early decades of the 20th century. The system of canals begins at the weir and run in a south westerly direction until Ankanimalinika, providing irrigation water to all the villages in this area.

Even with the established irrigation canal in operation, practically every village visited complained about problems with access to water for agricultural and/or domestic purposes.

This is mainly due to the following:

- The height of the weir has been reduced;
- The weir seems to be leaking; and
- Current management of the water resources is inefficient.

CURRENT LAND USE

Agriculture in Madagascar, including fishing and forestry, is the mainstay of the economy, accounting for one-third of the GDP and contributing more than 70% to export earnings. The main agricultural products are: coffee; vanilla; sugarcane; cloves; cocoa; rice; cassava (tapioca); beans; bananas; peanuts and livestock (mainly cattle, goats, ducks and chickens). In rural areas 90.1% of the active population is employed in agriculture and in urban areas it is still 71.8%.

In the study area, agriculture is mainly practiced in the area around the mine site, North of Andrevo Haut, where the RN9 turns away from the coast line. Two types of agriculture are practiced: permanent agriculture, which is used for cotton; and slash and burn, in the local dialect called *hatsaky,* which is used for maize and cassava crops. Agriculture is mainly manual, using oxen to plough the land. Several of the villages are connected to the 17 km long irrigation network which uses water from the Manombo River. However, the water distribution is not well organised and villages further along do not receive sufficient water. The major crops grown in the area consist of rice, cassava, cotton and maize. In addition to the crops listed above various other crops such as sweet potatoes, chickpeas, lentils, bananas, mangoes, papayas, sugar cane and various vegetables (tomatoes, onion, watercress, etc.) are grown sporadically throughout the area. Generally the period of April to June is important for agricultural practices. During the rainy season, when food supply is limited because the harvests are largely consumed, hunting and gathering is important.

In addition to crops, livestock farming is one of the livelihood activities adopted by households in the rural areas of the Toliara district. Zebu cattle are the most important form of livestock in the area. Cattle are not reared for commercial purposes as such but rather sold and bought according to a family's financial needs. Besides cattle, people keep goats, sheep, pigs and poultry (chicken, ducks, turkey, goose).

NATURAL RESOURCE UTILISATION

Building Material

A variety of local tree species are used for building purposes by local residents. Twenty three species of trees are used for various construction tasks such as building, furniture, coffins, fences and dug-out boats. Katrafy (*Cedrelopsis grevei*) is perhaps the most popular hardwood used for construction due to the hard nature of the wood. Very particular species are required for the construction of dug-out boats and coffins.

Charcoaling

There is extensive production of charcoal taking place in the Ranobe Forest. This was visually evident along the old Ranobe track and by the enormous amount sold along the RN9 and in the markets in Toliara. The practice of charcoaling is currently not illegal within the area. It is however in theory regulated. The production area and the species exploited are governed. Production of charcoal is only allowed within delineated areas and only authorised species may be exploited. Potential charcoal producers have to be registered as a charcoal producer. Once registered, harvesters will receive a licence to fell trees for charcoal. This licence will show the allowable quota per producer. This quota results from the evaluation of forest potential estimated for each zone by the forestry administration and is entered into a register. All producers are required to replant each year as compensation for the exploitation of the forest. Even though these regulations are in place they are extremely difficult to regulate and require a large presence within the region. There are no definitive means to establish whether licensed charcoalers have reached their quota and that replanting is taking place. In addition to this illegal charcoaling still occurs within the region. This was evident during the field visit since when members of CES came across kilns the producers would run away. Therefore, despite these regulations the Ranobe Forest has been nearly depleted of hardwood trees and locals have started to harvest woody shrubs for this purpose. The majority of charcoal producers interviewed were insistent that they would not practice charcoaling if there were sufficient water available for agriculture.

Fuelwood

All the villages visited appear to be able to access fuelwood easily in the immediate vicinity of the village or within 1 km of the village. It is mostly dry wood that is used and there appear to be no particular preferences or selectivity in the type of woods used. Even wood from the poisonous *Tabernaemontana coffeoides* is used for fuel. Respondents indicated that one long branch of wood would be sufficient for one day of fuelwood. There are currently no households involved in the sale of fuelwood and no local market for fuelwood appears to exist. Charcoal is not generally used for fuel by local residents but is transported to Toliara town and sold at the market there. Due to the easy accessibility of fuelwood it is unlikely that the construction of the proposed mine would impact on the use of fuelwood resources.

Fishing

Fishing occurs along the coast mainly south of Andrevo Haut in the Ifaty Lagoon, north of Toliara Port in the Toliara Lagoon, in the Fiherenana River and Ranobe Lake. The main coastal fishing villages in the affected area are Andrevo, Ambolimailaka, Mongile, Ifaty (fishing in Ifaty Lagoon) and Toliara I (fishing in the Toliara Lagoon). All communities living adjacent to the Fiherenana River and on the shores of Lake Ranobe appear to utilize the fish resources of these water bodies, using a variety of fishing gear.

The principle organisms sought after are finfish (reef fish, mangrove associated species, demersals and pelagics), elasmobranches (sharks, rays and sawfish), marine mammals (dolphins and dugongs), sea turtles, crustaceans (shrimp, lobster and mangrove crab), cephalopods (octopus, squid and cuttlefish), and echinoderms (sea cucumbers and edible urchins). During the month of December sea turtles are harvested at low tide on the reef flats or by free diving or even

by scuba diving, which is illegal but difficult to control. Only few larger motorised vessels and trawlers are used, mainly for trawling for prawns.

Food Gathering

Various plants are utilised for consumption at the end of the rainy season and during the dry season when food is scarce.

Hunting

Hunting appears to be another source of wild food, however, this is largely opportunistic and limited to small animals such as pigs, tortoises and hedgehogs, as well as birds (in particular a species called Akanga (Banded kestrel – *Falco zoniventris*) that is the size of a small chicken). One respondent admitted that during times of drought and famine, local residents sometimes resorted to eating insects such as locusts and crickets/cicadas.

Bee Keeping

Bee keeping within the potentially affected area is limited. Respondents believe it to be dangerous and not particularly lucrative. The proposed mine is not anticipated to impact on bee keeping within the area since this resource is only utilised in the various villages due to difficulties with theft when hives are established within the forest. Locals have however requested training in bee keeping practises.

Rum Production

Various villages within the potentially affected area engage in the production of rum. Rum is produced from sugar cane usually grown in close proximity to the villages. Respondents complained that there is currently not enough water available from the irrigation canal to cultivate the amount of sugar cane required. During the dry season yields are usually low with plants having a notable decrease in height and stem diameter. For this reason rum producers often have to supplement stock by buying sugar cane from other nearby villages such as Ranobe.

Salt Production

There are currently two areas within the potentially affected area that are involved in the large scale production of salt. The first is a family owned commercial saltworks situated in close proximity to the village of Mangily and consists of a number of salt evaporation ponds. The second large scale salt production takes place in close proximity to the town of Toliara in the region where the new jetty is proposed. These salt evaporation ponds are individually owned by local people.

Spirulina Production

There are currently two areas within the potentially affected area that are involved in the production of *Spirulina,* which is a microalga that can be consumed by humans and animals as a nutritional supplement.

SPIRNAM Ltd was granted a permit for the production of *Spirulina* products in Madagascar in 2004. Samples are regularly sent to an accredited laboratory in Anatananarivo for analysis in order to obtain market approval by the Minister of Health. SPIRNUM produces approximately 1 ton of product a year including capsules, tablets, granules and powder which is sold and consumed in Madagascar.

There is also a smaller area being used for *Spirulina* production by the local prison. Prisoners staff this facility and the product is used to feed prisoners.

Medicinal Purposes

According to respondents, local residents are not adverse to using commercial medicines. However commercial medicines are fairly expensive and therefore locals make considerable use of traditional medicines. In general, western medical services are often only used when traditional medicines fail. As indicated in the SIA report, there are only 2 doctors for every 11 211 people and one health centre per 7 475 people. The services provided by these doctors and centres are also hampered by a lack of equipment and medication. Local traditional remedies can be divided into two groups, i.e. medicinal use (for curing illnesses and ailments) and traditional use (for curing spiritual problems).

Sacred Plants

Various plants within the study area are considered to be sacred and these can be found in villages throughout the area.

TRADE AND BARTERING

Trade

The majority of goods produced from natural resources are sold within the markets within the study area and in Toliara. Whatever is not consumed is sold and vice versa. The majority of household income is from farming practises, including the sale of charcoal and thatch.

Bartering

Local bartering takes place on a daily basis. Ladies from the various inland villages travel approximately 20 km every day to the fishing villages along the coast where they barter fresh fruit and vegetable specifically cassava for fish. Residents of the fishing, villages however do not travel inland for bartering as the general concession is that the protein derived from fish is more important than the consumption of vegetables and fruit.

MANAGEMENT OF NATURAL RESOURCES

Decisions are generally made communally and personal and community responsibility is closely intertwined. There are traditional councils of village elders (*fokonolona*) responsible for decision and policy making. *Fokonolona* also play an important role in promoting solidarity and mutual assistance to critical to vulnerable land-based livelihoods. These structures use locally developed rules and norms to ensure cooperation, cohesion and to combat social disruption. Transgressions can lead to the imposition of fines but more importantly to social disapproval. These institutions are recognised by the Madagascan government as part of the local government institutions and their status has been defined in a decree published in 1962 (Comte, 1963). They have representation on the *Chef d'administration* and work within the penal code. The *Chef de fokontany* also sits on the Fokonolana and represents the administration (*fanjakana)*.

IMPACTS

The impacts on natural resources identified during this study are summarized in the table below:

ISSUE / IMPACT	SIGNIFICANCE	
	Without Mitigation	With Mitigation
EXISTING IMPACTS ON NATURAL RESOURCES		
Issue 1: Overexploitation or resources		
Impact 1: Hardwood Trees	HIGH	N/A
Impact 2: Softwood Trees	MODERATE	N/A
Impact 3: Medicinal Plants	LOW	N/A
Impact 4: Wild Foods	MODERATE	N/A
Impact 5: Fauna	MODERATE	N/A
Impact 6: Fish Resources	HIGH	N/A
Impact 7: Fire Wood	LOW	N/A
Impact 8: Species of Special Concern	HIGH	N/A
Issue 2: Existing impacts on land use		
Impact 1: Lack of water resources for agricultural practices	HIGH	N/A
Impact 2: Growth of water hungry crops	HIGH	N/A
IMPACTS OF THE PROPOSED MINING OPERATION		
Impact 1: Loss of natural resources	MODERATE	LOW
Impact 2: Loss of land during mining	MODERATE	LOW
Impact 3: Clearing virgin land for small scale farming as a result of agricultural displacement	HIGH	MODERATE
Impact 4: Increasing demand for natural resources	HIGH	MODERATE
Impact 5: Capacity of institutions to manage use of natural resources	HIGH	MODERATE

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World Titanium Resources Ltd (WTR - formerly Madagascar Resources NL), through its Malagasy subsidiaries, currently owns the Ranobe Mine Project (TSP), which includes the Ranobe mineral sand deposit and other zones of mineralised sand to the north. The Ranobe deposit is located north of the Port of Toliara in south-west Madagascar where a large mineral sands resource containing the valuable heavy minerals ilmenite, rutile, zircon and leucoxene has been identified.

Natural resources provided by the Ranobe Forest, Ifaty and Toliara Lagoons and rivers and lakes surrounding the proposed development site are an important component of the livelihoods of the potentially affected communities of the proposed Ranobe Mine Project (Figure 1.1). As in many parts of Africa, the local communities around these forests and woodlands rely heavily on the resources offered by the natural environment for their livelihoods and survival. Consequently, any developments that might impact on the resource base could potentially threaten food security and livelihood strategies. The Ranobe Forest is known for its multitude of resources including, but not limited to, fuelwood, mushrooms, wild fruit and vegetables, medicinal plants, wild bird and animal meat, fuel for slash and burn agriculture, wood for charcoal, and timber. The Ifaty and Toliara Lagoons provide an abundance of fishing resources. The rivers, lakes and wetlands provide thatch grass and are used for fishing, bathing and drinking water for livestock. The proposed Ranobe Mine Project intends to develop an area of the Ranobe forest, and is anticipated to construct a causeway on the Fiherenana River and a jetty in the Toliara Lagoon. It should however be noted that even though the proposed mine will affect a large area (approximately 455 ha) over its lifespan, only a limited area (approximately 35 ha) will be impacted upon at any given time due to progressive rehabilitation.

Demand for natural resources in the already stressed and over utilized Ranobe Forest is likely to increase, and supply decrease, as a direct result of the proposed project due to the required clearing of extensive areas of natural indigenous forest, much of which is considered to be endangered. This could affect natural resource availability and the lives of communities living nearby the proposed mine. Consequently, the main objective of this study is to gain a clear understanding of local community's reliance on the natural resources in and around the study area. This included an investigation of the extent to which natural resources are used for basic household needs such as food, medicines, shelter, and household utensils, to gain an understanding of the levels of community knowledge and dependence on natural resource use, and also to determine current levels of exploitation of potentially endangered species. This dependence on natural resources also needed to be understood in the context of the diversity of other agricultural land uses and (off and on-farm) livelihood strategies which local households combine to reduce their vulnerability to risk, ensure their survival and meet their needs. This information should also be used to inform the investigation of appropriate rehabilitation strategies for the concession area and how these could be integrated with existing land uses.

Initially a study for the investigation of the use of natural resources in and around the concession area was undertaken in April-July 2006 by Ms Maura Andrew of CES, with assistance from Mr Rolland Ranaivojaona, a botanist from Tsimbazana (the National Botanical and Zoological Park in Antanarivo) and Mr Tsimanaorate Paubert Mahatante who assisted with translation and facilitation. Due to the change in scale and project description the study area was revisited in June 2012 by Dr Chantel Bezuidenhout with assistance from Herisoa Manjakahery (Botanist from the Missouri Botanical Gardens) and Rudy Fidacy (Translator and Facilitator). Information from the previous Natural Resources Assessment was integrated into this report. In addition to this, complementary information was also obtained from other specialist studies such as the Social Impact Assessment, the Botanical Assessment, and the Faunal Assessment, and integrated into the findings of this report.

It is important to note that this report forms part of a series of biophysical specialist studies for the Ranobe Mine Project, in the Toliara Province of Madagascar. As part of the ESIA this report describes the land and natural resource use in the project affected area.

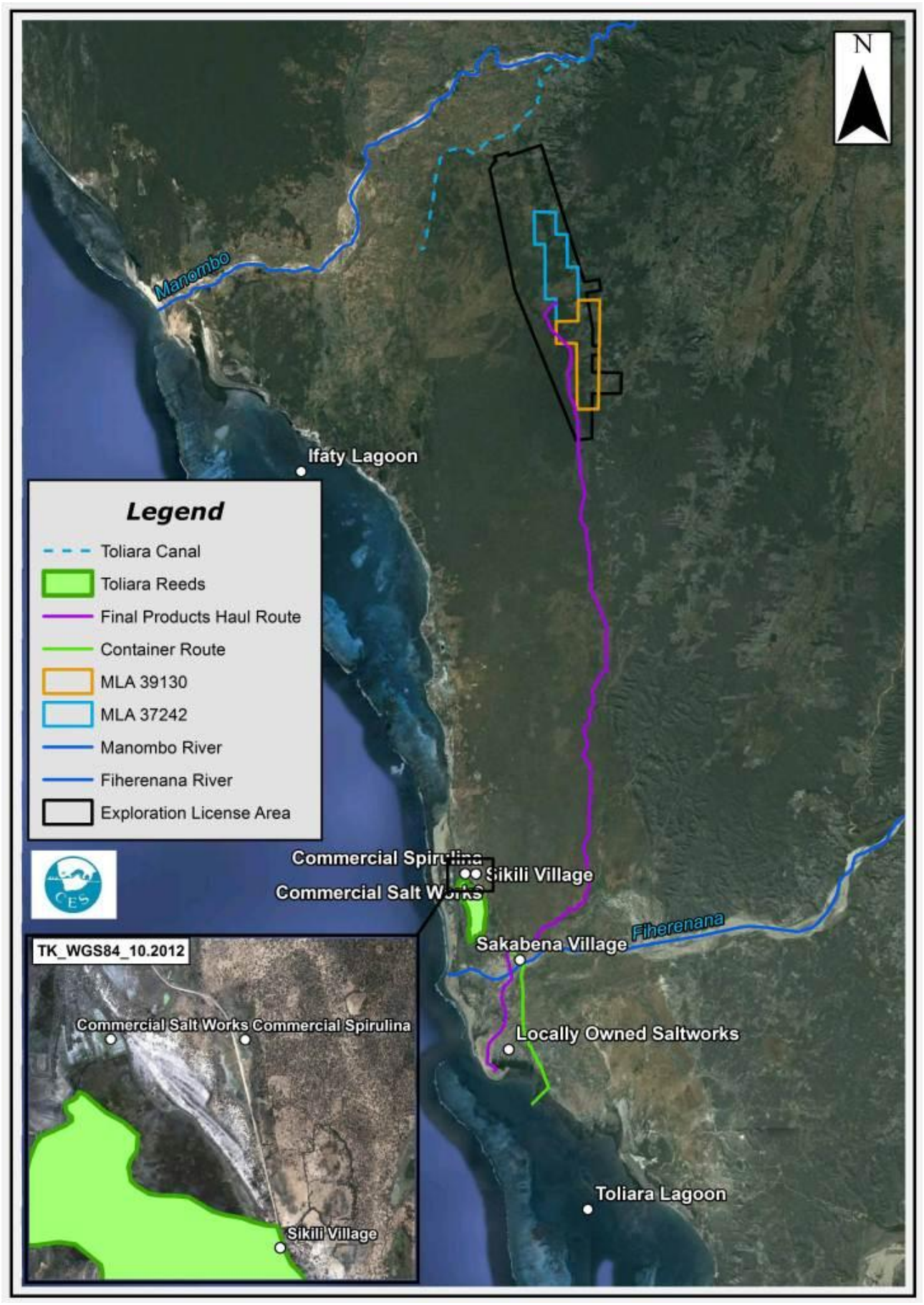


Figure 1.1: The distribution of various natural resources within the potentially affected area.

1.1. Objectives

A land and natural resource use study was undertaken in response to this important issue as part of the Ranobe Mine Project. The specific objectives of the study are to:

- Determine the suite of natural resources that are most important to the livelihoods of the directly-affected population of the proposed project;
- Examine concerns around natural resources that emerged from local stakeholders during the public participation process;
- Gauge the importance of the suite of natural resources to the livelihoods of the directly-affected population; and
- Determine whether any rare and irreplaceable natural resources exist within the proposed mine footprint and describe the location of those natural resources.

1.2. Terms of Reference

The specific terms of reference on which the 2007 report was prepared were as follows:

1. Gain an understanding of the levels of community knowledge and dependence on natural resource usage, focussing on plants.
2. Determine the reliance of local communities on different vegetation types for harvesting natural resources.
3. Determine current levels of exploitation of birds, small mammals and reptiles, particularly endangered species and CITES Appendix-II species.
4. Obtain information from the community regarding their understanding of the ecological functioning of their environment.
5. Assess the significance of the potential impacts of mining on the natural resources and the communities that utilise them.
6. Identify suitable mitigatory actions that can reduce negative impacts and enhance positive impacts, where possible.

In addition to the general terms of reference presented above this study must:

1. Evaluate the land capability of the mining area at a reconnaissance level, and comment on the potential of the area for agriculture and afforestation.
2. Identify the major impacts resulting from present agricultural practices.
3. Identify and assess the significance of impacts on soils and land use that could result from the mining operation.
4. Identify potential cash crop and plantation species that could be used in the rehabilitation process.
5. Work closely with the SIA specialist to ensure close alignment of these studies, and to gain an improved understanding of local community's livelihood strategies.
6. Review available literature and reports on natural resource use prepared in the past 5 years and update the report accordingly.
7. Assess the impacts of resource use (hunting) on faunal groups by drawing on information collected by the faunal expert.
8. Assess the impacts of harvesting wood and non-timber forest products on the vegetation of the Ranobe area by drawing on information collected by the faunal expert.
9. Integrate the results of surveys and research done by Madagascar Resources over the past 5 years on the impacts of resource use, specifically the impacts of hardwood harvesting for charcoal production.

