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# An Assessment of the Impact of Sand Mining: Unguja, Zanzibar

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*SIT Study Abroad*

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An Assessment of the Impact of Sand Mining: Unguja, Zanzibar



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SIT: Tanzania-Zanzibar Spring 2015  
Independent Study Project  
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May 6, 2015

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## Abstract

Resource consumption is one of the most crucial environmental problems facing the world today. Therefore non-renewable resources need to be sustainably used to ensure the survival of both future generations and the resources at stake. The goal of this study was to investigate the impacts of sand mining on the environment, economy, and communities of Zanzibar. The environmental, economic, and social impacts of sand mining activities were studied at various sites on the island of Unguja. The effects on vegetation, coastal erosion, communities, and local economies were researched based on field observations and interviews with local people and officials at the various sites. Five primary sites were visited throughout this study, three illegal quarries, one abandoned legal quarry, and one active legal quarry. The environmental impacts at each of the five sites were decidedly destructive, and the economic and social results were also found to be generally harmful as many people, children, and animals have drowned and the number of fruit-bearing trees and farms are shrinking, which decreases local incomes. The accelerated erosion, lack of plant regeneration, and reported issues with mining in local communities demonstrate that sand mining in Unguja has had adverse impacts overall.

## Introduction

Tanzania is a hub of biodiversity that lies just south of the equator: a tropical and subtropical environment providing homes for many species and an increasing population. As population steadily increases worldwide, the consumption of renewable and non-renewable natural resources has become a more pressing issue. Deforestation, water consumption, and water and air pollution have been increasing exponentially within the last few decades. The islands of Tanzania have crucial importance for the structure of the continental shelf, in addition to providing the ideal environment for biodiversity hotspots such as mangrove forests and coral reefs (Masalu, 2002). These islands, as the population spreads to the coasts, have been experiencing many of the same worldwide consumption and pollution problems. In recent years, these have manifested in Zanzibar as the most drastic sea level rise and highest temperatures on record (Kombo, 2010). These factors alone, however, cannot be the sole contributor to the severe coastal erosion along the coastline of Tanzania and the Zanzibar Islands. In Tanzania much of the mining occurs along riverbanks, while in Zanzibar it occurs along the coasts, though both processes contribute greatly to coastal erosion (Masalu, 2002 & Nyandwi, 2010). Human activity, as it has increased over the years, has significantly contributed to the coastal erosion issue evident throughout Zanzibar (Masalu, 2002). The current population of the Zanzibar archipelago is 1.3 million and is continually growing, having increased from just 300,000 in 1964 (H. Rijaal, personal communication March 12, 2015).

In addition to the steady increase in population, the need for economic development has led to increased environmental degradation as deforestation, water pollution, and the consumption of natural resources continue (Kombo, 2010). The economy of Zanzibar, until the 1980s, depended heavily on the exportation of cloves. However, as other countries began

producing them more efficiently, the price of cloves decreased by 60% and Zanzibar's economy was weakened. This downturn caused Zanzibar to turn toward tourism as a quick replacement for clove production (H. Rijaal, personal communication March 12, 2015). The economy of Zanzibar is now primarily dependent on tourism, manufacturing, fisheries, forestry, marine and coastal resources, and mining (United Republic of Tanzania, 2014). The increase in population as well as the economic need for tourism creates a large demand for construction materials, such as sand, coral rag, and limestone (Myers, 1999).

In mainland Tanzania, in comparison to Zanzibar, sand mining is done mainly along the coast and in river beds. This does a great deal of damage because it destabilizes the river banks and may collapse any bridges along them (Nyundwi, 2010). On the contrary, mining in Zanzibar is generally done on the coastal beaches or in the hinterland areas that are richer in available sand. Environmentally, mining along riverbanks and coastlines has had irrevocable effects, though it has had many social impacts as well. Illegal sand mining in the mainland, as well as in Zanzibar, can often create bad relationships between miners and property owners or communities. This occurs because the miners threaten property owners which creates an unfriendly and violent atmosphere (Masalu, 2002). Sand mining tends to occur along coastal zones due to the abundance of sand available to miners. The shoreline provides an open space without abundant vegetation, simplifying the process and providing a space where the evidence of mining will be erased with the tide. However, this contributes greatly to the coastal erosion problem that Zanzibar is already experiencing (Masalu, 2002 & National Environmental Policy, 1992). On the other hand, sand availability in the hinterlands, areas further inland, is much

scarcer. Mining in these areas has a much smaller impact on the current coastal erosion problem, and is thus where sand is often mined on a larger, legal scale.