1.3. Assumptions and Limitations

The following assumptions and limitations apply to this study.

Assumptions:

- The participants in the study responded truthfully in the interviews;
- Translation accurately captured the meaning and intentions of the interviewees;

- The proposed project will not change significantly in its design; and
- Ongoing public participation will take place involving all local stakeholders.

Limitations:
- This study only focuses on natural resource and land use.

1.4. Report layout

This report describes natural resource use and land use in the Ranobe Forest in south-west Madagascar. It demonstrates, and quantifies where possible, the importance of the forest, lagoons and rivers to potentially affected communities of the proposed Ranobe Mine Project from a land and natural resource use perspective. The report is divided into the following main sections:

- **Methodology** – provides the methods used for the land use and resource use sections.
- **Water Resources** – provides details on water resources in the area for consumption and irrigation of agricultural fields.
- **Land Use** – describes the agricultural techniques used, as well as a detailed description of the crops and livestock of the Ranobe Mine Project area.
- **Natural Resource Use** – describes in detail the resources used by the local people in terms of the various habitats.
- **Trade and Bartering** – discusses general trade and bartering practises in the study area.
- **Local Management of Natural Resources** – Discusses current management of forests, rivers and lagoons in the area.
- **Impact Assessment** – provides a detailed impact assessment together with impact ratings.
- **Conclusions and Recommendations** – summarises the report.

2. METHODOLOGY

2.1. Sites

The resource users interviewed for this study were residents of the villages around the proposed mine site. Participation was voluntary and residents were asked to participate prior to interviews being conducted. Numerous villages were interviewed in the Communes of Tsianisiha, Ankilimalinka and Belalanda. The villages interviewed are shown on figure 2.1 below.

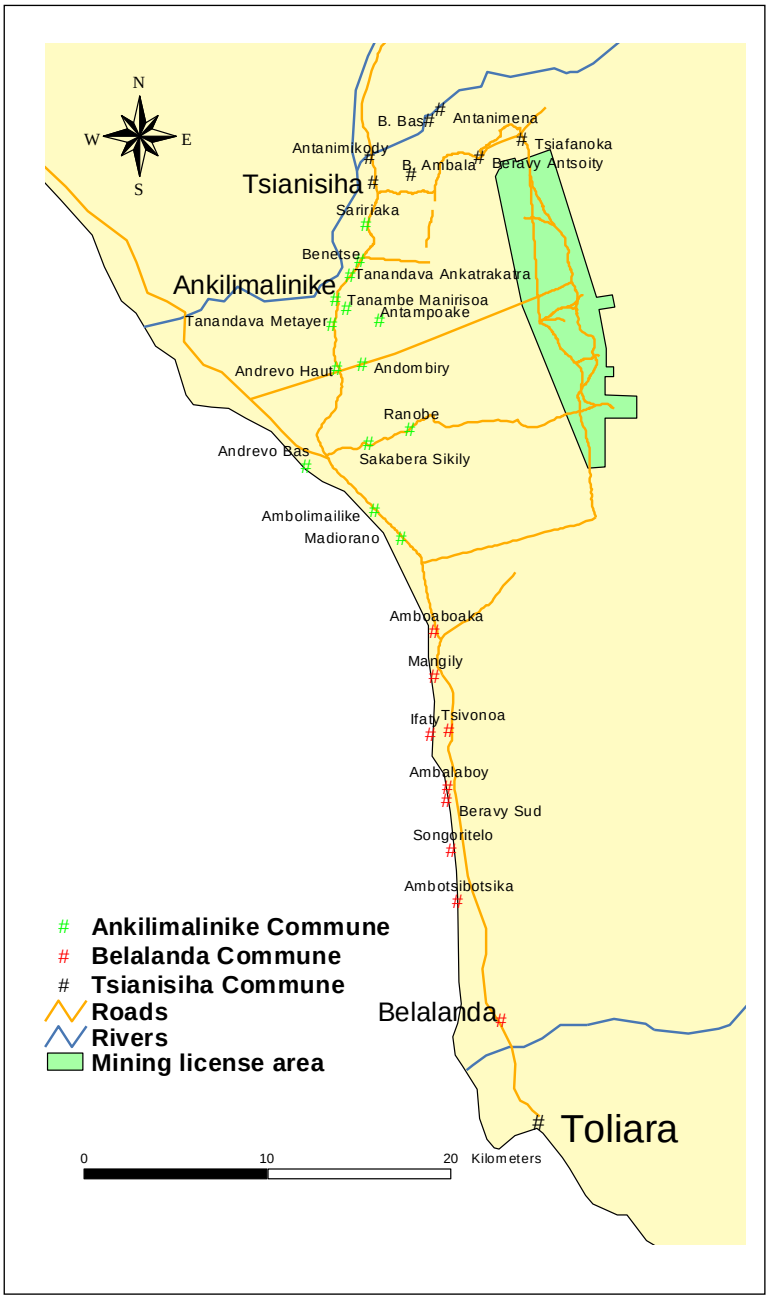


Figure 2.1: Villages in the study area.

In addition, a number of focus group meetings were held to clarify specialised practises such as rum making, salt production, *Spirulina* production, charcoaling, fishing, etc. These focus groups were held in villages where these practises were undertaken and a number of people participated. Plate 2.1 below shows the involvement in some of these focus groups.

Plate 2.1: Focus groups held in various villages
(Top): Rum processing in Benetse
(Bottom Left): Bee keeping in Tsianisiha
(Bottom Right): Weir at Manombo River

2.2. Interviews and Translation

In each village, two men and two women were asked to volunteer in participating in interviews. In some cases, there were many other residents in attendance and some of these contributed to the discussions.

In each case the interviews began with an introduction explaining who the researchers were and what the purpose of their visit and of the meeting was. Once the respondents were happy to proceed with the meeting, the interview began.

The respondents were asked about the following:

- Cultivation and the use of irrigated lands
- Livestock farming: extent to which residents engage in this activity
- Harvesting of natural resources for fuelwood, building materials, wild foods and medicinal purposes.

The discussion around the harvesting of natural resources formed the main focus of the interviews. The issues discussed included:

- What resources are harvested from where and for what purpose?
- How much product is harvested and when?
- Identifying the specific species used.
- The management or regulation of use of natural resources.

There were some interviews however that focussed on one particular aspect of natural resource use. These were the interviews with charcoal producers/traders, fishermen, rum producers, bee keepers, salt producers, *Spirulina* producers and traditional healers. In these cases the interviews were less structured and more open-ended.

Much of the information obtained was of a descriptive and qualitative form. However, some quantitative data on amounts of product harvested and prices were obtained, particularly with regard to the use of wood for building and for charcoal production.

2.3. Identifying Plants

One of the important aspects of the interviews was to identify what natural resources people were using. This was done by asking people what plants were used for building, food, charcoal production and medicinal purposes. The respondents had their own names for these plants and these were recorded. Plants were identified by Herisoa Manjakahery a botanist from the Missouri Botanical Gardens.

3. WATER RESOURCES

The cultivation of crops is probably the most significant livelihood activity in the study area. However, given the sandy nature of the soils in this area and the dry climate, there are very limited areas suitable for the cultivation of dryland crops, and cultivation is largely restricted to those areas which are supplied with irrigation water. Irrigated cultivation is a livelihood activity that residents of the study site appear to have been engaged in since the 1920s. The dam on the Manombo River and its associated 17 km of irrigation canal were apparently developed by the French authorities in the early decades of the 20th century. The system of canals begins at the weir and run in a south westerly direction until Ankanimalinika, providing irrigation water to all the villages in this area.

Even with the established irrigation canal in operation, practically every village visited complained about problems with access to water for agricultural and/or domestic purposes. There were also complaints about the levels of the water in the canals being too low to sustain the extent of cultivation required. This problem was also identified during the disclosure of the Scoping Report in April 2012. According to interviews with various villages the original weir constructed by the French authorities was washed away during a cyclone and resulting flood in 1978. At this time the local people from the villages crudely repaired the weir and some water was therefore available in the canal. According to interviews in the villages of Ankanimalinika and Tsiafanoke it took approximately 7-8 years for the weir to be re-built. Local villagers insist that prior to the destruction of the original weir there were no water related issues as is the current situation.

The new weir was constructed further upstream than the original weir (Figure 3.1) and as a consequence was in a narrower part of the river channel, e.g. the original weir was approximately 120 m in length and the existing weir is approximately 65 m in length. This variation is not anticipated to impact negatively on the available water in the irrigation canal. In addition to the reduction in length the new weir was also reduced in height by approximately 0.5 m. This on the other hand may influence the availability of water in terms of the amount of water that overtops the existing weir versus the original weir. Although this weir may therefore be considered to be fundamentally less efficient than the previous one due to the reduction in height a more significant issue is that the weir seems to be leaking through the wooden stop-logs and possibly underneath as well (Plate 3.1). This was evident by the fact that even though the Manombo River was flowing the water level was considerably lower than the height of the weir (Plate 3.1).

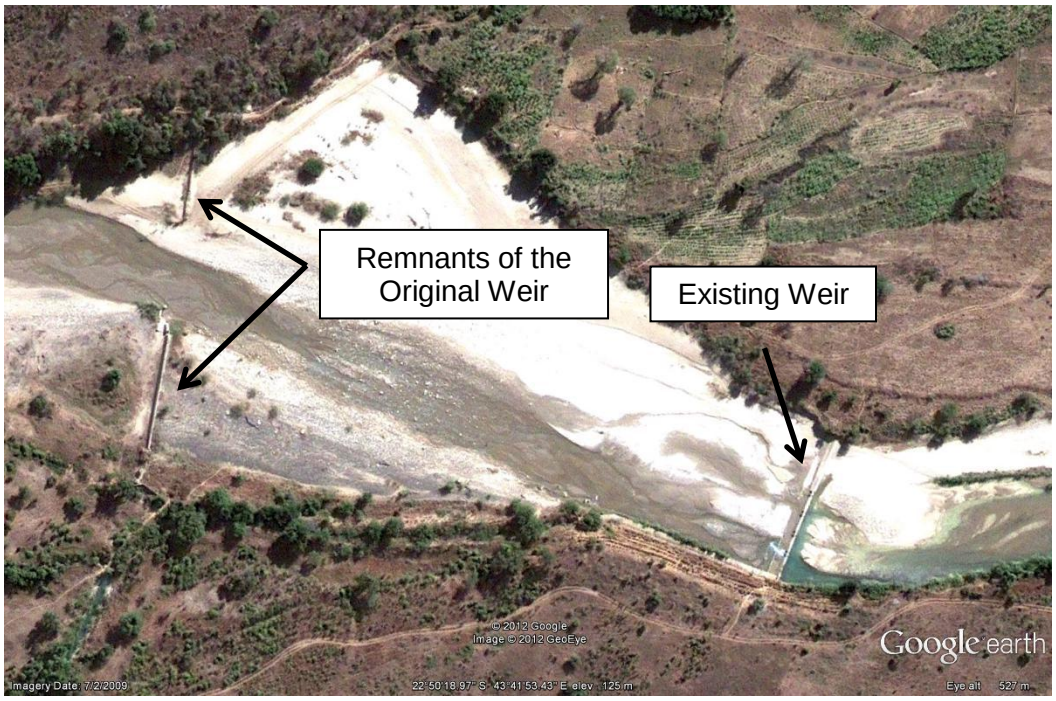


Figure 3.1: The proximity of the existing weir to the original weir.

Plate 3.1: The existing weir on the Monombo River
The insert shows the damage of the stop-logs and the extend of sedimentation.

In addition to the obvious issues with the new weir, management of the water resource is also troublesome. Local villages in the commune of Ankanimalinika complained that villages further north (closer to the Manombo River) consume the majority of the water available in the irrigation canal which results in there not being enough water left for them. It was evident during the site visit and aerial photographs (Figure 3.2) that this could very well be the case since the sluice gates along the canal are left permanently open and therefore flows decrease exponentially towards the south. In addition to this, the villages closer to the Manombo River such as Tsiafanoke grow rice which requires large amounts of water. The association currently managing the canal water in Tsifonaka is called "Andohoharano Mamovoke". This association is made up of a General Assembly of farmers who are responsible for repairing the canal and managing the dispatch of canal water. This local association is linked to a larger water management association called "The Federation", which comprises members from all associations in the Tsianisiha Commune. Even though this association is in place the access to water from the canal does not seem to be controlled and no relevant decisions have been made in the last year due to the need to replace the president of the association. However, according to local residents in Tsiafanoke Village this association have ruled that starting from the 19th of July 2012, sluice gates will be opened for 10 days in the Commune of Tsianisiha and then closed for 10 days, giving access to the Commune of Ankanimalinika. Although this shows that the association is acutely aware of the problem and actively trying to solve it, the closing of the sluice gates for extended periods of time may have serious repercussions. For example, rice consumes considerably more water than other cereal crops such as maize and wheat and is actively grown in areas close to the Monombo River. The extended closure of sluice gates in this area may be detrimental to the production of rice and it can therefore be assumed that once this is realised by the producers of these crops the situation will revert back to the current situation, i.e. sluice gates will be left open permanently. In addition to this

there are considerably more villages in the Commune of Ankanimalinika than in the Commune of Tsianisiha thereby resulting in the unfair distribution of water resources.

In summary, it is not clear whether the water levels in the irrigation canal are lower due to differences in the way the weir was reconstructed, because of the timing of the completion of the weir, because of leakage from the canal and/or weir or because of the spiralling demand associated with population growth. In all probability it may be a combination of all these factors. It is however clear that the distribution of water in the irrigation canal is not well organised and villages further along the network do therefore not receive sufficient water.

The hydrological EIA study indicates that the volume of water accessed via the irrigation system is 1 300 000 m^3/month (SRK, 2006). The mine will not be utilizing surface water from the Monombo River and groundwater extraction will take place at a considerable distance away. It is therefore not anticipated that mining operations will have a significant negative impact on the existing situation. In fact the mining operation could potentially result in a positive impact on water resources by contributing to improve the current situation by for example guiding the association of Andohoharano Mamovoke to efficiently manage the water in the irrigation canal, capacity building in terms of agriculture (i.e. which crops to grow in a water poor areas) and/or fixing and maintaining the weir. In addition to this the pressure on natural resources (such as charcoaling and food gathering) will decrease if the water situation is improved to support agriculture.

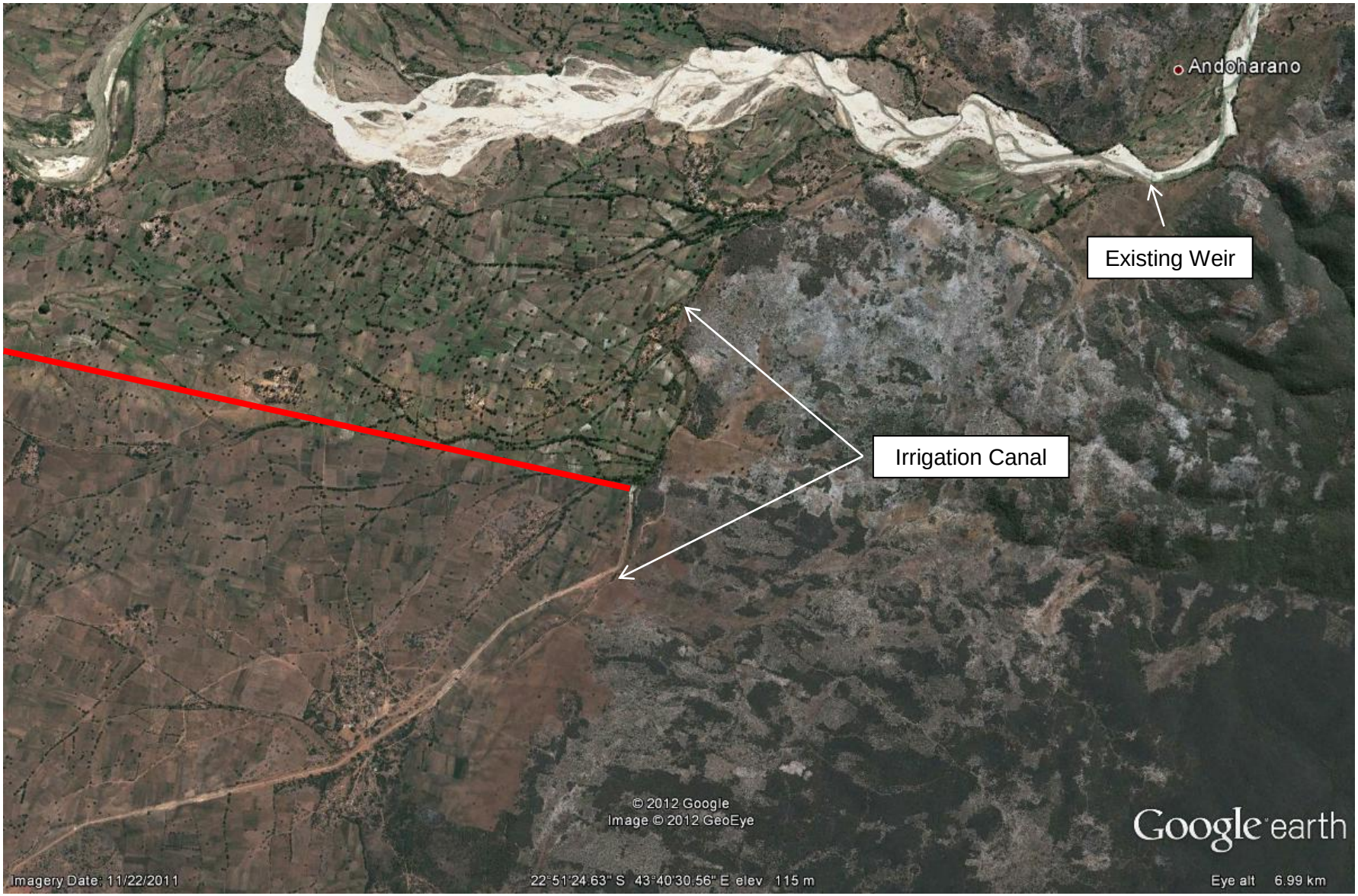


Figure 3.2: Aerial Photo showing the distribution of water from the irrigation channel.
It is evident from the photo that the area to the north of the red line has more water available for agriculture than the areas further south.

4. LAND USE

4.1. Agriculture

Agriculture in Madagascar, including fishing and forestry, is the mainstay of the economy, accounting for one-third of the GDP and contributing more than 70% to export earnings. The main agricultural products are: coffee; vanilla; sugarcane; cloves; cocoa; rice; cassava (tapioca); beans; bananas; peanuts and livestock (mainly cattle, goats, ducks and chickens). In rural areas 90.1% of the active population is employed in agriculture and in urban areas it is still 71.8% (Cook, 2010).

In the study area, agriculture is mainly practiced in the area around the mine site, North of Andrevo Haut, where the RN9 turns away from the coast line. Two types of agriculture are practiced: permanent agriculture, which is used for cotton; and slash and burn, in the local dialect called *hatsaky,* which is used for maize and cassava crops. Agriculture is mainly manual, using oxen to plough the land. Several of the villages are connected to the 17 km long irrigation network which uses water from the Manombo River. However, as described in Chapter 3, the water distribution is not well organised and villages further along do not receive sufficient water. The major crops grown in the area consists of rice, cassava, cotton and maize. A seasonal calendar for these crops is included in Table 4.1 below. In addition to the crops listed above various other crops such as sweet potatoes, chickpeas*,* lentils, bananas, mangoes, papayas, sugar cane and various vegetables (tomatoes, onion, watercress, etc.) are grown sporadically throughout the area. Generally the period of April to June is important for agricultural practices. During the rainy season, when food supply is limited because the harvests are largely consumed, hunting and gathering is important.

Table 4.1: Seasonal calendar for the most prominent agricultural activities in the area

ACTIVITY	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
Rainy Season												
Hunt and Gather												
Forest Burning and Clearing												
Cotton Sowing												
Cotton Harvest												
Maize Sowing												
Maize Harvest												
Rice Sowing												
Rice Harvest												
Cassava Sowing												
Cassava Harvesting												

The potential for commercial agriculture is hampered by problems such as distance between the production areas and internal and external markets, poor transport infrastructure, low monetary returns to farmers and lack of irrigation, modern techniques and capital. The collapse of the weir on the Manombo River in 1978, which provided irrigation to the area was a great setback for the local farmers. As a result, the commercialisation of natural resources such as timber and charcoal, have become an important part of the livelihood strategy in the area. The dam has recently been repaired and as a result agricultural activities are slowly being re-established.

4.1.1. Crops

Cash crops

Cotton

Cotton production was initiated in the mid 20th century and currently takes place in two regions of Madagascar; the Mahajanga region in the north-west and the Toliara region in the south-west. In the north-west region of Madagascar cotton farming predominantly consists of flood recession agriculture, i.e. cotton is planted after the rainy season once the floodwaters have receded (Regional Agricultural Trade Expansion Support Program, 2005). In the study area cotton is planted in November-December (during the rainy season) and is therefore rain-fed with some supplemental irrigation required after the rainy season has ended and is harvested during the months of April and May. Permanent agriculture is practised for the production of cotton.

The majority of villages in the study area (specifically in the Communes of Tsianisiha and Ankanimalinika) are involved in a commercial cotton production scheme which is organised by HASYMA, a former state-owned company that was privatized in 2004. In this scheme, farmers are organised into groups and provided with seed, fertiliser, pesticides and equipment on credit at cost price to grow cotton and then sell their cotton to the scheme. The costs of the inputs are then deducted from the payment the farmer receives for his crop. While there is considerable involvement in this scheme there are also many farmers who prefer not to participate in it. A number of farmers object to the insistence on the use of inputs and the deduction of these costs from the price received for the harvest. These imposed costs are viewed by some as taxes. A source in Ampasimalinki indicated that the cost of inputs may amount to as much as 60% of the crop price. The increasing cost of inputs has resulted in a considerable decline in the profitability of cotton production and therefore the overall production of cotton has decreased over the last 10 years.

In addition to the costs involved the cultivation of cotton results in a loss of available agricultural land for the production of food. Furthermore, cotton is referred to as a “thirsty crop” requiring large amounts of water. According to the Environmental Justice Foundation it takes approximately 3 litres of water to produce one cotton bud. As mentioned in Chapter 3 above, according to interviews with villagers, there is not sufficient water available in the irrigation canal to supply all villages with sufficient water for agriculture. The growth of “thirsty crops” such as cotton and rice may be exacerbating the situation.

From the above it can be surmised that the production of cotton is not beneficial to the communities of the area due to the low profitability of production and the reduction in land and water resources available for food production. However, textile and clothing is a major export sector in Madagascar, and since cotton is only grown in two areas any decreases in production may seriously impede upon this on a national scale. It therefore stands to reason that it could be more beneficial if cotton production in the area could be improved. Cotton yield could potentially be increased by increasing water application which may increase the output while keeping input the same thereby increasing profitability and giving incentive to cultivate cotton. As stated previously in Chapter 3 this could be achieved by either fixing the weir or by teaching the Andohoharano Mamovoke to efficiently manage the water in the irrigation canal or a combination thereof.

Maize

Maize is considered to be a cash and subsistence crop in the study area. Maize is cultivated by the majority of villages specifically in the Communes of Tsianisiha and Ankanimalinika and is usually planted in October and harvested in the months of April and May. Maize is cultivated by using slash and burn practises, i.e. cutting and burning the forest to make land available for agriculture. Slash and burn farming is referred to as *hatsaky* in the local dialect. *Hatsaky*, which is carried out mainly in the savannah and near the escarpment but also in the spiny forest and the *plateau calcaire*, usually has a low productivity. The plots are generally abandoned after three to five years. Although declared illegal because of its negative effect on the environment, *hatsaky* is still popular, since people believe that returning to old fields will not bring good yields. According to Cook (2010) deforestation rates in south-west Madagascar were the highest in the country during the period of 1990-2000, with a total area of 255 000 ha deforested. Based on the total amount of maize exported and local productivity measures, approximately 50 000 ha can be directly attributed to international trade (Cook, 2010).

Maize was initially considered to be used only as a food crop in the study area, however due to the rapid increase in meat production in the Ile de la Reunion there was an increase demand for the export of maize as fodder and therefore maize production expanded, i.e. Madagascar exported 160 000 tons of maize between 1988 and 1998 (Cook, 2010). However since then the export of maize has declined due to various reasons such as irregular supply and the small size of the Port of Toliara (only small ships can access the Port). In 2005, 4 300 ha of the Toliara II district was estimated to be under maize production with a yield of 4300 tons. In 2002 Tsihanisiha produced an estimated 30 tonnes of maize and Ankilimalinke produced 200 tonnes, of which 120 was consumed locally[1]. The collapse of exports to Reunion has not substantially reduced maize production in the area and maize (5 000 – 10 000 tons/year) is still sold for export (Cook, 2010).

Slash and burn practises for the cultivation of maize is considered to have a negative impact on natural resources as this diminishes the forest and therefore available resources. This impact could however be reduced by teaching local residents how to practise conservation farming in areas closer to the villages and the irrigation canal.

Plate 4.1: Maize cultivation in the study area in close proximity to the plateau calcaire

Subsistence crops

Rice is the preferred staple diet of the people in the area and is grown wherever there is enough water, but particularly around the Manombo River near Ankililoaka. The collapse of the weir in 1978 resulted in only small quantities of water being available for agriculture. Since the cultivation of rice requires copious amounts of water, this resulted in no rice being cultivated in the area for an extensive period of time. However, since the repair of the weir rice is being cultivated again specifically in villages close to the Manombo River such as Tsiafanoke in the Tsianisiha Commune. In fact most villages within this Commune are involved in rice cultivation whereas this practise is less prominent in the Commune of Ankanimalinika, probably due the lack of adequate water

[1] Direction Régional Développement Rurale, figures for 2005

resources. Rice is also cultivated in the riverbed of the Manombo River. In 2002, 7 830 tonnes of rice were harvested from an area of approximately 3 940 ha in the south-west region of Madagascar (CES SIA, 2008). Since the Toliara / Ifaty region is not one of the country's primary rice producing area (such as the Alaotra in the east-central region and the Vakinankaratra in the Highlands region), rice is mainly cultivated for subsistence.

Cassava is mainly grown for household food consumption. While people prefer to eat rice, cassava is the staple food in periods of drought and in between the rice harvests. Dried cassava is the main kind of cassava consumed in the study area. According to Dostie *et al.* (1999), dried cassava accounts for more than half of the calories consumed in southern Madagascar. This value is much higher compared to the estimated 20% for other regions of the country. Fresh cassava is also used for animal fodder. Although cassava is mainly mono-cropped it is also intercropped with mainly maize, beans and groundnuts. Cassava surplus is sold in the markets or bartered for fish in villages in close proximity to the coast. Currently, only 15% of cassava is sold when compared to national production. In 2002 the yield for cassava in Tsianisiha was 150 tonnes and in Ankilimalinike 1 650 tonnes the majority of which was consumed locally (CES SIA, 2008).Cassava does not contribute significantly to export in Madagascar due to high production costs, increased transportation costs due to the lack of good infrastructure and insufficient storage capacity near the Port of Toliara (Dostie *et al.,* 1999).

Sugar cane, mangoes, bananas, papayas, peanuts, lentils and sweet potatoes are cultivated mainly as subsistence crops in most villages, although surplus is sold at the local markets. Farmers may bring their produce to Toliara, alternatively collectors visit villages or local markets to buy up produce. Large stands of sugar cane, bananas and other "thirsty" subsistence crops are cultivated in the riverbed of the Manombo River (Plate 4.2). Sugar cane is used locally for the preparation of rum (discussed in Section 5.8 of this report).

Plate 4.2: Intercropping in the Manombo riverbed

4.1.2. Livestock

Livestock farming is one of the livelihood activities adopted by households in the rural areas of the Toliara district. Zebu cattle are the most important form of livestock in the area. Cattle (Plate 4.3) are not reared for commercial purposes as such but rather sold and bought according to a family's financial needs. In times of need, cash is obtained through the sale of a number of Zebu cattle and extra income is promptly invested in cattle. Besides being a measure of wealth, cattle are used during sacrificial ceremonies and as working animals. The average number of livestock per family is 2.5 beasts (according to the household survey). However some families have very large herds, while others have very few or none at all.

Plate 4.3: Zebu cattle being herded in Benetse Village

Cattle usually roam freely in the communal areas and require minimal management. These animals are grazed in the areas mainly around the villages and close to the available water sources (i.e. river, canals, wells, etc.). However, it appears that the residents of Ranobe, Ampasimalinika and Tsiafanoke sometimes graze their cattle in the wooded grassland area which coincides with the proposed mine site. However, it is somewhat inappropriate to call this area grassland as it is dominated by an unpalatable colonising forb (annual shrub) which does not provide good grazing for livestock. In addition to this, areas of grassland are regularly burned to encourage new grass growth in order to provide sufficient grazing land for the cattle. The grazing of cattle outside villages has been discouraged in recent years (since 2000) due to an increase in livestock theft which has encouraged people to keep their livestock closer to their homesteads. Cattle theft is a serious problem in the area and recently families have started to invest in pigs (who can more easily be supervised) rather than in cattle.

Besides cattle, people keep goats, sheep, pigs and poultry (chicken, ducks, turkey, geese). Figure 4.1 shows the percentage of various animals kept by various households interviewed during the household survey. Most animals are sold opportunistically, when there is need for cash. Occasionally animals are slaughtered for own consumption. Interestingly zebu cattle are hardly ever slaughtered for own consumption (besides for ceremonial purposes), whilst zebu meat (from Toliara) is regularly bought at the local market.

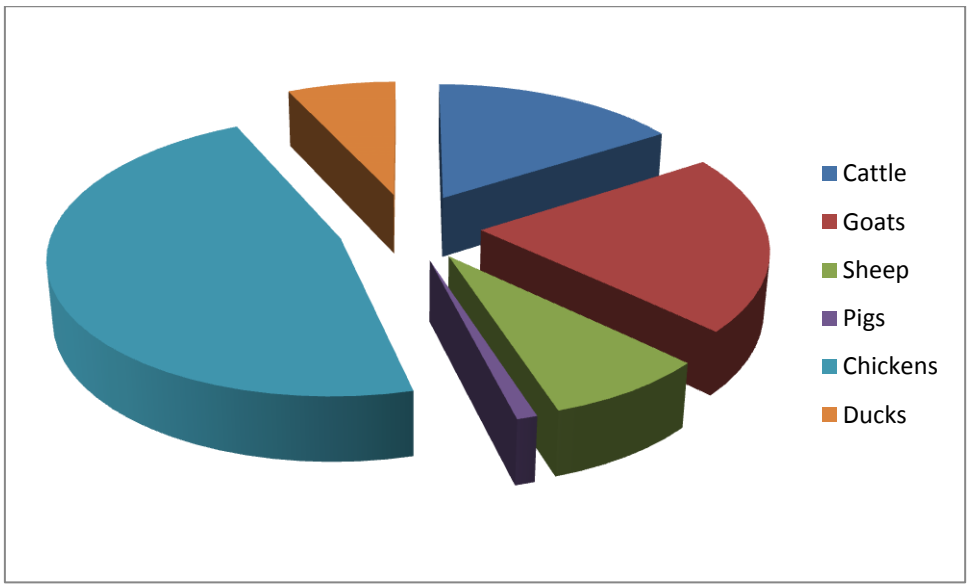


Figure 4.1: The distribution of livestock among households in the study area

4.1.3. Agricultural Techniques

Crop growing in the area uses the traditional shifting cultivation (i.e. plots of land are cultivated temporarily and then abandoned) although some permaculture does take place primarily for the cultivation of cotton. In addition to this local villages also cultivate crops within riverbeds. The various methods of cultivation in the area are discussed in detail below.

The dominant form of shifting cultivation within the study area is slash and burn practises referred to as *hatsaky.* This method involves the felling of smaller trees and shrubs which are then left to dry. Prior to the rainy season the dried timber is set alight and left to burn. These areas are mostly cultivated with maize and cassava. The land is cultivated until it no longer yields sufficient produce (usually 3-5 years), at which time it is abandoned and naturally regenerated by forest. The areas may be cultivated again within approximately 20 years. The practise of *hatsaky* has been deemed illegal due to the considerable deforestation in the area. Penalties include fines and in extreme cases imprisonment. This has however not deterred locals from practising *hatsaky*. Similarly areas of grassland are regularly burned to encourage new grass growth in order to provide sufficient grazing land for the cattle.

People have also developed the *baiboho* system of cultivation. The process involves dry season cultivation in empty riverbeds such as the Manombo River. Various crops (specifically “thirsty” crops such as sugar cane and bananas) are planted after the last rising waters during the rainy season. This process is undertaken each year probably due to the fact that fertile alluvial sediment is washed downstream during flooding of the Manombo River. In addition, this hyporheic flow provides adequate water resources to sustain agriculture.

Cultivation is done by hand and by spanned *Zebu* oxen; men clear the woodland for new cultivation using axes and fire while women tend the crops.

5. RESOURCE USE

5.1. Building Material

A variety of local tree species are used for building purposes by local residents. The species of trees used for various construction tasks such as building, furniture, coffins, fences and dug-out boats are listed in table 5.1 below. There are twenty three different species. Very particular species are required for the construction of dug-out boats and coffins. Katrafy (*Cedrelopsis grevei*) is perhaps the most popular hardwood used for construction due to the hard nature of the wood.

Wood for building is sourced from the more distant eastern, southern and/or south-eastern forests (Ranobe) in and around the proposed mine site and existing villages. None of the villages interviewed collect wood for building purposes from the forests north of the Manombo River or the woodlands west of the main road. Generally, residents have to go some way into the forests to harvest the required species, due to heavy levels of charcoal production in recent years resulting in residents having to source building wood in forested areas further and further from their homesteads. Even the residents of Ranobe have to spend two hours walking to the areas where these trees can be found. This indicates that the sought after species have become more difficult to obtain.

Wood is collected from the forest via *zebu*-drawn carts. Residents will access an area for wood collection via one of the many road and cart tracks that traverses the proposed study site and surrounds. Once a suitable area is located individuals will scour the area in a radius of approximately 200 m around the *zebu*-cart. The fact that local villagers use the existing access roads and tracks to access the forest indicates the importance of this network. Therefore if the operations of the mine (i.e. mine site and haul road) obstruct the existing access routes, villagers may have to find alternatives means to access the forest which may result in further deforestation and/or degradation of the area. In addition to this, the removal of a large area of forest (approximately 455 ha over its lifespan, however only a limited area (approximately 35 ha) will be impacted upon at any given time due to progressive rehabilitation) for the construction of the mine may result in a reduction in the wood supply for building purposes and thereby in an increase in costs of completed products such as dug-out boats and dwellings. This may be remedied by establishing woodlots in areas outside of the forest and closer to villages.

Most residents indicated that they generally harvest wood from the forests for their own purposes. Few if any harvest for sale. The only resident, who acknowledged that they harvest and sell trees to other people, was one resident from Ranobe. In this case, they only did so when requested once or twice a year. This was usually done for residents of other nearby villages, who are further from the forest (such as the coastal villages).

Some of the more important construction tasks are discussed in detail below.

Table 5.1: Species used for building purposes

MALAGASSY NAME	SCIENTIFIC NAME	BUILIDING PURPOSE	STATUS
Boy	*Commiphora mafaidoha*	Timber	IUCN Lower Risk/near threatened
Farafatse	*Givortia madagascariensis*	Boat	Not Listed
Halampo	*Kosteletzkya diplocrater*	Dwelling	Not Listed
Handy	*Neobeguea mahafaliensis*	Coffin	Not Listed
Harofy	*Commiphora aprevalii*	Timber	Not Listed
Hazomafio	*Zanha suaveolens*	Coffin	Not Listed
Hazombango	*Dalbergia xerophila*	Dwelling	IUCN Endangered
Hazomena	*Securinega perrieri*	Dwelling	Not Listed
Katrafay	*Cedrelopsis grevei*	Dwelling	Not Listed
Lopingo	*Diospyros aculeata*	House	Not Listed
Lovainafy	*Dichraepetalum mahafaliense*	Coffin, Dwelling	Not Listed
Manary	*Dalbergia* sp.	Dwelling	Not Listed
Monongo	*Zanthoxylum decaryi*	Dwelling	Not Listed
Nato	*Capurodendron androyense*	Coffin	Not Listed
Paky	*Boscia madagascariensis*	Dwelling	Not Listed
Remoty	*Tephrosia alba*	Dwelling	Not Listed
Satia	*Phragmites* sp.	Dwelling	Not Listed
Sengopony	*Grewia* sp.	Dwelling	Not Listed
Sono	*Didieria madagascariensis*	Fence	CITES APP II
Tainakanga	*Entada chrysostachys*	Coffin	Not Listed
Tsifolaboay	*Baudouinia fluggeiformis*	Dwelling	Not Listed
Tsilaiby	*Terminalia* sp.	Dwelling	Not Listed
Vondro	*Typha angustifolia*	Dwelling	Not Listed

5.1.1. Dwellings

The dwelling occupied by a resident is an indication of his economic status to some extent (Plate 5.1). The very poor usually occupy dwellings made of poles and thatch or mud, whereas those considered to be middle class occupy dwellings constructed of corrugated steel or wood. Only the very wealthy can afford to construct dwellings from concrete, although the majority of businesses and government buildings such as schools and clinics are constructed from concrete.

Plate 5.1: Various types of dwellings used in the study area

Top – Dwelling made from poles and thatch and mud dwelling; Middle – Dwelling made from corrugated steel; Bottom – Dwelling made from concrete.

While some residents living in villages along the main road between Toliara and Ankarabato live in concrete or corrugated steel houses, the vast majority of residents live in dwellings made from poles and thatch. The village of Sakabera, directly adjacent to the Fiherenana River specialises in the construction of these dwellings. Residents of this village estimated that a large dwelling, 8 m in length, would require the use of approximately 50 poles. A more average size dwelling would require 8 main poles as uprights, 11 long vertical poles, 8 poles for the roof and a number of smaller horizontal poles for attaching the thatch to the main poles (Figure 5.2). So on average, each dwelling would use approximately 40 poles of varying widths and lengths. The reeds are purchased from the village of Ambondro. This village specialises in the production and sale of thatch specifically for construction (see Section 5.1.4). Thatch is purchased at the cost of 1 000 Ariary per bundle. Approximately 50 bundles are required for the construction of an average size dwelling. It takes approximately 1 week to construct an average size dwelling and 1 month to construct a large dwelling. The main income in the village of Sakabena consists of profit made from constructing and selling these dwellings. Dwellings are sold at the price of 60 000 Ariary for an average size and 900 000 Ariary for a large size dwelling. The entire house can be purchased from the village of Sakabena and then transported on a *Zebu*-cart to the area of residence. These dwellings need to be replaced every 20 years and the roof will need mending during this period. Every adult has their own dwelling, and any children they have live with them in their dwelling.