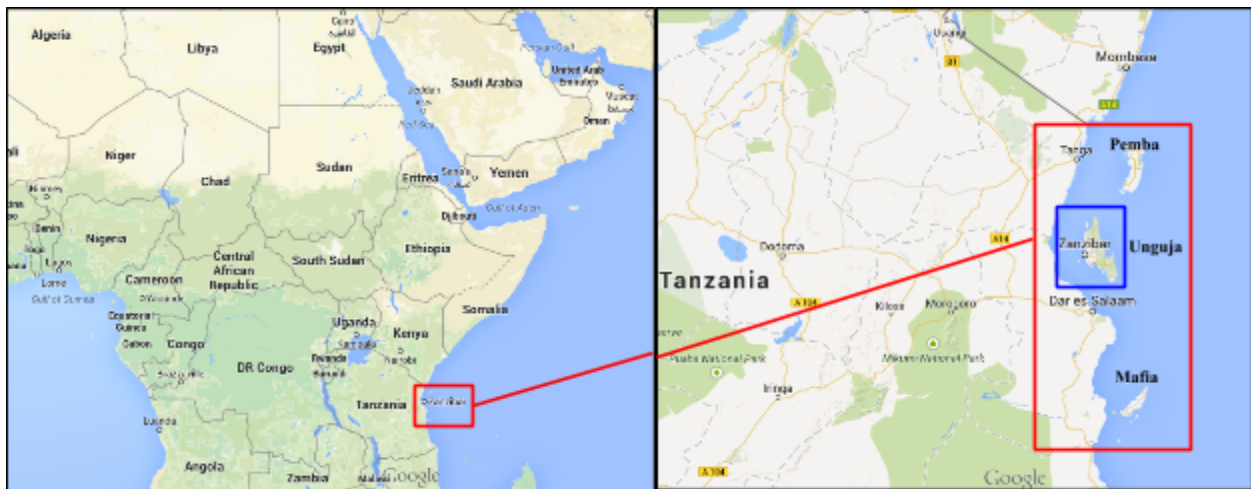
In Zanzibar the control, maintenance, and management of non-renewable natural resources is under the Department of Forestry. The principal goal of the forestry policy is to “protect, conserve, and develop forest resources for the social, economic, and environmental benefit of present and future generations of the people of Zanzibar” (Zanzibar Revolutionary Government, 1999). If adhered to, this stated goal and the policy would create an ideal environment for the conservation of the island’s renewable and non-renewable resources. The non-renewable resources in Zanzibar include sand, gravel, rocks, stones, soil, moorum, and limestone, but the excavation of these resources is unsustainable and is resulting in less productive arable land as well as lowered biodiversity in certain areas (Zanzibar Environmental Policy, 2013). In addition to the biodiversity decrease, during rainy season the quarries often fill with stagnant water, which provides an ideal breeding place for mosquitoes. This increase in standing water could lead to elevated levels of malaria across Zanzibar if continued (Masalu, 2002). If mining is conducted unsustainably it can have a negative impact on both the coastline and estuaries (United Republic of Tanzania, 2014). The government of Zanzibar has agreed to attempt to minimize the degradation caused by the consumption of non-renewable resources, and to promote the rehabilitation of the areas in which they are excavated by planting trees in the areas that have been mined (Zanzibar Environmental Policy, 2013). The aim of this study is to investigate the impacts that sand mining, both legal and illegal, has had on the communities and environment of Unguja.



The investigation of the impacts of sand mining is crucial because of the additive effects the process can have on the island's coastal erosion, local economies, and community safety. The illegal sites tend to be located toward beaches and coastal areas, contributing greatly to erosion (Masalu, 2002 & H. Rijaal, personal communication March 12, 2015). The legal sites are in the hinterland areas of Zanzibar, where access to larger quantities of sand is more feasible and there is thought to be no contribution to coastal erosion. Mining in the hinterlands, however, requires the removal and destruction of vegetation which should be replenished once mining has been completed in the area. The goal of this paper is to show that the abundance and prevalence of legal and illegal sand mining throughout the villages of Unguja has a negative impact on the environment, the economy, and the local communities.