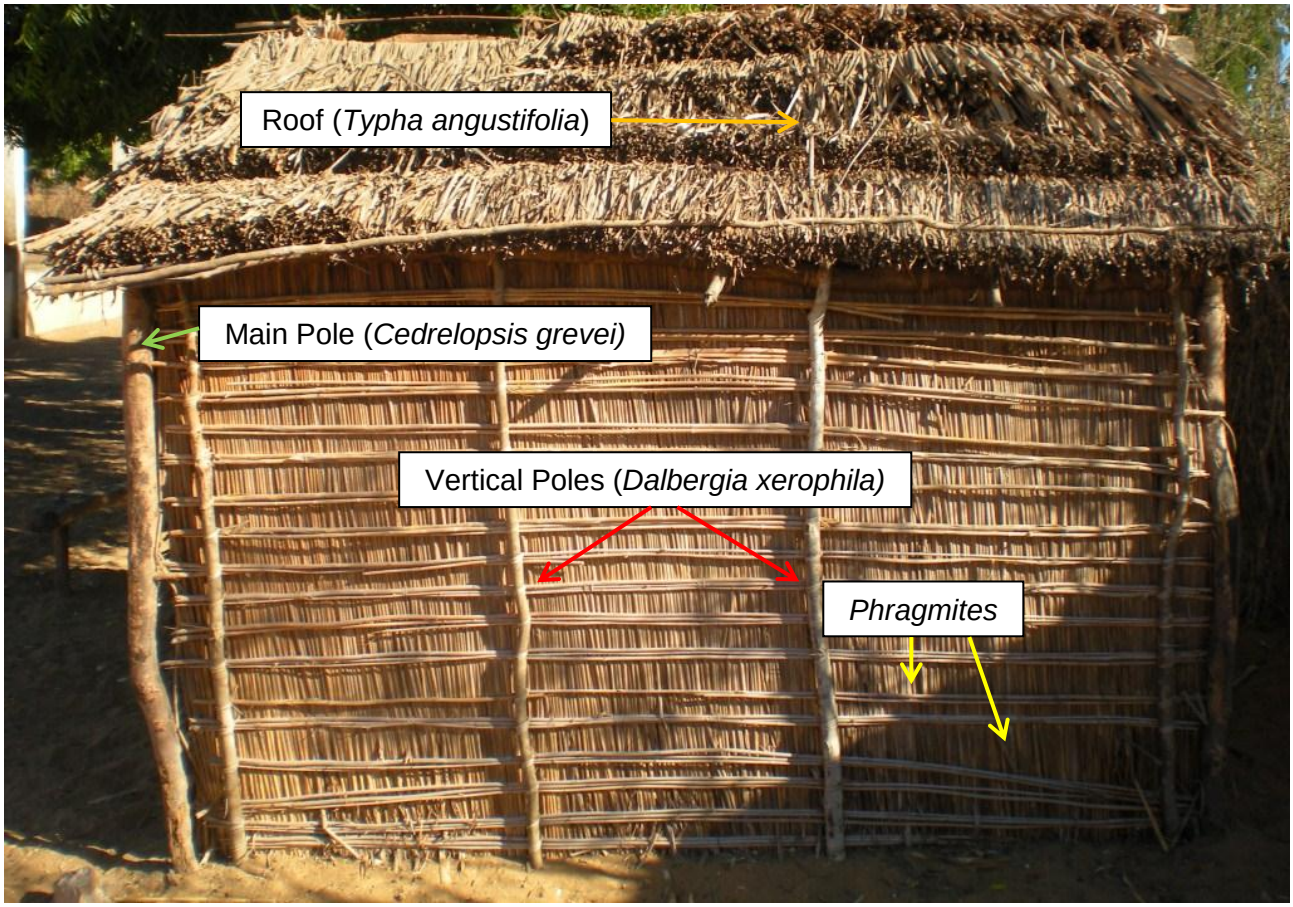


Plate 5.2: The structure of a pole and reed dwelling

5.1.2. Fences

Wood is also used for the construction of fences. There are mainly two types of fences used. Fences constructed of a number of vertical poles are used primarily around dwellings, livestock enclosures and homestead sites, particularly in the larger villages along the main road. Fences made of vertical poles intersected by a number of horizontal poles are used to keep livestock out of arable lands. The former type of fences use approximately 25 poles per meter of fencing. The poles are generally 1.7 to 2 m high. Plate 5.3 illustrates the use of *Didieria madagascariensis* for the construction of this type of fence.

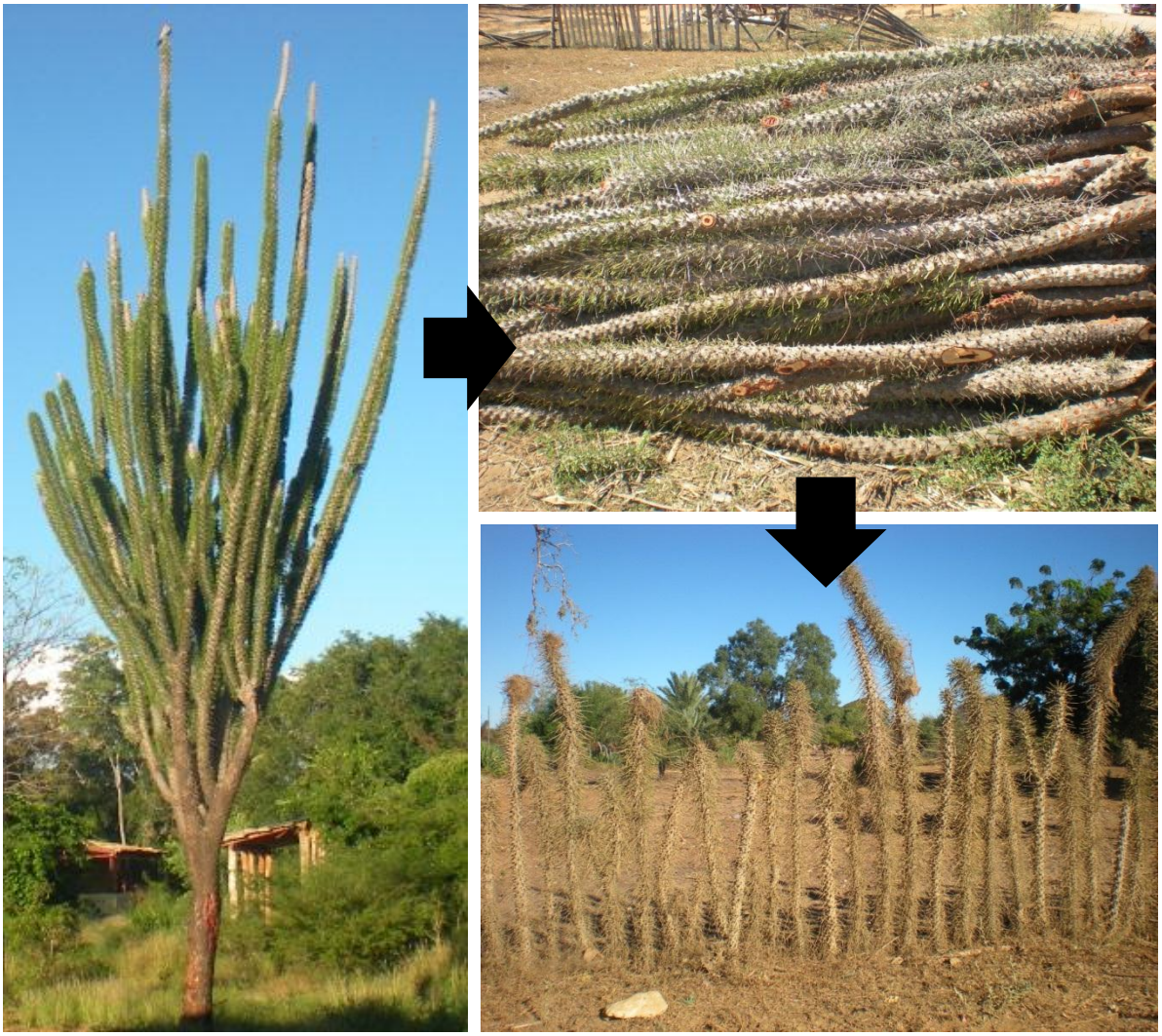


Plate 5.3: The use of Didieria madagascariensis for the construction of fences

5.1.3. Boats

Local fishing villages construct their own dug-out boats for the purpose of fishing. Only one particular species, Farafatse (*Givotia madagascariensis*) is utilized for this purpose. Givotia madagascariensis is native to western Madagascar and is a deciduous tree with a thick swollen trunk and palmate leaves (see Plate 5.4).

The Givortia trees are harvested from the Ranobe Forest. Boat makers do not cut the trees down as this results in a shorter length of the boat. Instead trees are dug out manually and cut down below the roots. The area surrounding the tree is cleared to ensure that trunk does not encounter any obstacles when it falls to the ground. In cases where the trunk accidentally breaks the tree is abandoned and a new one is sought. Once the trees have been felled they are left to dry for a couple of weeks. This process results in the wood becoming soft, light and extremely supple.

The construction of each boat consists of two Givortia trees. The first tree is dug out with a spade like tool (see Plate 5.5). This is accomplished easily since the wood is very soft as stated above. Smaller pieces are cut from the second tree to increase the height of the boat (see Plate 5.4). The separate pieces are then burned which allows them to stick together (i.e. like being glued). Small wooden nails are then inserted along the edges to ensure that the newly constructed boat does not fall apart. Once completed the boats are polished and painted. The construction of a single boat can take up to 2 months. Local residents have to replace these boats every 3-4 years since they are not waterproofed and therefore rot over time.

Interviewed boat makers in Ifaty Village said that they produce approximately 100 boats per annum. This equates to 200 Givortia trees per annum. Toliara Sands monitored the amount of boats leaving Ifaty for Toliara during the period of September 2009 to September 2010 by situating an observer north of the bridge in the Belalanda Commune (Jules, R.P., 2011). During this period 351 boats were counted. This equates to 702 Givortia trees. It is important to note that the sale of these boats is not the norm, since they are mainly constructed for personal use. According to residents interviewed in Ifaty Village only 40% of boats made are sold. Therefore if we assume that the boats leaving Ifaty are the ones to be sold only, the number of boats increases to 877 boats per annum which equates to 1 754 Givortia trees. This number does not include any trees that were damaged during the felling process, rendered unusable and left to rot. Depending on the density of the stands this equates to a significant portion of the Ranobe Forest.

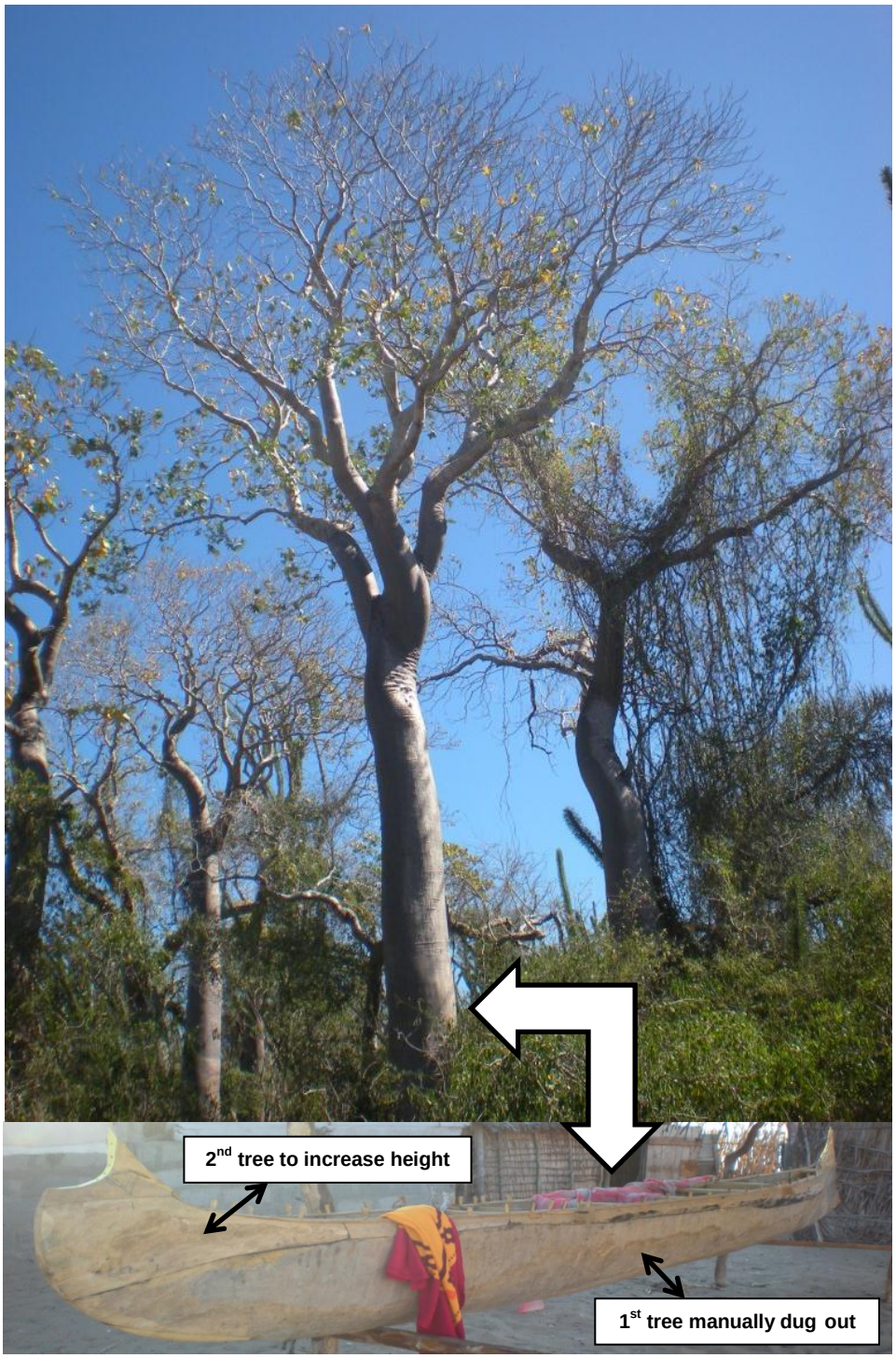


Plate 5.4: The use of Givotia madagascariensis for the construction of dug-out boats

Plate 5.5: Spade-like tool used in the construction of dug-out boats

5.1.4. Thatching

As discussed in Section 5.1.1 the majority of dwellings within and surrounding the proposed development area are roofed and walled with thatch. Two species are used for the construction of dwellings. These include *Typha* for the construction of roofs and *Phragmites* for the construction of walls. There are only a few places where such thatching can be sourced. One of those areas are the wetlands around the Ranobe and Sikili villages, another is a site north of the Manombo River and a third is in the wetlands just north of Toliara town and the Fiherenana River, and east of the northbound road.

In Ranobe Village residents claimed that these southern thatch resources have now been exhausted. For most of the villages in the immediate vicinity of the proposed mine site, the source area for thatching is Ranobe. The Ranobe thatch grows in brakish wetlands that used to be sugar cane fields prior to the 1960s. These wetlands were apparently created as a result of a large flood which swamped the area for 2 years. The dying mango trees which stand in the middle of the reeds bear testimony to this former land use. Due to the fact that the area now inundated used to be arable land cultivated by specific households, these households appear to have retained their exclusive rights to these land parcels and subsequently the thatch which can be harvested from it.

The area further south of the proposed mine site, specifically the Commune of Belalanda (potentially affected by the construction of the haul road) source thatch primarily from the wetlands just north of Toliara and the Fiherenana River. In this area the residents of Ambondro Village (occurring between the wetlands to the east and the RN9 to the west) are the sole suppliers of thatch.

In both the villages of Ranobe and Ambondro it is the women who are responsible for harvesting the thatch, since this resource grows in close proximity to homesteads and women can therefore integrate this activity with domestic responsibilities. The thatch is cut and then left to dry (Plate 5.6) for 1 week during the dry season and 2 weeks during the wet season before being used or sold. The thatch can be harvested during the majority of the year, except during periods of extreme rainfall when the water levels become too high. During these wet periods harvesting is limited to the edge of the wetlands. The cutting of the thatch is not considered to be labour intensive, however it does take an extended period of time since each reed has to be cut individually. In addition to this the reeds have to be a specific size before cutting takes place and generally new growth is not harvested immediately. Furthermore, the reeds are fast growing and available for harvesting within 3 months. For these reasons the levels of harvesting have not been sufficient to diminish the resource, thus indicating that this is a sustainable harvesting practice.

Plate 5.6: Harvesting of thatch in Ambondro Village

In both villages the women harvest the thatch for their own household use but also for sale. In Ranobe two weeks of harvesting thatch can yield two *Zebu*-cartloads of thatch, whereas in Ambondro this equates to approximately 14 bundles. In Ranobe Village thatch is sold for approximately 5 000 Ariary per cartload. In addition to this, men construct portable walls for dwellings using wood and thatch and sell them to people who place orders with them. The number of orders received is variable. These portable walls can then be transported to the homestead site and simply attached to the frame of the dwelling. Ranobe residents sometimes allow other households to harvest thatch from their sites, on condition that half of the thatch harvested is given to the rights holders. The harvesting and sale of thatch in Ranobe is used to supplement income attained from farming practises. In Ambondro Village thatch is sold for approximately 1 000 Ariary per bundle (Plate 5.7) and is primarily sold to the village of Sakabena which specialises in the construction of dwellings (see Section 5.1.1). However, bundles of thatch may be sold to whoever requires it. The harvesting and sale of thatch in Ambondro is the primary income for residents. In both villages, thatch is also transported for sale to local markets and Toliara.

Due to the use of thatch for the construction of dwellings there appears to be a constant demand for this resource. It is estimated that thatch used for the roofing and walls of dwellings needs to be replaced approximately every four to six years. Demand will therefore increase as the number of households increase.

Plate 5.7: The transport of thatch from Ambondro to Sakabena

5.2. Charcoaling

There is extensive production of charcoal taking place in the Ranobe Forest. This was visually evident along the old Ranobe track (see Plate 5.8 below) and by the enormous amount sold along the RN9 and in the markets in Toliara. The practice of charcoaling is currently not illegal within the area. It is however in theory regulated. The production area and the species exploited are governed. Production of charcoal is only allowed within delineated areas and only authorised species may be exploited. Potential charcoal producers have to be registered as a charcoal producer. Once harvesters are registered they receive a licence to fell and can become a legal charcoal producer. This licence will show the allowable quota per producer. This quota results from the evaluation of forest potential estimated for each zone by the forestry administration and is entered into a register. All producers are required to replant each year as compensation for the exploitation of the forest. Even though these regulations are in place they are extremely difficult to regulate and require a large presence within the region. There are no definitive means to establish whether licensed charcoalers have reached their quota and that replanting is taking place. In addition to this illegal charcoaling still occurs within the region. This was evident during the field visit since when members of CES came across kilns the producers would run away.

Respondents indicated that charcoal production is a relatively new activity in their area. Respondents interviewed indicated that it started in the study area in 1980. It apparently began in earnest when the weir/dam on the Manombo River was washed away in a hurricane and flood (see Chapter 3: Water Resources). The dam was subsequently rebuilt but washed away again. This dam supplies water to the irrigation canals in the area south of the Manombo River. This provides irrigation water for all the villages along the river and road from Beravo Atm to Ankilimalinika. Without water for cultivation, local residents had no means of providing food for themselves or earning a living. Once someone demonstrated how they could make charcoal, most people turned to this as a means of survival. One chief in the area serviced by the canals admitted that when the

dam was washed away everyone was engaged in charcoal production. Now that the dam has been restored and people can cultivate again, the proportion of households still engaged in charcoal production is said to have declined. However, in the areas further south where people have no access to irrigated land, due to lack of water in the irrigation canal, charcoal production seems to be more prevalent. The SIA report indicates that charcoal production is the main livelihood activity in the villages of Sikili, Tanambe Manirisoa and Tanandava Metayer. This is evident from the large quantities of charcoal on offer at the side of the road, and the considerable degradation evident in the woodlands along the road. There was considerable evidence of charcoal production going on in the forests west of Sikily village. However, it is also clear from the SIA report that households in almost all villages are involved in charcoal production to some extent. Roughly half said that many people were involved, and half that some people were involved. Apparently all households in Ampasimanilike are involved in it. The only village which claimed that no residents were involved in charcoal production was Ranobe – the village involved in the Gelose. However, a number of charcoal production mounds were found in the forests near Ranobe village. While Ranobe residents may not be involved in this, it is not possible to discount the possibility that some may be involved.

Charcoal is produced by cutting down hardwood trees that provide good quality charcoal. The preference and suitability of trees used for charcoal production varies with size, availability and accessibility of the tree species (below is a list of species preferred and those currently available for charcoal production). Large tree species with high caloric values are the most preferred; due to the large quantity of dense and hard charcoal they produce (NL Agency, 2010). According to local charcoal producers preferred trees such as various hardwood trees, are currently not available for charcoaling since only seedlings and saplings are available in areas harvested for charcoal. In fact the availability of suitable species have decreased by such a margin that villages are now using woody shrub species for the production of charcoal.

Charcoal is produced by slow pyrolysis (thermochemical decomposition of organic material at elevated temperatures without the participation of oxygen). The wood is placed on the ground, covered with sand and set alight. This is referred to as an above ground kiln. The kiln is mostly sealed, although a few air pockets are left open for steam and smoke to escape. The wood in the kiln is left to burn for approximately 15 days. The entire process (cutting trees, building the kiln, burning, packaging, transporting and selling) takes approximately 1-2 months. The radius of the area from which the raw materials are collected is steadily increasing with charcoal makers needing to travel progressively further to obtain the resources needed. Charcoal producers in the village of Benetse said that approximately 12 years ago, when they started to produce charcoal, they would travel 3 km to the forest to harvest wood for charcoaling whereas today that distance has increased to 13 km. Charcoal producers in the village of Sakabiry Sikily said that approximately 5 years ago (2007), when they started to produce charcoal, they would travel 2 km to the forest to harvest wood for charcoaling whereas today that distance has increased to 5 km.

Charcoal producers interviewed said that they produce approximately 30 bags of charcoal (50 kg per bag if hardwood is used and 30-40 kg per bag if other types of wood are utilized) at an average of 3-5 times per annum. These estimates of the volume of charcoal production per household can also be used to develop an estimate of the volume of wood being harvested per household. World Bank estimates of the volume of wood used to produce a kilogram of charcoal in Madagascar are 8.9 kg. Therefore if we average the weight of the bags to 40 kg this equates to a total of 32 040 kg of wood used per household per annum if they only produce charcoal 3 times a year. Toliara Sands monitored the amount of charcoal leaving Ifaty for Toliara during the period of September 2009 to September 2010 by situating an observer north of the bridge in the Belalanda Commune (Jules, R.P., 2011). During this period 92 208 bags of charcoal were counted. Using the same conversion as used previously this equates to 32 826 tons of wood per annum. Depending on the density of the stands this equates to a significant portion of the Ranobe Forest.

The majority of charcoal producers interviewed were insistent that they would not practice charcoaling if there were sufficient water available for agriculture. It was the consensus that agriculture is more lucrative and considerably less work. Furthermore, residents complained that

the production of charcoal lead to respiratory illnesses which they refer to as tuberculosis. There have been numerous studies on the effects of charcoal production on the respiratory system (Tzanakis et al., 2001 and Souza et al., 2010). The overall conclusion is that exposure results in increased respiratory symptoms and decreased pulmonary function.

Table 5.2: Species used for charcoaling purposes

MALAGASSY NAME	SCIENTIFIC NAME	TYPE	STATUS
Ampeny	*Strychnos* spp.	Tree	Not Listed
Anakaraky	*Cordyla madagascariensis*	Tree	Not Listed
Borohoho	*Acacia pervillei*	Tree	Not Listed
Fatipatiky	*Mimosa delicatula*	Tree	Not Listed
Fatra	*Terminalia fataea*	Tree	Not Listed
Hazomafio	*Zanha suaveolens*	Tree	Not Listed
Hazombango	*Dalbergia xerophila*	Tree	CITES APP III RL Endangered (1994)
Hazomena	*Securinega perrieri*	Tree	Not Listed
Hazontaha	*Rhigozum madagascariensis*	Tree	Not Listed
Kalaogna	*Crataeva excelsa*	Tree	Not Listed
Katepoky	*Grewia grevei*	Shrub or small tree	Not Listed
Katrafay	*Cedrelopsis grevei*	Tree	Not Listed
Kily	*Tamarindus indica*	Tree	Not Listed
Mafangalitsy	*Stereospermum nematocarpum*	Shrub	Not Listed
Mangarahara	*Stereospermum* spp.	Unknown	Not Listed
Manoampotony	*Chadsia grevei*	Shrub	Not Listed
Nimo	*Azadirachta* sp.	Tree	Not Listed
Rantsa	*Grewia tulearensis*	Shrub or small tree	Not Listed
Remoty	*Tephrosia alba*	Shrub	Not Listed
Sarikiby	*Albizia masiborum*	Tree	Not Listed
Sasavy	*Maerua filiformis*	Tree	Not Listed
Sono	*Didieria madagascariensis*	Densely spiny succulent	CITES APP II
Tainakanga	*Entada chrysostachys*	Straggling shrub	Not Listed
Tsinefo	*Ziziphus* sp.	Spiny shrubs and small trees	Not Listed
Tsingilo	*Azima tetracantha*	Shrub	Not Listed
Vaovy	*Tetraptereocarpon geayi*	Unknown Legume	Not Listed
Volivaza	*Gardenia decaryi*	Shrub	Not Listed

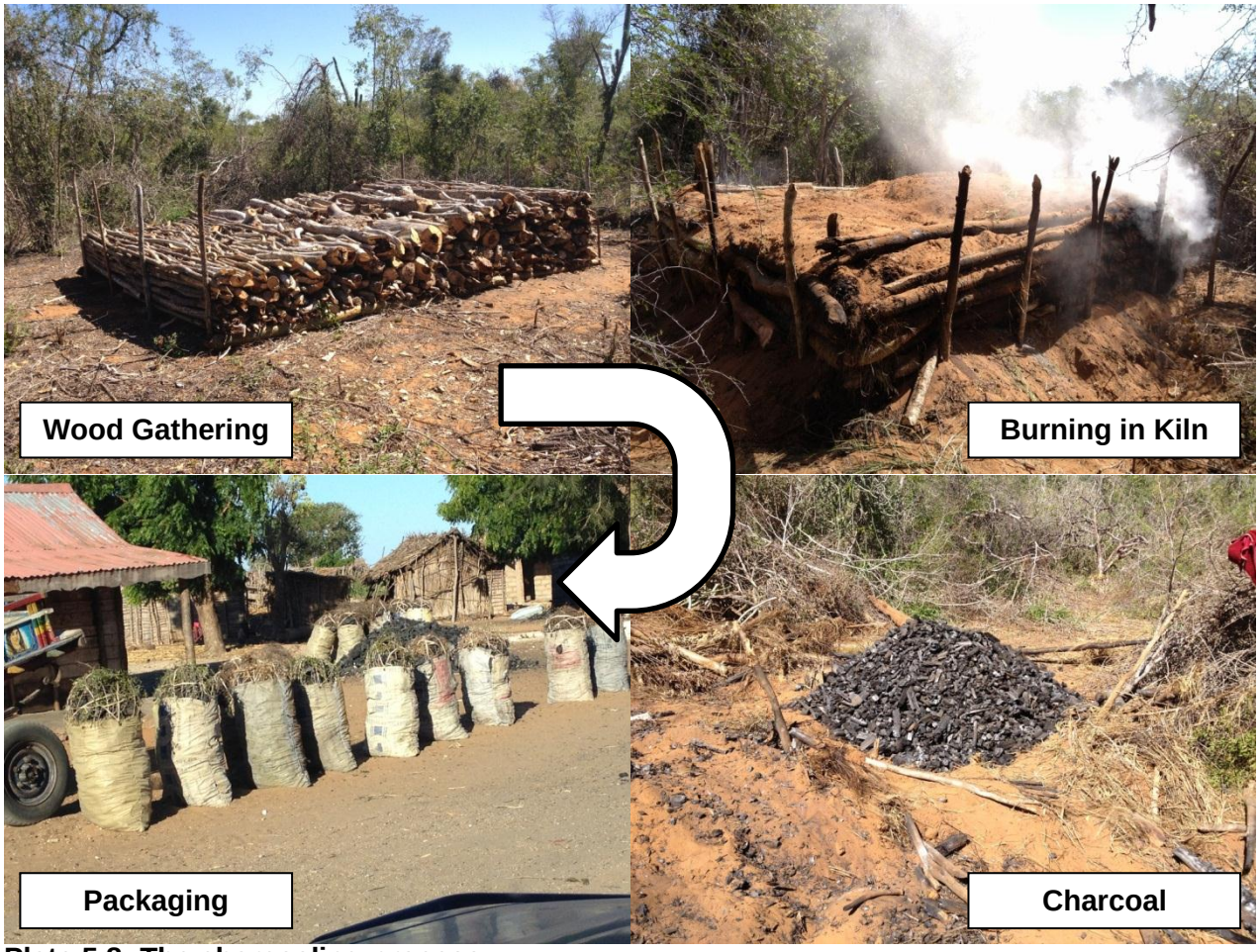


Plate 5.8: The charcoaling process

5.3. Fuelwood

All the villages visited appear to be able to access fuelwood easily in the immediate vicinity of the village or within 1 km of the village. It is mostly dry wood that is used and there appear to be no particular preferences or selectivity in the type of woods used. Even wood from the toxic *Tabernaemontana coffeoides* is used for fuel. Respondents indicated that one long branch of wood would be sufficient for one day of fuelwood. There are currently no households involved in the sale of fuelwood and no local market for fuelwood appears to exist. Charcoal is not generally used for fuel by local residents but is transported to Toliara town and sold at the market there (see Section 5.2). Due to the easy accessibility of fuelwood it is unlikely that the construction of the proposed mine would impact on the use of fuelwood resources.

5.4. Fishing

Fishing occurs along the coast mainly south of Andrevo Haut in the Ifaty Lagoon, north of Toliara Port in the Toliara Lagoon, in the Fiherenana River and Ranobe Lake. The main coastal fishing villages in the affected area are Andrevo, Ambolimailaka, Mongile, Ifaty (fishing in Ifaty Lagoon) and Toliara I (fishing in the Toliara Lagoon). All communities living adjacent to the Fiherenana River and on the shores of Lake Ranobe appear to utilize the fish resources of these water bodies, using a variety of fishing gear.

Traditional marine fishing is carried out from outrigger canoes hollowed out from tree trunks and fitted with one outrigger pole and a rectangular sail (see Section 5.1.3) referred to as a *piroque*. Fishermen generally go out to sea early in the morning in groups of three (also sometimes at night). Often family members work together, but teams can consist of acquaintances. In such cases, harvests are divided equally amongst the members of the team. The men usually fish, but when fish is plentiful women also go to sea.

Various methods of fishing are used, which include both line fishing and the use of both seine and gill nets. Hook and line fishing is common amongst all the villages with many fishermen using handlines in conjunction with other gear types. Fishing is usually undertaken during daylight hours although some fishermen fish at night targeting larger fish. Fishermen also troll lines to catch small pelagic species or squid and cuttlefish on jigs while moving to or between fishing sites. Fish caught on hook and line, are generally easy to sell due to their larger sizes and catch rates of between 4-6kg. The seine nets used are relatively large being approximately 300-400 m in length and approximately 3 m in depth. The mesh size of the main net is in the range of 20-30 mm with the central collection bag area being covered with a fine mosquito mesh net. These nets are used predominantly as purse seine nets being set using *pirogues* in the deeper water within the lagoon. They are set in a semi-circle and left for up to an hour before being retrieved allowing fish time to move into the net. The fishermen retrieve the net using *pirogues* while some fishermen hit and splash the water surface near the entrance to chase fish further into the net. There are generally four fishermen per *pirogue* with two boats working together to set and retrieve nets each day. Seine nets are also used as beach seines in some cases, being set from the shore using a *pirogue*. The net is pulled over the sandy or sea grass substrates collecting all fish in its path back towards the beach. The entire process takes up to an hour to complete with local fisher groups indicating the net being set 3-4 times per day. The catches in beach seines are usually low in comparison to the purse seine catches with a variety of small species being caught. In general seine catches tends to be harder to market due to the smaller sizes and species of fish caught not being favourable to the consumers. These small sized fish (Plate 5.9) is either sold directly to sub-collectors in each village or is cooked, made into a paste and eaten with cassava. Gillnets are homemade, and range in length from 100 to 300 m. The mesh sizes range considerably depending on individual preferences with size ranges varying from 20-70 mm. These gillnets are used either as fixed nets (passive) or as surround nets (active) where several fishermen work together setting their nets to form a large square which is gradually reduced in size. Most gillnetting takes place in the morning, however individual gillnets are also set overnight. Fish caught by gillnets tend to be more easily marketed due to their larger sizes and preferred species composition and are sold to sub-collectors at the landing sites each day.

Plate 5.9: Under sized fish caught in the Ifaty Lagoon (left) and the Toliara Lagoon (right)

The principle organisms sought after are finfish (reef fish, mangrove associated species, demersals and pelagics), elasmobranches (sharks, rays and sawfish), marine mammals (dolphins and dugongs), sea turtles, crustaceans (shrimp, lobster and mangrove crab), cephalopods (octopus, squid and cuttlefish), and echinoderms (sea cucumbers and edible urchins). During the month of December sea turtles are harvested at low tide on the reef flats or by free diving or even by scuba diving, which is illegal but difficult to control. Only few larger motorised vessels and trawlers are used, mainly for trawling for prawns.

According to residents utilising fish resources in both the Ifaty and Toliara Lagoons, overfishing is evident in the dramatic decrease in fish resources and the size of fish. Declining catches has led to a reduction in the mesh size used by fishermen allowing them to maintain their current levels of catches. This results in smaller fish being caught and is a sign of over utilisation of the resource. According to the President of Toliara 1 various shark and mullet species have disappeared completely from the Toliara Lagoon.

A number of residents pointed out that approximately 10 years ago the average size of fish caught was in the region of 20-30 kg, whereas today that has decreased to 4-5 kg. It is unlikely that fishing in the Ifaty Lagoon or the Ranobe Lake will be impacted upon by mining activities. However, fishing in the Toliara Lagoon and the Fiherenana River may be impacted upon. In the Toliara Lagoon this may occur by restricting access to the area due to safety issues involved with fishing in close proximity to the jetty and subsequent marine traffic. In addition to this according to the ichthyologist (Ichthyology Specialist Assessment) all seven of the indigenous species found in the Fiherenana River are thought migrate between freshwater and estuarine or marine habitats at some stage of their life cycle. The construction of the causeway if poorly designed may result in a barrier obstructing migration. This could interfere with or even completely block the natural upstream migrations of numerous fish and invertebrate species. As marine-breeding species migrate high upstream as relatively weak-swimming young fish (or larvae) and form a very important component of the fish and crustaceans found in the Fiherenana River, both the ecology of the system, as well as the artisanal fisheries could be negatively affected. It is therefore important that this is taken into account when designing the causeway.

5.5. Food Gathering

Various plants are utilised for consumption at the end of the rainy season and during the dry season when food is scarce. A comprehensive list is available in Table 5.3 below.

Table 5.3: Species used for consumption

MALAGASSY NAME	SCIENTIFIC NAME	LOCAL USE	STATUS
Ampeny	*Strychnos decussate*	Fruit	Not Listed
Babo	*Dioscorea* sp.	Root	Not Listed
Balo	*Dioscorea* sp.	Root	Not Listed
Guava	*Psidium* sp.	Fruit	Not Listed
Holatsy	All species (wood mushroom)	Mushroom	Not Listed
Jujubes	*Ziziphus* sp.	Fruit	Not Listed
Kapikala	*Combretum grandidieri*	Nut	Not Listed
Kily	*Tamarindus indica*	Fruit	Not Listed
Lamoty	*Flacourtia ramontchii*	Fruit	Not Listed
Ovy	*Dioscorea* sp.	Root	Not Listed
Sakoa	*Popartia minor*	Fruit	Not Listed
Sely	*Grewia* sp.	Fruit	Not Listed
Sosa	*Dioscorea sosa*	Root	Not Listed
Tsingilo	*Azima tetracantha*	Whole Plant	Not Listed
Volivaza	*Rothmannia* sp.	Fruit	Not Listed
Za	*Adansonia za*	Fruit	Not Listed

Of these species the majority of villages within the potentially affected area harvest various types of roots belonging to the *Dioscorea* genus from the Ranobe Forest. These are more commonly referred to as yams. There are two particular species which are harvested by local residents from the forests. These are called *babo* and *balo* by the native people. Both of these species are vines and are harvested and eaten mostly by women and children. *Babo* is eaten raw while *balo* needs to be cooked. During the growing season households may go out in search of these roots 3-4 times per week. However, harvesters need to walk deep into the forest to source these foods. Sometimes they are as much as 10 km away. One of these roots, *balo*, is becoming far less

prevalent than it used to be, and is said to be almost extinct. The other is easier to find. Some respondents indicated that they needed to go to the escarpment and plateau to harvest these foods. *Balo* is cooked and used as substitutes for maize, rice and cassava and are particularly valuable when these sources of food are scarce. *Babo* is very juicy (like a melon). It is not cooked but eaten fresh (and sometimes with honey) to provide an important source of refreshment for those working in the forest where water is scarce. *Babo* can be harvested all year around (when it can be found), but *balo* is only available in March and April (and possibly up till October). There are other roots similar to *Balo* called *Ovy* and *Sosa* which two respondents mentioned was used as a wild food source. Both *Ovy* and *Sosa* also belong to the *Dioscorea* genus.

Other wild plant foods harvested are largely fruits which are available from April to June. These provide useful supplements to the normal diet of households when in season. In addition to this various nuts and mushrooms can also be harvested from the forest and consumed.

Plate 5.10: Lamoty (left) and balahazo (right) harvested from the Ranobe Forest

5.6. Hunting

Hunting appears to be another source of wild food, however, this is largely opportunistic and limited to small animals such as pigs, tortoises and hedgehogs, as well as birds (in particular a species called Akanga that is the size of a small chicken). One respondent admitted that during times of drought and famine, local residents sometimes resorted to eating insects such as locusts and crickets/cicadas. It is important to note that the species hunted for consumption varies between the villages. For example in the village of Ankatrakatrake in the Commune of Ankilimalinika the hunting and consumption of tortoises are considered taboo and is therefore not allowed whereas this is not the case in various other villages such as the village of Betakilotsy in the Commune of Tsianisiha.

5.7. Bee Keeping

Bee keeping takes place in villages throughout the area. Local residents involved in this practice make artificial hives using 2 x 10 litre barrels positioned adjacent to each other usually close to homesteads (Plate 5.11). These barrels are lined with fish oil (extracted by boiling fish) or sugar (bought in the various markets). The fish oil and/or sugar serve to attract the bees to the artificial hive. Once established, honey is usually harvested from the hives only once a year. Approximately 3.5 litres of honey is harvested per barrel making a total of 7 litres per hive. The honey is then divided into smaller tins with a capacity of approximately 300 ml. These tins of honey are then sold in the market at a price of 800 Ariary per tin. The potential income from honey is therefore relatively low at approximately 20 000 Ariary per hive / annum. Households involved in bee keeping usually have a maximum of two hives. The honey that is not sold in the markets is usually eaten with cassava.

Plate 5.11: Artificial beehive

Bee keeping within the potentially affected area is limited. Respondents believe it to be dangerous and not particularly lucrative. The proposed mine is not anticipated to impact on bee keeping within the area since this resource is only utilised in the various villages due to difficulties with theft when hives are established within the forest. Locals have however requested training in bee keeping practises.

5.8. Rum Production

Various villages within the potentially affected area engage in the production of rum. Rum is produced from sugar cane usually grown in close proximity to the villages. Respondents complained that there is currently not enough water available from the irrigation canal to cultivate the amount of sugar cane required. During the dry season yields are usually low with plants having a notable decrease in height and stem diameter. For this reason rum producers often have to supplement stock by buying sugar cane from other nearby villages such as Ranobe. The cost of one *Zebu*-cart of sugar cane can cost between 40 000 and 50 000 Ariary resulting in a decrease in the profit margin.

Plate 5.12 below shows the rum making process in detail. Sugar cane is harvested throughout the year and if yields are low it is usually bought from elsewhere (Plate 5.12 (A)). Once harvested, the sugar cane is crushed (Plate 5.12 (B)) and cut into small pieces. In addition to this the pulp is mixed with tamarind, which is usually harvested from the Ranobe Forest. A large barrel is then half filled with the sugar cane and tamarind mixture and approximately 40 litres of water (Plate 5.12 (C)). This mixture is left standing until the taste is between sweet and sour. Sugar cane is then added to the mixture again and the excess liquid is drained (Plate 5.12 (D)). Both the drums with the liquid and with the drained sugar cane and tamarind are left for 1 week.