## Study Area

The Zanzibar archipelago is a group of islands that are a semi-autonomous part of the United Republic of Tanzania (Figure 1). It consists of three primary islands: Unguja, Pemba, and Mafia. These islands, in 1964, joined Tanganyika to become Tanzania (*Zanzibar's Climate Change Strategy: Summary*, 2013) (Figure 2). The islands lie approximately 6° south of the equator off the eastern coast of Tanzania, have tropical climates, and are rich in limestone from the abundant coral rag.



**Figure 1:** Map of the Zanzibar Archipelago off the eastern coast of Tanzania (Google Maps).

**Figure 2:** Map of the three principal islands of the Zanzibar Archipelago (Google maps)

Zanzibar, geologically, is an ancient coral reef that has risen out of the water over the past few million years. Pemba, conversely, broke off of the mainland of Africa approximately 10 million years ago and has a similar geologic composition to that of Tanzania (Richmond, 2011). The abundance and availability of both sand and coral rag (limestone), makes these perfect construction materials for the homes and roads of the islands (Myers, 1999).

The sites visited throughout this study were chosen based on the known presence of mining in addition to their proximity to Stone Town. Primarily five sites were visited during this study, representing three different examples of the sand mining in Unguja: illegal, previously legal, and presently legal (Figure 3). The first three locations, Mwana Kwerekwe, Saateni, and Kwarara were visited as examples of current and previous destructive illegal mining. The fourth, Mangapwani, was visited due the extensive legal mining that occurred around the village in the past. The final quarry, Donge, was visited because it is currently the only legal and approved site on Unguja Island. The GPS locations of the principal quarries assessed are located in the table below (Table 1).



**Figure 3:** Site map of the five sites visited in this study (Google Maps).

**Table 1:** Table of the GPS coordinates of all assessed quarry locations.

Quarry Site	Latitude	Longitude
Mwana Kwerekwe	6°10'56.0"	39°13'46.9"
Saateni	6°09'14.0"	39°12'18.5"
Kwarara	6°12'16.2"	39°14'39.1"
Mangapwani #1	5°59'48.5"	39°12'34.8"
Mangapwani #2	5°59'35.3"	39°12'39.8"
Donge- Chechele	5°57'40.5"	39°14'00.0"
Donge- Mchangani	5°55'43.8"	39°14'03.9"

## Methodology

This study was carried out from April 5th, 2015 through May 2nd, 2015. Data was collected through the various methods listed below, and recorded in a field notebook. At each site, it was necessary to make changes to methodology based on the legality and sizes of the sites. Transects were only able to be completed at large, inactive sites, and interviews were only possible in certain locations. Each respondent was asked if they were willing to answer the interview questions, no method of payment for participation was given, and the participants were all kept completely anonymous unless asked if their names could appear in this paper.

### **Mwana Kwerekwe, Saateni, & Kwarara:**

For the three illegal sites visited, similar methodologies were used. At each site, interviews were conducted where possible, and all observations of the sites were recorded. This includes primarily observations of vegetation cover, erosion, absence or presence of trees, distance to homes or structures, depth and scale of mining, presence of trash, groundwater intrusion, and the presence of animals. Transects were not possible at these sites for various reasons including the small size of the sites, the absence of current mining due to rain, and the delicate nature of the surveyed sites. Each site, however, had different opportunities for interviewing which is explained below. At Mwana Kwerekwe interviews with television reporters in the area were completed, although no interviews with local community members were completed, as suggested by Hamza Z. Rijal. At Saateni, interviews with locals were completed in addition to interviews with Hassan Is-hak from the Department of Forestry. At Kwarara, interviews with community members, several miners, and a government employee

were conducted in addition to the observations of the illegal quarry. The three illegal sites were primarily assessed using participant observation in addition to interviewing people with knowledge of the issues or the sites.

### **Mangapwani:**

In Mangapwani, the methodology was different than at Donge and the illegal sites because of the absence of activity and legality of the sites. First, the size of the sites were measured and firsthand observations were recorded to get a scale of the extent of mining impacts in the area. The larger sites were measured using GPS locations of the border and then Google Earth to calculate area. Observations were recorded of vegetation regrowth and loss, depth and scale of mining, groundwater intrusion, animal presence, and any new activity within the abandoned quarries. Then informal interviews were conducted with members of the community to identify and explore the environmental, social, and economic effects further (Appendix A, Survey 1). Basic demographic information was collected to gather information about the possible biases of the interviewees. The interviews in Mangapwani were done with the help of two translators, Haji Abaeid and Ali Chaga. The third method of gathering data was performing transects of 100 m length at the two larger quarries. Along these transects, every 25 meters a circle of radius 10 meters was drawn and observed for percentage plant cover and primary plants present. Using percent vegetation, observations, and information from interviews, a holistic appraisal was completed of the social and environmental impacts of mining at Mangapwani.