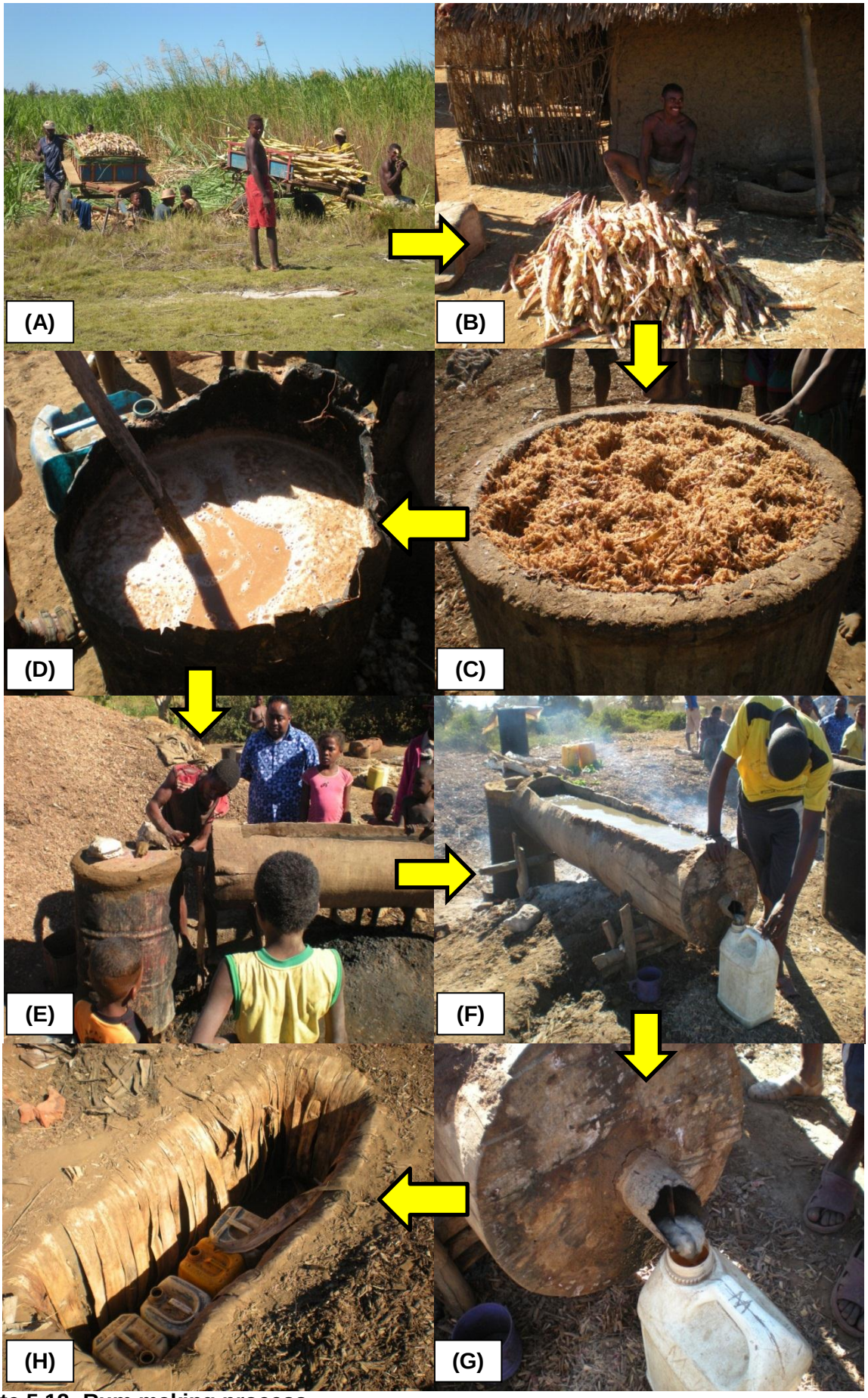


Plate 5.12: Rum making process

The sugar cane and tamarind is remixed with the drained liquid in a large drum. This drum is then sealed with manure (Plate 5.12 (E)) and heated on a fire. The drum is attached to a still (Plate 5.12 (F)). The still is made from a hollowed out Givortia tree that is filled with water and fitted with a steel pipe. These steel pipes are bought in Toliara at a cost of 100 000 Ariary and lasts approximately 1 year. Locals have however started to use aluminium pipes which are more expensive (i.e. 200 000 Ariary) but lasts longer. The heat from the fire causes the juice to evaporate and the vapour passes through the still and the pipe. The water in the hollowed out Givortia serves to cool the still so that the vapour is condensed back to a clear liquid which is collected at the other end (Plate 5.12 (G)). The rum is stored in 20 litre plastic jugs in hollows in the ground (Plate 5.12 (H)).

According to respondents approximately 40 litres of rum can be produced per day per still. Rum is taken to Toliara via Taxi Bruisse on a daily basis to be sold at a price of 2 000 Ariary per litre. Whatever is not sold is consumed in the village. It is unlikely that mining will impact negatively on rum production in the area. In fact employment and subsequent salaries may result in an increased market for rum in the area. In addition to this, should the weir be repaired more water will be available for sugar cane cultivation.

5.9. Salt Production

There are currently two areas within the potentially affected area that are involved in the large scale production of salt. The first is a family owned commercial saltworks situated in close proximity to the village of Mongily and consists of a number of salt evaporation ponds (Figure 5.1). Seawater is pumped to a primary pond on a daily basis. The average temperature in this pond is approximately 6 °C due to the shallow depth and increased surface area of the pond. From here water is pumped to a secondary pond where the water temperature is left to increase to approximately 10 °C. Insoluble impurities such as sand and clay and slightly soluble impurities such as calcium carbonate settle to the bottom as evaporation begins. From here the brine is pumped to another pond where calcium sulfate settles out as evaporation continues. The brine in this pond reaches a temperature of approximately 20 °C. From here the remaining brine is moved to a crystallization pond where the salt settles out as evaporation proceeds. Approximately 5 tons of salt is produced every 2 weeks during the summer and every month during winter. The commercial saltworks employs 13 workers on a permanent basis and an additional 20 temporary workers during the summer months when production is high.

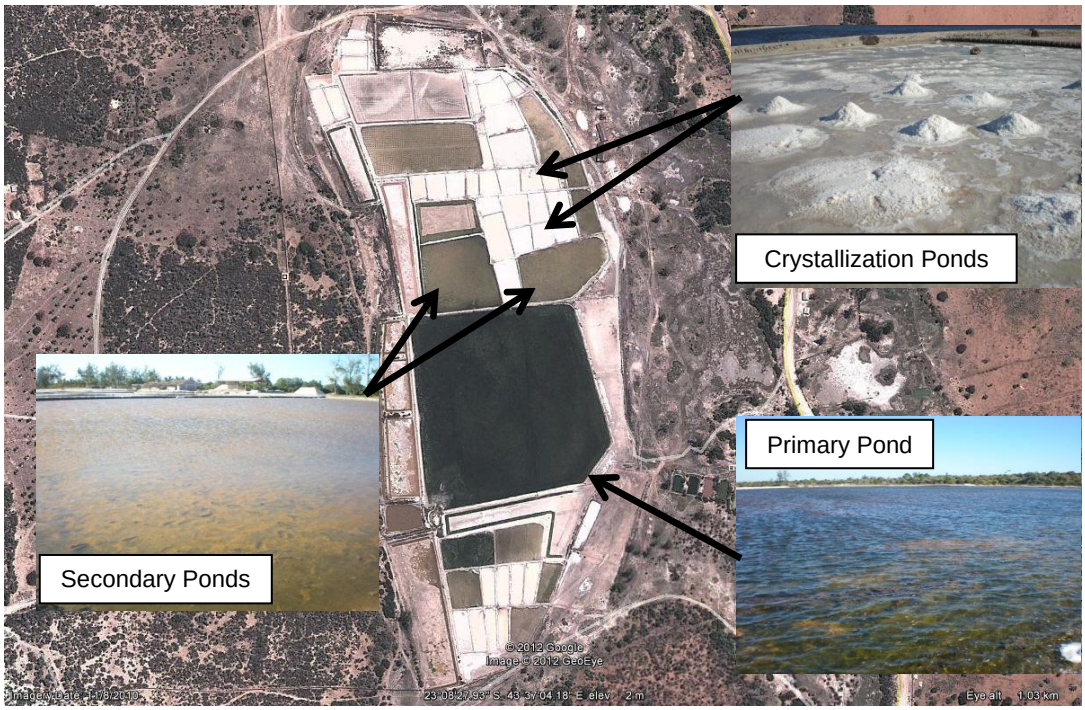


Figure 5.1: Commercial saltworks

The second large scale salt production takes place in close proximity to the town of Toliara in the region where the new jetty is proposed. These salt evaporation ponds are individually owned by local people. There are also slight variations in the process. For example water is not pumped from the sea but large trenches are dug and saline groundwater is used. Water is pumped using a small pump bought in Toliara at a cost of 1.5 million Ariary. In addition to this water is pumped only once from the trench to the evaporation ponds. Each trench and surrounding evaporation ponds are owned by a single individual. Approximately 45 x 60 kg bags of salt are produced every week during the summer months whereas only 30 x 60 kg bags of salt are produced every two weeks in the winter months. Therefore during the summer months the price attained for salt is lower (5 000 Ariary per 60 kg bag) than during the winter months (9 000 Ariary per 60 kg bag) due to an increase in production and subsequent availability. Salt is taken to Toliara via *Zebu*-cart to be sold.

Figure 5.2: Traditional saltworks

It is unlikely that the proposed mining activities will impact upon either the commercial or traditional salt production operations. Even though the traditional saltworks are relatively close to the proposed jetty site access will not be impeded since it is also within close proximity to the town of Toliara.

5.10. Spirulina Production

Spirulina is a microalgae that grows naturally in tropical and subtropical lakes with a high pH and high levels of carbonate and bicarbonate. There are currently two areas within the potentially affected area that are involved in the production of *Spirulina*.

SPIRNAM Ltd was granted a permit for the production of *Spirulina* products in Madagascar in 2004. Samples are regularly sent to an accredited laboratory in Anatananarivo for analysis in order to obtain market approval by the Minister of Health. SPIRNUM produces approximately 1 ton of product a year including capsules, tablets, granules and powder which is sold and consumed in Madagascar.

There is also a smaller area being used for *Spirulina* production by the prison (Plate 5.13).

Prisoners staff this facility and the product is used to feed prisoners. During heavy rainfall the *Spirulina* will settle on the floor of the pond. The pond is then mixed using a turning wheel to bring the *Spirulina* back to the surface. The *Spirulina* rich water is filtered through a sieve and the remaining product is then scraped off and consumed either with rice or cassava. It is unlikely that the proposed mine will impact on *Spirulina* production in the area.

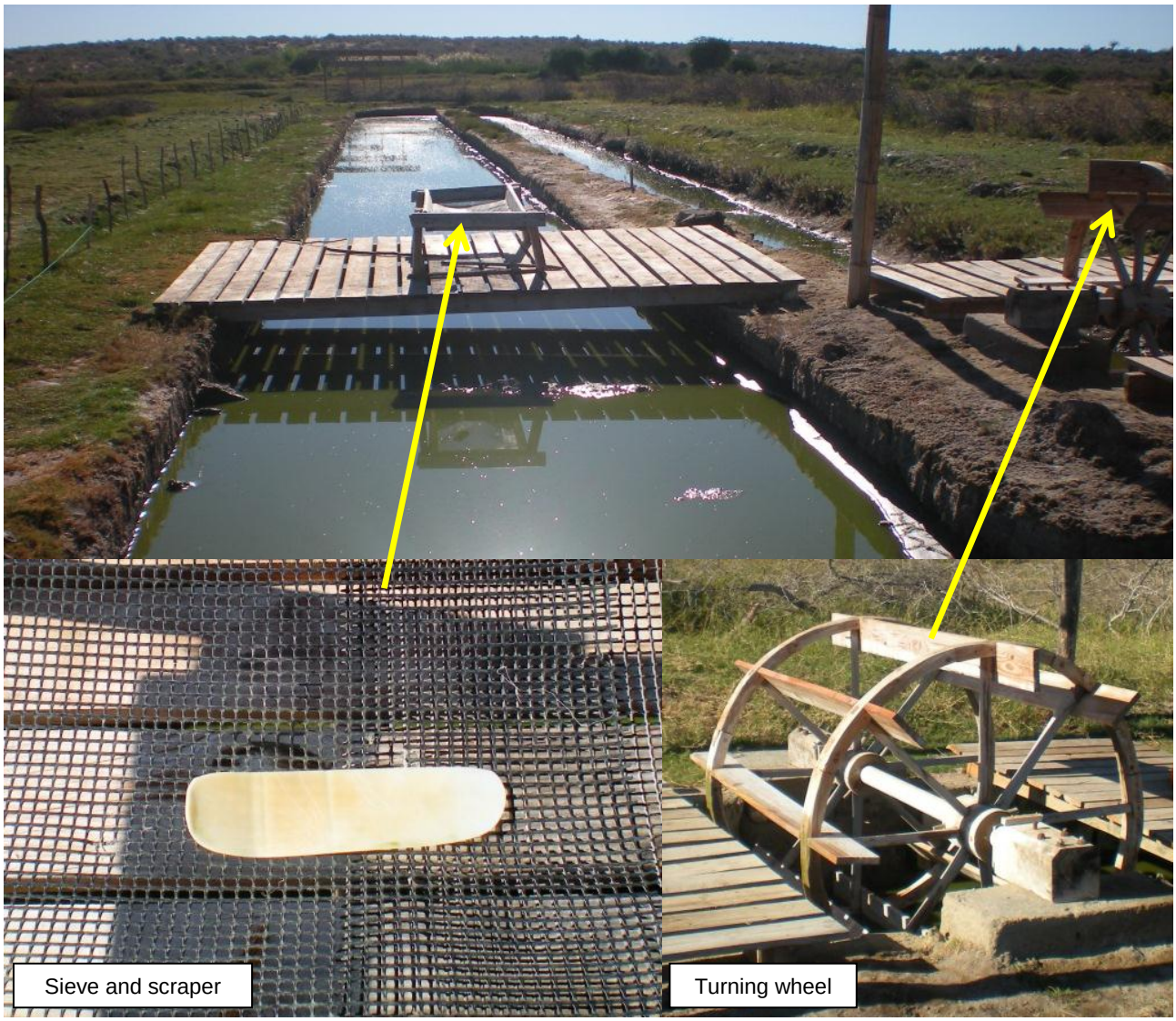


Plate 5.13: Spirulina production

5.11. Medicinal Use

According to respondents, local residents are not adverse to using commercial medicines. However commercial medicines are fairly expensive and therefore locals make considerable use of traditional medicines. In general, western medical services are often only used when traditional medicines fail. As indicated in the SIA report, there are only 2 doctors for every 11 211 people and one health centre per 7 475 people. The services provided by these doctors and centres are also hampered by a lack of equipment and medication. Local traditional remedies can be divided into two groups, i.e. medicinal use (for curing illnesses and ailments) and traditional use (for curing spiritual problems). The plants used for both medicinal and traditional use is discussed in the sections below.

5.11.1. Local Medicinal Use

As indicated in Table 5.4 below, the number of plants (or parts of plants) used for medicinal purposes is considerable. Some of these plants are sourced in the areas around the villages but

many are derive from the forests. These plants are used for a wide variety of purposes such as the treatment of wounds and infections (i.e. boils and acne), stomach and bowel problems, pain, arthritis, broken bones, sore muscles, tonics, fatigue, etc. Given the ease with which even children could identify and find these plants, they appear to be an important and well-used resource for local residents. Only one animal or part of an animal is used for local medicinal purposes. This is the hoof of a *Zebu*. It is boiled and the oil that is released can be deposited in the ear and used to cure an earache.

Table 5.4: Plants used for medicinal purposes

MALAGASSY NAME	SCIENTIFIC NAME	PREPARATION	USE
Ahibe		Leaves are boiled in water. The water is then ingested as a cure.	Numerous uses, e.g. pain, fever, fatigue, etc.
Andriambolafotsy	*Croton* sp.	Leaves are boiled in water. The water is then ingested as a cure.	Fever
Famata	*Euphorbia stenoclada*	The sap of the tree is placed on a piece of cotton which is then placed on a tooth.	Toothache
Fany	*Albizia mahalao*	The branches of this plant are placed around the head.	Headache
Folotse	*Folotsia* sp.	The outer layer of the roots is removed. The roots left in the sun to dry. The dried roots are boiled in water. The water is then ingested as a cure.	Cough It is used exclusively for infants.
Handy	*Neobeguia mahafaliensis*	Bark is boiled in water. The water is then ingested as a cure or alternatively bathed in.	Backache
Hangoma	*Tridax procumbens*	The juice of the leaves is applied to cuts and scrapes.	Cuts and scrapes
Hazontaha	*Rhigozum madagascariensis*	Branches are cut into small pieces and then boiled in water. The water is then ingested as a cure.	It is used by women who have recently given birth to regain their strength. It is ingested daily for approximately 6 months.
Jabihy	*Operculicarya decaryi*	Leaves are boiled in water. The water is then ingested as a cure.	It is used by women who have recently given birth to regain their strength. It is ingested daily for approximately 4 months.
Kadidoke	*Helinus integrifolius*	Roots are crushed into powder form and rubbed on fontanel. Leaves are boiled in	Fontanel closure in babies. Cough It is used exclusively

MALAGASSY NAME	SCIENTIFIC NAME	PREPARATION	USE
		water. The water is then ingested as a cure for coughing.	for infants.
Karimbola	*Croton* sp.	The entire plant is used. It is cut into small pieces and grill. The grill pieces are then boiled in water. The water is ingested as a cure	It is used by women who have recently given birth to regain their strength. It is also used as a remedy for backache and applied to broken bones.
Katrafay	*Cedralopsis greveii*	Bark is boiled in water. The water is then ingested as a cure or alternatively bathed in.	It is used by women who have recently given birth to regain their strength. Sore feet Fatigue Katrafay oil is sold commercially in Madagascar and has various uses such as fatigue, headaches, rheumatism, muscular aches and pains, and sciatica. It is also a natural anti-inflammatory and antibiotic.
Lelatrandraka	*Clerodendrum* sp.	Leaves are boiled in water. The water is then ingested as a cure.	Fever
Lisindrere	*Croton* sp.	Leaves are boiled in water. The water is then ingested as a cure.	It is used by women who have recently given birth to regain their strength. It is ingested daily for approximately 6 months.
Lombiry	*Cryptostegia madagascariensis*	The outer layer of the roots is removed. The roots are heated on coals. The heated roots are brushed on a stone until powder form. The powder is then rubbed on the throat.	Sore throat
Maroaty	*Chadsia grevei*	Leaves and branches are boiled in water. The water is then ingested as a cure.	Backache
Monongo	*Zamthoxylum decaryi*	Bark is boiled in water. The water is then ingested as a cure.	Muscle Pain
Netse	*Indigofora* sp.	Leaves are boiled in water. The water is	It is used by women who have recently

MALAGASSY NAME	SCIENTIFIC NAME	PREPARATION	USE
		then ingested as a cure.	given birth to regain their strength. It is ingested daily for approximately 6 months.
Papolahy	*Strophanthus boivinii*	The bark is cut into small pieces and then boiled in water. The water is then ingested as a cure.	It is used by women who have recently given birth to regain their strength. It is ingested daily for approximately 6 months.
Ranga	*Cychanchum* sp.	Bark is boiled in water. The water is then ingested as a cure.	It is used by women who have recently given birth to regain their strength. It is ingested daily for approximately 4 months.
Sanatrindolo	*Sida acuta*	Leaves are crushed into cold water and the inflicted will take a bath in it.	Used to cool down and an extremely hot day.
Seva	*Solanum auriculadum*	Leaves are crushed into cold water and the inflicted will take a bath in it.	Childhood Illnesses
Sono	*Didieria madagascariensis*	The bark is cut into small pieces and then boiled in water. The water is then ingested as a cure.	Numerous uses, e.g. tension, stomach ache, headache, backache etc.
Somotsoy	*Fernandoa madagascariensis*	Leaves are boiled in water. The water is then ingested as a cure.	Relieves Pain
Teloravy	*Cratava excelsa*	Leaves are boiled in water. The water is then ingested as a cure.	This is given daily to infants (0-1 years of age) and acts as a vitamin.
Tohiravy	*Phyllartron* sp.	Leaves are boiled in water. The water is then ingested as a cure.	It is used by women who have recently given birth to regain their strength. It is ingested daily for approximately 6 months. Fever
Totonga	*Aristolochia albida*	Leaves are crushed into cold water and the inflicted will take a bath in it.	Insect Bites
Tranoamonto	*Waltheria indica*	The entire plant is boiled in water. The water is then ingested as a cure.	Stomach Ache Diarrhoea Used exclusively for infants.

MALAGASSY NAME	SCIENTIFIC NAME	PREPARATION	USE
Tsimaitinamany	*Phyla nodiflora*	The entire plant is boiled in water. The water is then ingested as a cure.	Urinary hesitancy in babies. Used exclusively for children between the ages of 0-2 years.
Tsimenamena	*Chadsia grevei*	The entire plant is boiled in water. The water is then ingested as a cure.	Stomach Ache Fever It is used exclusively for infants.
Tsomphia		Leaves are boiled in water. The water is then ingested as a cure or applied to the skin.	Broken Bones Bruises
Vahipinde	*Loeseneriella urceolus*	Leaves are boiled in water. The water is then ingested as a cure.	This is given daily to infants (2-12 month of age) and acts as a vitamin. Fontanel closure in babies.
Vaho	*Aloe divaricata*	The juice of the leaves is applied to bruises. Leaves are also boiled in water. The water is then ingested as a cure for primarily stomach ailments.	Bruises Body Pain Stomach Ache
Valonaondry	*Pycreus mundtii*	The entire plant is boiled in water. The water is then ingested as a cure.	It is used by women who have recently given birth to regain their strength. Uterine Issues
Voafariha	*Cardiospermum halicacabum*	The juice of the leaves is used as eye drops. Leaves are also boiled in water. The water is then ingested as a cure for primarily constipation (only infants).	Soreness of the eyes Infant constipation
Voamena	*Albus precatorius*	Leaves are boiled in water. The water is then ingested as a cure.	Cough

5.11.2. Traditional Use

Various plants are used to cure more traditional aliments such as possession, bad days, evil spirits, etc. Some of these plants are known by local residents, however the majority is only known by the various traditional healers. A variety of these plants have been included in table 5.5 below.
According to a traditional healer in Benetse one such plant, used to cure possession and referred to as Manjakabetany, has become increasing hard to find. According to the healer sometimes 10 people can search for an entire month and only find a single plant. As is the case with medicinal use very few animals or animal parts are used for this purpose. The shoulder blade of the Zebu can be ground into a fine powder and consumed to cure a bad day. In addition to this the raw liver of a Zebu can be consumed to cure possession. It is very rare that only one plant and/or animal

part is consumed to cure these ailments. Usually a combination of various remedies is used and the cure will ultimately depend on the kind of ailments and the severity thereof.

Table 5.5: Plants utilized for traditional purposes

MALAGASSY NAME	SCIENTIFIC NAME
Ambiotse	Olax sp.
Bokabe	Marsdenia cordifolia
Fany	Albizia mahalao
Lavahantsy	Cordia sp.
Mandravasarotra	Sida cordifolia
Mandresy	Ficus sp.
Maintifototra	Diospyros sp.
Mantsake	Tarenna malacophylla
Tapisaky	Xerosicyos danguyi
Tsilaitsa	Noronia sp.
Tsilavondrivotra	Scoparia dulcis

5.12. Sacred Plants

Various plants within the study area are considered to be sacred and these can be found in villages throughout the area. It is believed that if you plant *Broussonetia greveana* it will protect the land. It is also planted within or close to agricultural fields and is believed to keep the land fertile. In addition to this it keeps *Zebu* from wandering away from the villages and brings good fortune. It is unlikely that the proposed mining activities will impact on these plants as they are usually kept within villages.

5.13. Miscellaneous

In addition to the various resources listed and discussed above plants are used for a variety of other uses some of which are listed below.

- The roots of *Alibiza mahalao* are used for the washing of clothes.
- *Aristolochia albida* is used for cosmetic powder for facial masks (Plate 5.14).
- *Cynodon dactylon* is placed around the horns of Zebu to protect them from illness.
- *Santalina madagascariensis* is used for cosmetic powder for facial masks
- *Uncarina abbreviata* is used for washing hair. Leaves are crushed in water and the water is then used to wash hair.
- The burrs of *Uncarina abbreviata* are used to catch birds. The burrs get stuck to the wings of the birds which prevent them from being able to fly away.

It is likely that the proposed mine will impact on these resources during the short term. However the loss of these resources can be mitigated by allowing local residents to harvest what they can from the forested area prior to clearing and to use the plants listed in this report in rehabilitation efforts.

Plate 5.14: Face masks worn by women

6. TRADE AND BARTERING

6.1. Trade

As described in Chapter 5 the majority of goods produced from natural resources are sold within the markets within the study area and in Toliara. Whatever is not consumed is sold and vice versa. Therefore in this Chapter only the revenue made from major trade items such as cash crops and charcoal will be discussed in detail below. Figure 6.1 shows the origin of income as derived from the household survey.

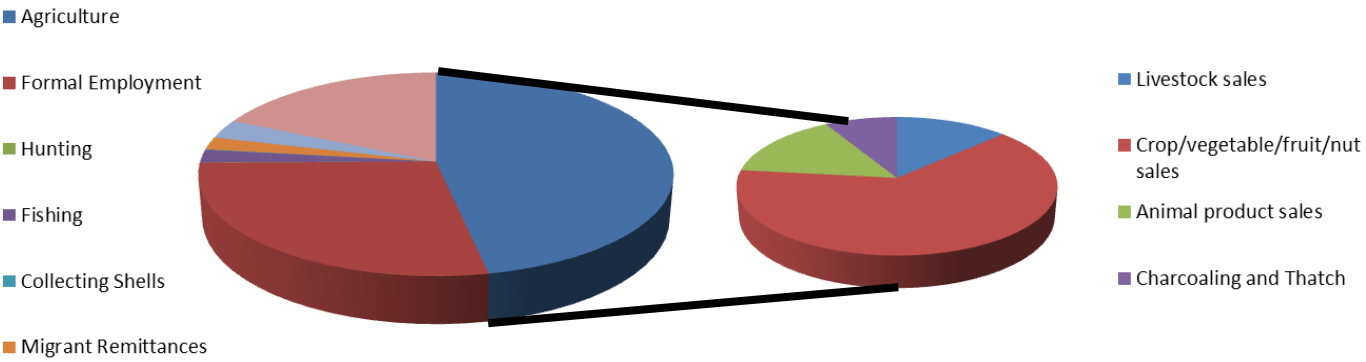


Figure 6.1: Major income for local communities

6.1.1. Crops

The major cash crops within the study consist of cotton and maize as discussed in Chapter 4 of this report. Earnings from cotton are somewhere in the region of 500 Ariary per kg. Cotton used to be an important source of income for the area, and was exported as well as being used locally in a thriving textile manufacturing sector. However the cotton textile industry has declined and the political unrest during 2002 led to an even greater collapse of the industry. In 2002 the cotton yield in Tsianisiha was estimated to be 270 tons and 950 tons for Ankilimalinke. Recently cotton growing in the region is regaining some strength. According to the SIA report, the average monthly income derived from cotton production was around 80 000 Ariary.

In 2005, 4 300 ha of the Toliara II district was estimated to be under maize production with a yield of 4300 tons. In 2002 Tsihanisiha produced an estimated 30 tonnes of maize and Ankilimalinke produced 200 tonnes, of which 120 was consumed locally. According to the SIA report, the estimated average monthly income from maize production was 4 000 Ariary.

6.1.2. Charcoaling

All 4 communes are involved in charcoaling to some extent. The charcoal value chain in Madagascar is shown in the figure below. In general the charcoal producer brings the charcoal to the roadside (along the RN9) from where it is transported by truck or *Zebu*-cart to Toliara and then sold to the consumer at the various market areas.

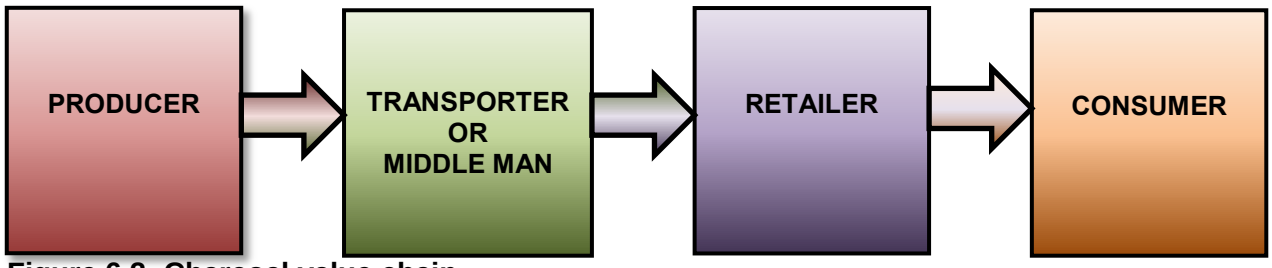


Figure 6.2: Charcoal value chain

Charcoal producers sell bags of charcoal along the RN9, but also transport charcoal to Toliara to be sold at the markets. Currently the average selling price for a bag of charcoal (approximately 25 kg per bag) bought along the RN9 is 3 000 Ariary. Various charcoal producers transport charcoal to the market in Toliara via chevet where the selling price is increased to 6 000 Ariary. Producers who are unable to transport charcoal to Toliara themselves can do so by utilizing the services of various truck drivers. A number of large trucks visit the villages between Toliara and the Manombo River every two days to transport charcoal to Toliara. These truck drivers receives approximately 2 000 Ariary per bag of charcoal transported to the market in Toliara. Consumers in Toliara can then purchase a bag of charcoal for 10 000 Ariary at the markets.

The consistency of production of charcoal varies among producers. For some local residents this is a way to sub-limit income during periods of drought and/or the period of hunger between harvests. These producers may make charcoal as little as 3 times a year. However, for some this is a permanent form of income and these producers may make charcoal 12-15 times per year. According to interviews it takes approximately 1 month to produce charcoal. The average yield is approximately 30 bags (± 750 kg). At the going price of 3 000 Ariary per bag this amounts to 90 000 Ariary per round. On an annual basis this would amount to an average of approximately 270 000 Ariary per annum for charcoal producers who produce 3 loads per annum and 1 080 000 Ariary per annum for full time charcoal producers (i.e. 12 loads per annum).

6.2. Bartering

Local bartering takes place on a daily basis. Ladies from the various inland villages travel approximately 20 km every day (Plate 6.1) to the fishing villages along the coast where they barter fresh fruit and vegetable specifically cassava for fish. Residents of the fishing villages however do not travel inland for bartering as the general concession is that the protein derived from fish is more important than the consumption of vegetables and fruit.

Plate 6.1: Ladies from inland villages traveling to the coast for the purpose of bartering for fish.

7. MANAGEMENT OF NATURAL RESOURCES

7.1. Knowledge

Our interviews with respondents demonstrated that most local residents, including very young children, had considerable knowledge of the plants and trees used for medicinal purposes, food consumption and construction purposes. They also had a clear understanding of the boundaries of their village's resource areas, and of the rules of use. Most people confirmed that they understood that charcoal production was regulated and only allowed in some woodland areas (particularly those areas south of the Manombo river and between the main road and the sea). This knowledge stems from considerable reliance on these resources for basic household needs and livelihood activities.

7.2. Management

Decisions are generally made communally and personal and community responsibility is closely intertwined. There are traditional councils of village elders (*fokonolona*) responsible for decision and policy making. *Fokonolona* also play an important role in promoting solidarity and mutual assistance so critical to vulnerable land-based livelihoods. These structures use locally developed rules and norms to ensure cooperation, cohesion and to combat social disruption. Transgressions can lead to the imposition of fines but more importantly to social disapproval. These institutions are recognised by the Madagascan government as part of the local government institutions and there status has been defined in a decree published in 1962 (Comte, 1963). They have representation on the *Chef d'administration* and work within the penal code. The *Chef de fokontany* also sits on the Fokonolana and represents the administration (*fanjakana)*.

The boundary of the land that belongs to each village (or group of villages) is well understood by respondents. Respondents also indicated that there were certain protocols those wishing to access natural resource in forests need to adhere to, especially if they are from outside the rights holding community. Respondents were also generally aware of the restrictions on charcoal production and apparently some offenders have been taken to the authorities in Toliara. However, it was also clear that the enforcement of the rules in the villages between Tsiafanoko and Ankilimalinika was abandoned during the period when the irrigation system was inoperable. In the villages further south that have no access to irrigated land, there appears to be even less regulation of charcoal production and more engagement in this activity.

This suggests that the traditional management institutions appear to be having difficulty coping with crises and adapting to the rapidly changing socio-economic context. The changing socio-economic context includes population growth, livelihood and food crisis linked to the collapse of the irrigation system, high urban demand for charcoal, the growth of tourism development along the coast and diminishing fish stocks in the lagoon/coastal waters.

As a result of over-consumption of natural resources, abuses of the licensing system and current trends in participatory conservation management, community based natural resource management initiatives have been developed in the study area. For example, FiMaMi (*Fikambanana Miaro ny Alan'I Mikea*), an inter communal association for the conservation of the Mikea Forest, consisting of the mayors of all the *firaisana* around the Mikea forests was set up as a network for conservation and development in the Mikea region, and to take over the execution of some of the government functions with regard to management of natural resource use. As part of this initiative, management of local resource use is negotiated between local stakeholder communities. This is called *Gestion Local Sécurisée* (*Gelose*). The *Gelose* is organised at three levels, namely at the *committee concentration* (at village level) at the *structure communale* (*commune* level) and at the *structure inter communautaire* (at *firaisana* level). Once agreement is reached on resource use issues at all levels, a *dina*, which is a kind of interior rule based on local custom, is formulated. The decision made by the *Gelose* and the *dina* are subsequently ratified by national law. In the study area there is only one *Gelose*, namely in the village of Ranobe. The Malagasy organisation SAGE currently provides capacity building services for the *Gelose.*

Furthermore, in response to efforts made by WWF since 2005 the Government of Madagascar has granted temporary protection status of an area referred to as PK32 on 2 December 2008 (*ibid.*). PK32 lies north of the regional capital of Toliara on the southwest coast, and stretches between the Fiherenana River to the south and the Manombo River to the North (Gardner *et al.*, 2009). It is bordered to the west by the Mozambique Channel, and extends to the eastern edge of the Tertiary Limestone Mikoboka Plateau. The area is co-managed by WWF and an inter-communal association, which includes eight rural communes that are organised in a co-management structure (*ibid*) based on the Gestion Locale Sécurisée (GELOSE), which translated, means 'protecting local management'. This legal framework was designed to increase awareness of conservation importance within communities by enabling community based management of natural resources (Fritz *el al.* 2009).

In addition to this there is an association currently managing the canal water in Tsifonaka called "Andohoharano Mamovoke". This association is made up of a General Assembly of farmers who are responsible for repairing the canal and managing the dispatch of canal water. This local association is linked to a larger water management association called "The Federation", which comprises members from all associations in the Tsianisiha Commune. Even though this association is in place the access to water from the canal does not seem to be controlled and no relevant decisions have been made in the last year due to the need to replace the president of the association. However, according to local residents in Tsiafanoke Village this association have ruled that starting from the 19th of July 2012, sluice gates will be opened for 10 days in the Commune of Tsianisiha and then closed for 10 days, giving access to the Commune of Ankanimalinika. Although this shows that the association is acutely aware of the problem and actively trying to solve it the closing of the sluice gates for extended periods of time may have serious repercussions.

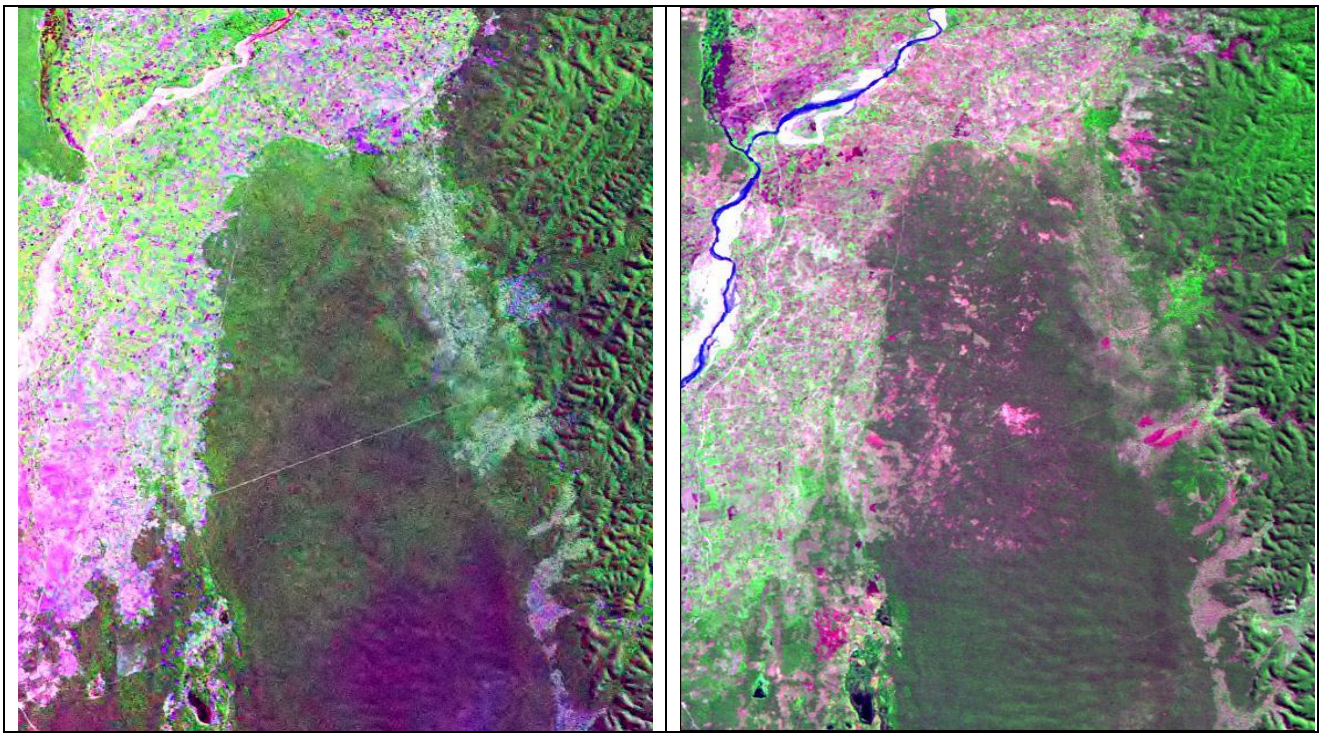
8. IMPACTS OF MINING ON NATURAL RESOURCES

This Chapter has been divided into two sections. This first (Section 8.1) deals with existing impacts on natural resources such as current land use activities i.e. burning for grazing land, slash and burn practises to acquire farmland, charcoaling, etc. The second sections (Section 8.2) deals with the potential impacts of the mine on land and natural resource use.

8.1. Existing impacts on natural resource use

8.1.1. Issue 1: Over-exploitation of resources

At present there is a considerable degree of resource utilisation; people collect plants and, to a smaller extent, wild animals from the Ranobe Forest that provide for their needs with respect to health, shelter, food and income. Currently the Ranobe Forest is decreasing at an alarming rate as illustrated in Figure 8.1 below which shows satellite images of the northern part of Ranobe forest. It is evident that large portions of forested areas have been cleared. In the top left image all forested area in the north are intact, whereas in 2005 (top right) large cleared patches in the forested area are evident as pink patches on the image. This is where soil has been exposed, and the canopy is no longer intact. By 2010 a vast swathe of forest had been cleared, with the open area almost bordering with the vegetation of the calcere to the east (right). By 2011 almost no forested area is present in the central part of the image (light coloured areas) and clearing to the south is also evident. Note the large amount of calcere vegetation cleared (compare the top right and bottom right images). This trend is unlikely to remedy itself and is anticipated to worsen over time as populations within the area increase.