**Donge:**

At Donge, as it is an active site, forestry officers, miners, and locals were all informally interviewed about the activity and impacts of the current mining processes there. No transects were completed, as the site is actively mined and the process of completing the transects would have been dangerous. The interviews at Donge were done with the help of a translator, Mohammed Salaamah. Observations of vegetation regrowth and loss, depth and scale of mining, groundwater intrusion, animal presence, and any activities around the mine were recorded. In addition, first hand experience of being in the trucks with the miners and informally interviewing and discussing with them the details of their job was done to further knowledge of the process itself. The information collected from the interviews with miners, officials, and community members in addition to site observations was used to provide a complete assessment of the impacts the current mining site has had.

**Results & Discussion****Mwana Kwerekwe:**

There are two separate cemeteries in Mwana Kwerekwe, one is a Christian cemetery while the other is Muslim. Both cemeteries at Mwana Kwerekwe are being mined for sand, which both desecrates lives lost while it degrades the environment. Both sites had abundant trash dumped around the graves as well as in the holes that had been mined. The Muslim graveyard had approximately four small, deep holes where sand had been removed, each approximately 0.5m x 0.5m x 1m. There was also one larger pit approximately 2m x 2m x 1m. Almost no vegetation was removed, as the surface of the pits was small. Many of the pits were extremely close to the

graves themselves, and the miners have removed tiles and taken stone from the graves themselves in addition to the sand. There was also charcoal production happening on top of the graves in the Muslim cemetery, and cows were grazing among the graves. No erosion was evident, as the pits themselves were too small. There used to be guards in place to protect the cemetery, but they were being attacked by those doing the mining thus the guards have been removed for safety.

The Christian cemetery had much more extensive mining, but no charcoal was being produced, and no animals were observed grazing among the graves. This graveyard was missing large patches of vegetation where sand had been mined, and the pits seen were of much larger sizes: 2.5mx2.5mx0.5m, 11mx3.5mx1m, and 13.5mx1.5mx1m. The mining was more evident, there was abundant erosion from the exposed sand in the cemetery downslope, and more vegetation was absent than at the Muslim cemetery. At both cemeteries pieces of the graves were broken and the stone had been taken where the sand was mined. In general, the damage being done at these sites has primarily social impacts. There is a small level of environmental degradation, seemingly no effect on the local economy, but a large effect on the communities of Unguja, as these graves are being mutilated and disrespected through the act of mining. Surprisingly, the social degradation is much worse at the Muslim cemetery while the environmental impacts are more severe at the Christian cemetery. Even after being told to stop, no decrease of the activity has been seen, and the guards put in place in an effort to stop the mining were simply attacked, demonstrating the severity of the issue at hand in Mwana Kwerekwe.

## Saateni:

The mining at Saateni occurs along a small brackish river surrounded by a fecund mangrove forest of *Avicennia Marina* near the community during the dry season. This site was visited twice, and no evidence of mining was seen but Hassan Is-hak, a forestry official, explained that mining cannot be done along the river during the rainy season due to the amount of mud and erosion in the area (Figure 4). However, during the dry season the river area is mined to a depth of approximately 1.5 meters, and all evidence of the mining is generally eroded away quickly. There used to be a large dune near the river, but it has been completely mined and has disappeared entirely (H. Is-hak, personal communication April 22, 2015). There was abundant trash dumped in the area, and erosion was evident in areas Hassan said had been mined.

At Saateni, ten members of the community were also interviewed to assess their knowledge and opinions of the illegal sand mining occurring around them. Almost no one knew how long sand mining had been occurring near the village, but two people approximated a length of ten years, and a 29-year old said it had been occurring since she was a child. All those surveyed believed that the mining was being done by outsiders: people who owned a donkey or ox and cart. Although



**Figure 4:** Image of the river at Saateni that is mined during the dry season.



everyone believed it was not people from Saateni mining, two men interviewed provided very evasive answers which conveyed that they could have been involved in illegal mining in the area. Many members of the community mentioned a small island closer to shore called Mpigaduri, which has almost completely disappeared due to the extensive sand mining and erosion in the area of the island.

Other problematic effects for the people of Saateni included water encroaching toward the village and destabilizing homes, soil erosion, deforestation of mangroves, a loss of coconut trees, and the injury and death of community members. An environmentalist living in Saateni described that after the sand is removed, the mud and water in the holes forms a material similar to quicksand, which has injured or killed several children and women who go into the mangroves to collect dead wood for fires (A. Salum, personal communication April 23, 2015).

Economically, the mangroves used to be highly important for the village because of the production of charcoal and firewood, but they can no longer use live mangroves for these purposes. Therefore, the village of Saateni has not really been affected economically. Overall, the social effects of the injuries and deaths in addition to the environmental degradation due to illegal mining is affecting the community of Saateni area very negatively.

**Kwarara:**

The quarries in and around the town of Kwarara are along a 35 kilometer power line that extends from Mtoni to Fumba on Unguja Island. The site visited in this study was within the village of Kwarara Kwangurangwa, and measured approximately 40m x 51m x 0.7m (Figure 5A&B). No standing water was seen in the quarry, much of it was filled with garbage, the pit was surrounded by cassava and banana crops, and many children were digging through the trash.

Two trucks were seen coming to dump trash in the area, and four miners with ox carts were observed illegally mining sand at the quarry.



**Figure 5:** A&B. Pictures showing proximity of the site in Kwarara to homes, the power line, the presence of trash, and children playing in the pit.

According to ten interviews with members and the sheha of the community, the size of this site has begun to endanger the nearby homes and the stability of the power line itself. Many of the people of the community closest to the area have been threatened by miners if they were to do or say anything about their illegal behavior. The people of Kwarara agreed that the mining was being done by people within the village and from nearby villages, only three of the people surveyed responded that outsiders were involved. The people of Kwarara wanted action to be taken, as they felt helpless because of the atmosphere created by the aggressive miners. Many felt that the mining occurring was either already having negative impacts or would begin to in the future. The government, therefore, has begun hiring trash collectors to dump garbage within the pit, as this discourages and blocks miners from utilizing much of the area (Figure 5A). This however has brought increased flies into the area, and thus illnesses with it. The mining is so

near to the houses that the soil erosion and flooding has caused structural damage to people's homes and many fear that it will soon destabilize the power lines standing nearby.

The opportunity to observe illegal mining allowed more information to be collected. One miner said he sold his cart for 7,000 and another said 15,000, and both said they sell to whoever asks for it. The size of the cart is approximately 1.2m x 0.9m x 0.4m, which would weigh approximately 0.60 tons (1 cubic meter of sand weighs 1.4 tons). Buying approximately 10 tons illegally would cost anywhere from 115,000 to 250,000, which would not be substantially cheaper than purchasing legally, depending where the customer lives. The illegal mining along the powerline in Kwarara has been threatening the community's safety and environment in the area, without much of an effect on the local economy.

## Mangapwani:

In Mangapwani, two very large, abandoned quarries were found in addition to several smaller sites.

The first is a site, Bondeni Mzungu, dug approximately 20 years ago, and the second site, Zingwe Zingwe, was

dug only a few years ago (A. Chaga, personal

communication April 5, 2015) (Figure 6). No definite

time period of mining was discovered, though the most common responses were ‘Many years’ or

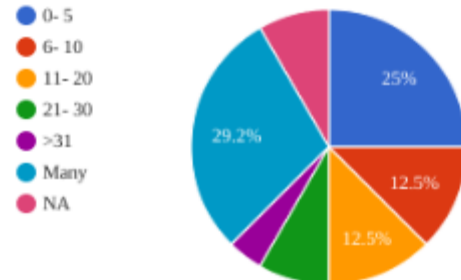
between 0 and 5 years. In this study, Bondeni Mzungu will be referenced with the number 1, and

Zingwe Zingwe will be referenced with the number 2. These sites were calculated to have areas