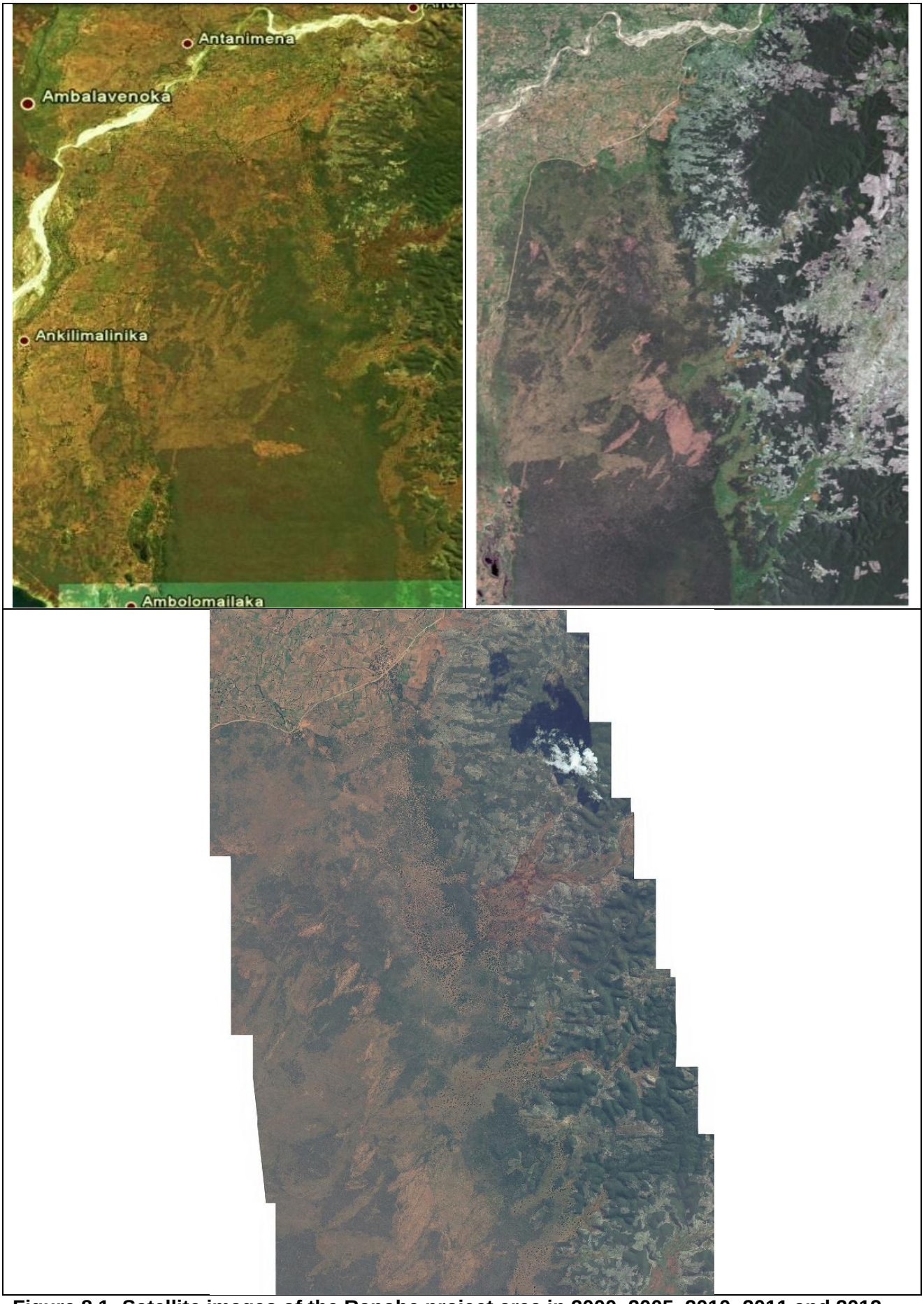


Figure 8.1: Satellite images of the Ranobe project area in 2000, 2005, 2010, 2011 and 2012

Impact 1: Hardwood Trees

Cause and comment: Hardwood trees are preferred for charcoal production in the area. On-site investigations showed that the majority of hardwood trees within the Ranobe Forest area have already been cleared and the few that remain are seedlings and/or saplings. The lack of hardwood trees have subsequently resulted in the use of woody shrubs for charcoal production. According to Mr Anthony from Ranobe Village attempts to propagate various hardwood species in a nursery in Ranobe Village have been unsuccessful to date.

Significance Statement: It is *definite* that communities will continue to harvest hardwood trees as currently their livelihoods depend upon this. The nature of the impact would be **Permanent**. The impact is of high severity and of HIGH significance.

Without mitigation					With mitigation	
Temporal scale	**Spatial scale**	**Likelihood**	**Severity**	**Significance**	**Severity**	**Significance**
Permanent	Study area	Definite	High	High	N/A	N/A

Impact 2: Softwood Trees

Cause and comment: Softwood trees such as *Givortia* are utilized for the construction of dug-out boats and stills. Even though the uses for these trees are limited large amounts are still harvested on an annual basis. To date *baobab* trees were not harvested on a regular basis and are used only for fibre and fruit. However in recent months it was established that these trees are being cut down to water cattle. It is anticipated that this situation will be exacerbated should more uses for these trees be discovered.

Significance Statement: It is *probable* that communities will continue to harvest softwood trees to construct dug-out boats and stills. The nature of the impact would be **Long term**. The impact is of moderate severity and of MODERATE significance.

Without mitigation					With mitigation	
Temporal scale	**Spatial scale**	**Likelihood**	**Severity**	**Significance**	**Severity**	**Significance**
Long term	Study area	Probable	Moderate	Moderate	N/A	N/A

Impact 3: Medicinal Plants

Cause and comment: A large number of plants are utilised for medicinal purposes. These plants however are not harvested on a regular basis but rather based on need. In addition to this the majority of the plants utilised are not removed in their entirety since only specific parts of plants such as the roots, leaves, stems etc. are used for any particular cure.

Significance Statement: It is *probable* that communities will continue to harvest plants for medicinal purposes. The nature of the impact would be **Long term**. The impact is of low severity and of LOW significance.

Without mitigation					With mitigation	
Temporal scale	**Spatial scale**	**Likelihood**	**Severity**	**Significance**	**Severity**	**Significance**
Long term	Study area	Probable	Low	Low	N/A	N/A

Impact 4: Wild Foods

Cause and comment: Various plants are utilised for consumption at the end of the rainy season and during the dry season when food is scarce.

Significance Statement: It is *probable* that communities will continue to harvest wild foods from the forest. The nature of the impact would be **Long term**. The impact is of moderate severity and of MODERATE significance.

Without mitigation					With mitigation	
Temporal scale	**Spatial scale**	**Likelihood**	**Severity**	**Significance**	**Severity**	**Significance**
Long term	Study area	Probable	Moderate	Moderate	N/A	N/A

Impact 5: Loss of Fauna from Hunting

Cause and comment: Hunting appears to be another source of wild food, however, this is largely opportunistic and limited to small animals such as pigs and tortoises as well as birds.

Significance Statement: It is *probable* that communities will continue to hunt wild animals from the forest for consumption. The nature of the impact would be **Long term**. The impact is of moderate severity and of MODERATE significance.

Without mitigation					With mitigation	
Temporal scale	**Spatial scale**	**Likelihood**	**Severity**	**Significance**	**Severity**	**Significance**
Long term	Study area	Probable	Moderate	Moderate	N/A	N/A

Impact 6: Fish Resources

Cause and comment: There are several active fisheries in the Toliara and Ifaty Lagoons, Fiherenana River and Ranobe Lake (seine netting, line fishing, gill netting and fish trapping); these fisheries are important to the local fishermen, and provide an important source of income to the local communities. Evidence of over-fishing is evident in the small size of fish caught within the coastal and riverine areas. In addition to this the President of Toliara 1 mentioned that various species of fish that were abundant within the Toliara Lagoon are now absent.

Significance Statement: It is *definite* that fishing communities will continue to fish as currently their livelihoods depend upon this. The nature of the impact would be **Permanent**. The impact is of high severity and of HIGH significance.

Without mitigation					With mitigation	
Temporal scale	**Spatial scale**	**Likelihood**	**Severity**	**Significance**	**Severity**	**Significance**
Long term	Study area	Definite	Severe	High	N/A	N/A

Impact 7: Fuelwood

Cause and comment: All the villages visited appear to be able to access fuelwood easily in the immediate vicinity of the village or within 1 km of the village. For this reason fuelwood is not readily sourced from the Ranobe Forest.

Significance Statement: It is *probable* that communities will continue to harvest fuelwood, however it is unlikely that this will be from the proposed project area. The nature of the impact would be **Long term**. The impact is of low severity and of LOW significance.

Without mitigation					With mitigation	
Temporal scale	**Spatial scale**	**Likelihood**	**Severity**	**Significance**	**Severity**	**Significance**
Long term	Study area	Probable	Slight	Low	N/A	N/A

Impact 8: Species of Special Concern

Cause and comment: Various species of special concern are currently being harvested for various purposes, such as *Dalbergia xerophila* which is listed on the IUCN as endangered, and which is used for both building and charcoaling purposes.

Significance Statement: It is *definite* that communities will continue to harvest species of special concern as currently their livelihoods depend upon this. The nature of the impact would be **Permanent**. The impact is of high severity and of HIGH significance.

Without mitigation					With mitigation	
Temporal scale	**Spatial scale**	**Likelihood**	**Severity**	**Significance**	**Severity**	**Significance**
Permanent	Study area	Definite	Severe	High	N/A	N/A

8.1.2. Issue 2: Existing impacts on land use

Impact 1: Lack of water resources for agricultural practices

Cause and comment: The majority of local residents complained about the lack of available water resources for agricultural practises. This seems to be the result of the weir on the Manombo River leaking and the mismanagement of water resources.

Significance Statement: It is *definite* that communities will continue to have water supply problems if the existing situation is to continue. The nature of the impact would be **Long Term**. The impact is of high severity and of HIGH significance.

Without mitigation					With mitigation	
Temporal scale	**Spatial scale**	**Likelihood**	**Severity**	**Significance**	**Severity**	**Significance**
Long term	Study area	Definite	Severe	High	N/A	N/A

Impact 2: Growth of water hungry crops

Cause and comment: The project area occurs in the driest part of Madagascar, yet the residents grow various water hungry crops such as rice and cotton.

Significance Statement: It is *probable* that communities will continue to grow water hungry crops. The nature of the impact would be **Long Term**. The impact is of high severity and of HIGH significance.

Without mitigation					With mitigation	
Temporal scale	**Spatial scale**	**Likelihood**	**Severity**	**Significance**	**Severity**	**Significance**
Long term	Study area	Probable	Severe	High	N/A	N/A

8.2. Impacts of the proposed mining operation

8.2.1. Impact 1: Loss of natural resources

Cause and comment: An area of the Ranobe forest will have to be cleared for the construction of the proposed heavy minerals mine. It should however be noted that even though the proposed mine will affect a large area (approximately 455 ha) over its lifespan, only a limited area (approximately 35 ha) will be impacted upon at any given time due to progressive rehabilitation. This will result in significant impacts on natural resource use since these resources provide households with building materials, food, medicine and income (i.e. charcoal production). It is anticipated that in addition to natural resources some grazing land will also be lost. This however is not expected to be significant due to the low livestock numbers, the poor quality of the grazing in the mine deposit area, the lack of water sources in this area and the high risks of livestock theft.

Mitigation measures:

- The area has to be rehabilitated progressively with species that are utilised by the local communities for various purposes.
- It is recommended that villages have controlled access to the proposed mining area prior to clearing commences to harvest all available resources.
- The implementation of measures that would allow local residents to access the forest resources that are cleared could also help to meet local needs and reduce the pressure on the remaining forest resources.

Significance Statement: It is *definite* that the removal of vegetation will be required for the construction of the mine and associated infrastructure. The nature of the impact would be **Short Term** as the area will be mined and rehabilitated in phases. The impact is of moderate severity and of MODERATE significance as it is anticipated that under the no-go situation these areas will be regularly harvested and even cleared for grazing purposes. With mitigation measures in place this impact could be reduced to that of LOW significance.

Without mitigation					With mitigation	
Temporal scale	**Spatial scale**	**Likelihood**	**Severity**	**Significance**	**Severity**	**Significance**
Short term	Study area	Definite	Moderate	Moderate	Slight	Low

8.2.2. Impact 2: Loss of land during mining

Cause and comment: During the mining process, the land which is being prepared for mining, the land being mined and that which has been mined but not yet rehabilitated will be disturbed to the extent that productive land use will not be possible. In addition to this local people will be excluded from this area and unable to utilise the land in the short term.

Mitigation Measures:

- The area has to be rehabilitated progressively with species that are utilised by the local communities for various purposes.
- It is recommended that villages have access to the proposed mining area prior to clearing commences to harvest all available resources.
- Consideration should be given to fencing this land off from the rest of the study area to prevent the ingress of livestock and people.

Significance Statement: It is *definite* that access to parcels of land will be unavailable to local residents during the mining process. The nature of the impact would be **Medium Term** as the area will be mined and rehabilitated in phases. The impact is of moderate severity and of MODERATE significance as it is anticipated that under the no-go situation these areas will be regularly harvested and even cleared for grazing purposes. In addition to this areas within the proposed

mining area consist of fallow and severely degraded land. With mitigation measures in place this impact could be reduced to that of LOW significance.

Without mitigation					With mitigation	
Temporal scale	Spatial scale	Likelihood	Severity	Significance	Severity	Significance
Medium term	Study area	Definite	Moderate	Moderate	Slight	Low

8.2.3. Impact 3: Clearing virgin land for small scale farming as a result of agricultural displacement

Cause and Comment: There is a number of grazing areas and agricultural land within the proposed concession area. Locals who are economically displaced by the proposed development may clear additional areas within the Ranobe Forest to continue these livelihoods, resulting in an induced secondary impact.

Mitigation Measures:

- Toliara Sands will have to replace any arable land parcels that they displace from their mining activity. This process will have to be dealt with in the Resettlement Action Plan (RAP).
- Facilitate (including sourcing potential funders) alternative and environmentally sustainable forms of local economic development, such as establishing woodlots for charcoaling, improving agricultural practices to produce larger yield on existing land parcels etc.
- Consideration should be given to assist with the improvement of surrounding agricultural practises by providing guidence to improve the existing irrigation canal and scheduling of irrigation water. This will increase yields in those areas and could potentially form part of WTRs social responsibility.
- Monitor vegetation clearing activities in the general project area, beyond the Ranobe Mine project boundaries.
- Implementation of a programme to monitor the rate of vegetation clearing is a crucial activity. Annual monitoring during the planting season must be carried out and must consist of monitoring the presence of and impacts on identified intact spiny thicket areas within the project area.

Significance Statement:

It is probable that communities will clear the adjacent Ranobe Forest due to being displaced by the mine. The nature of this secondary impact would be Long-term. The impact would be severe and of HIGH significance. The mitigation measures provided would reduce the likelihood of clearing and the severity, resulting in a MODERATE post-significance rating of the impact.

Without mitigation					With mitigation	
Temporal scale	Spatial scale	Likelihood	Severity	Significance	Severity	Significance
Long term	Study area	Probable	Severe	High	Slight	Moderate

8.2.4. Impact 4: Increasing demand for natural resources

Cause and comment: The proposed development is likely to result in the in-migration of job seekers, the employment and accommodation of mine staff, increased tourism (linked to improvements in infrastructure and increased demand for accommodation, meals and entertainment by mine staff), and increase trading opportunities. This influx of people needing accommodation, meals and entertainment and improved infrastructure is likely to increase the demand for charcoal, building materials, thatch and other natural resources.

Mitigation Measures: It is recommended that an influx management plan is developed for the proposed Ranobe Mine to deal with the issue of in-migration in its entirety.

Significance Statement: It is *probable* that there will be in-migration to the area due to the potential for employment. The nature of this secondary impact would be Long-term andsevere and of HIGH significance. The mitigation measures provided would reduce the likelihood of clearing and the severity, resulting in a MODERATE post-significance rating of the impact.

Without mitigation					With mitigation	
Temporal scale	**Spatial scale**	**Likelihood**	**Severity**	**Significance**	**Severity**	**Significance**
Long term	Study area	Probable	Severe	High	Slight	Moderate

8.2.5. Impact 5: Capacity of institutions to manage use of natural resources

The capacity of local management institutions to effectively regulate the use of natural resources and ensure compliance with rules is expected to be undermined as a result of 1) the loss of forest resources and increasing pressure from existing population, 2) increasing demand for resources due to the influx of job seekers, mine employees, and tourists, 3) the lack of knowledge and reduced compliance with rules due to in-migration. It is already clear that local management institutions have struggled to control and restrict engagement in charcoal production amongst local residents in recent years, even deep in the Ranobe forest. While there are rules these are often not adhered to and the local authorities appear to have little ability to discipline offenders and ensure compliance. This impact will affect the concession area and immediate surrounds, but may also impact on areas further afield.

Mitigation Measures: If possible it is recommended that the Ranobe Mine Project contribute to government departments such as Madagascar National Parks and NGO's such as WWF to assist with the protection of the remainder of the Ranobe Forest and any high value conservation areas in PK32. In addition to this the establishment of woodlots and agricultural programmes may result in a reduction of harvesting from forested areas which may alleviate some of the stress placed on local management institutions.

Significance Statement: At present existing capacity to manage the proposed protected area of PK32 is limited, and degradation of the environment continues, as described above. This is due to, *inter alia,* the limited capacity and resources available to Madagascar National Parks, resulting in a Long-term severe impact. The impact is of moderate severity and of HIGH significance. The mitigation measures provided would help to improve existing capacity, and mitigate this constraint, resulting in an impact of MODERATE significance.

Without mitigation					With mitigation	
Temporal scale	**Spatial scale**	**Likelihood**	**Severity**	**Significance**	**Severity**	**Significance**
Long term	Regional	Probable	Severe	High	Moderate	Moderate

9. CONCLUSIONS AND RECOMMENDATIONS

This report has documented the extensive use made of natural resources by local residents in the forests and woodlands in and around the mine site. These resources are used by local residents to meet their basic needs for shelter, food and medicine. They are also used as important sources of supplementary household income. The clearing of areas of the forests and woodlands to make way for the mine will therefore result in considerable long-term loss of access to valuable resources for local residents. Although the mine is planning to rehabilitate the land, the arid nature of the local climate means that it will take time for the forests to be restored to their current state.

The following existing and predicted impacts were assessed in this report.

ISSUE / IMPACT	SIGNIFICANCE	
	Without Mitigation	With Mitigation
EXISTING IMPACTS ON NATURAL RESOURCES		
Issue 1: Overexploitation or resources		
Impact 1: Hardwood Trees	HIGH	N/A
Impact 2: Softwood Trees	MODERATE	N/A
Impact 3: Medicinal Plants	LOW	N/A
Impact 4: Wild Foods	MODERATE	N/A
Impact 5: Fauna	MODERATE	N/A
Impact 6: Fish Resources	HIGH	N/A
Impact 7: Fire Wood	LOW	N/A
Impact 8: Species of Special Concern	HIGH	N/A
Issue 2: Existing impacts on land use		
Impact 1: Lack of water resources for agricultural practices	HIGH	N/A
Impact 2: Growth of water hungry crops	HIGH	N/A
IMPACTS OF THE PROPOSED MINING OPERATION		
Impact 1: Loss of natural resources	MODERATE	LOW
Impact 2: Loss of land during mining	MODERATE	LOW
Impact 3: Clearing virgin land for small scale farming as a result of agricultural displacement	HIGH	MODERATE
Impact 4: Increasing demand for natural resources	HIGH	MODERATE
Impact 5: Capacity of institutions to manage use of natural resources	HIGH	MODERATE

This report therefore recommends that the following mitigatory measures are undertaken:

- Mining should be undertaken in a phased manner and progressively rehabilitated.
- Consideration should be given to assist the local community with the upgrading of the existing weir to increase water supply in the irrigation canal.
- An agricultural programme should be established to teach local residents about sustainable agricultural practices within the general project area.
- The mining area should be rehabilitated with various species currently utilised by local residents.
- Various species of plants (specifically species of special concern) should be propagated in the various on-site nurseries and the communities should be encouraged to re-plant what is removed.
- It is recommended that villagers have access to the proposed mining area prior to clearing commencing to harvest all available resources.
- It is recommended that an influx management plan is developed for the proposed Ranobe Mine to deal with the issue of in-migration in its entirety.

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