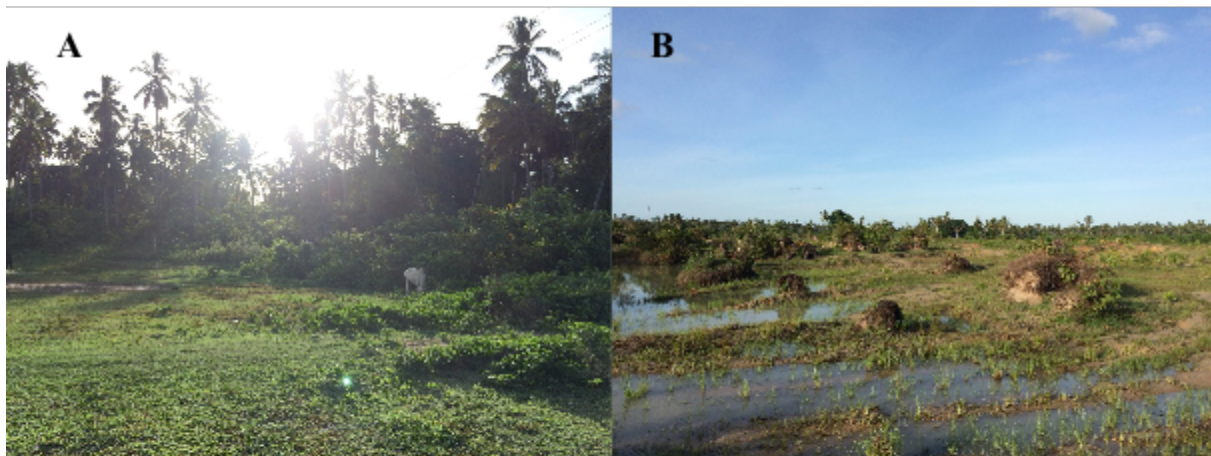
of 78,200m<sup>2</sup> and 197,950 m<sup>2</sup>, respectively (Appendix B).

Neither site had any visible garbage, there was vegetation regrowth at both sites, and there were large pools of standing water at both locations (Figure 7A&B). However, the vegetation was not as dense or as diverse as the surrounding, unquarried land. All trees were

**Mangapwani: Number of Years Ago Mining Began**



**Figure 6:** Pie chart showing the surveyed responses for the number of years since mining began.



**Figure 7 :** A) Bondeni Mzungu (#1- S 5°59'48.5", E 39°12'34.8"), a lowland area that was dug approximately 20 years ago B) Zingwe Zingwe (#2-S 5°59'35.3", E 39°12'39.8"), an inactive quarry dug approximately four years ago.

absent at the sites, and many cut coconut stumps were observed at Zingwe Zingwe (Figure 7B). This may have been done by others after the pits had been dug, or during the mining process to make more profit. Despite the very uneven terrain, some farmers had begun to attempt to plant rice and cassava within the pits. The sign of vegetation regrowth is excellent, though the number and quality of species appears to be different due to the wetter environment. The smaller illegal sites had been dug out with ox carts, and many appear to have been done more recently than the large sites. The small quarries appear to have been done around the coconut trees, rather than cutting them down as in the larger sites. There are an abundance of small dig sites along the dirt road leading into the large quarries. The illegal mining, the smaller pits, at Mangapwani seemed to have many fewer impacts on the environment, as no trees were cut and no groundwater intrusion was seen.

The vegetation densities at each of the sites were evidently different, likely based on the time that each quarry was mined. Some of the smaller pits were overrun with grasses and weeds,

**Table 2:** Transects completed at two Mangapwani quarries for percentage cover water, vegetation, and sand. Average percentage vegetation cover shown on the right.

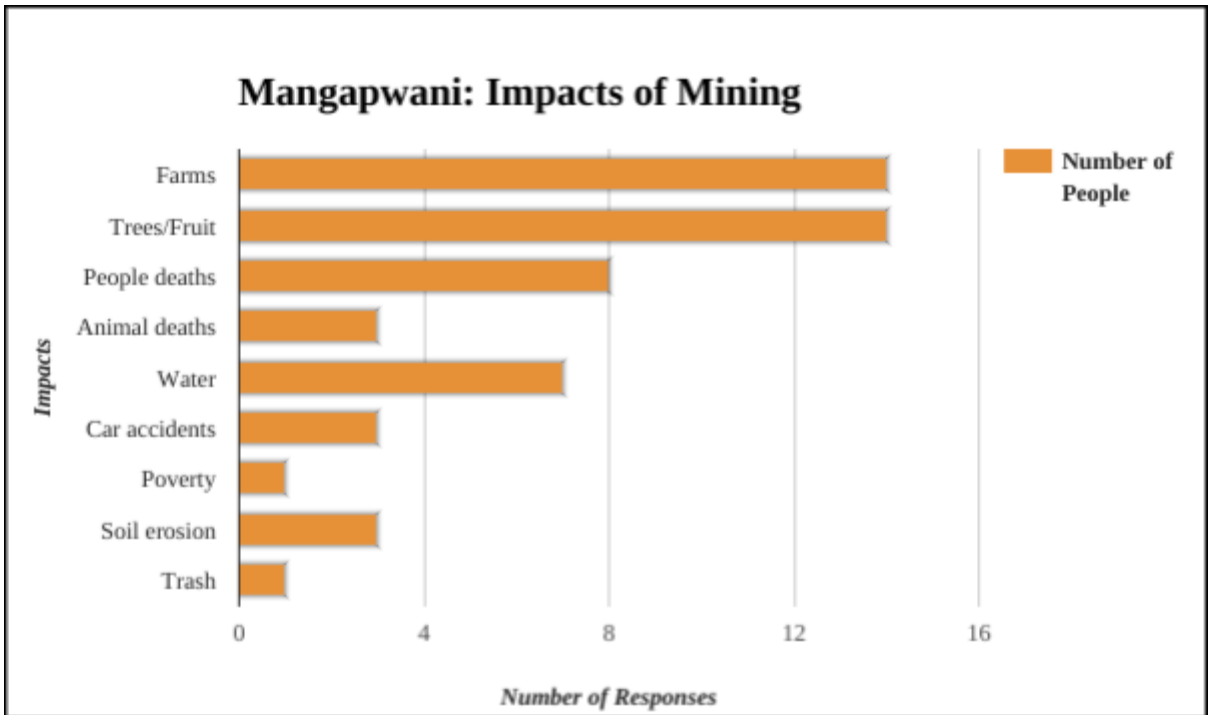
Site #, Transect	Veg			Sand			Water			Main plants:			
	25 m	50 m	75 m	100 m	Avg. % vegetation:								
#1, 1	25	75	0	100	0	0	75	25	0	100	0	0	
#1, 2	50	50	0	100	0	0	100	0	0	100	0	0	Mfyagio, guava,
#1, 3	75	25	0	100	0	0	100	0	0	100	0	0	mimmosa,
#1, 4	95	5	0	90	10	0	80	20	0	80	20	0	
#1, 5	90	10	0	80	20	0	75	25	0	90	10	0	Avg. % vegetation:
	67			94			86			94			85.25
#2, 1	60	40	0	30	70	0	40	60	0	35	65	0	
#2, 2	20	40	40	30	70	0	50	50	0	60	40	0	<b>Main plants:</b>
#2, 3	70	30	0	60	40	0	50	50	0	30	60	10	Mfyagio, guava,
#2, 4	70	30	0	60	40	0	50	50	0	35	45	20	mimmosa, mburgamu,
#2, 5	30	50	20	30	70	0	55	45	0	60	20	20	mnjaanjaa
#2, 6	25	75	0	15	85	0	30	30	40	45	55	0	Avg. % vegetation:
	45.83			37.5			45.83			44.17			43.33

while some were still completely barren. At the larger two quarries, Bondeni Mzungu was a lustrous, fecund site, while Zingwe Zingwe had begun to regenerate vegetation but was still largely devoid of plant life (Figure 7A&B). Bondeni Mzungu had roughly twice the vegetation density of Zingwe Zingwe, though the diversity of plants at the latter quarry was higher (Table 2).

Results at Mangapwani were conclusively destructive environmentally as well as harmful economically and socially. The ecological impacts are evident through observation, discussion with the people of the surrounding villages, and the vegetation densities. There is no evidence that any attempt to regenerate vegetation was made, although one of the Department of Forestry policy goals is to do so after mining is complete. Twenty four interviews were conducted with people of the villages around the two main quarries. The economic impacts reported largely revolve around the changes in available farmland and the availability of fruit-bearing trees to sell produce from. Stripping the top few meters of soil has decreased the fertility of the land, making farmers unable to grow their crops. In addition, there are many fewer coconut and mango trees, which has been affecting the local economy because they can no longer sell these easily. Selling coconuts is traditionally an easy way to make money, especially for children (Olivia Gramprrie, personal communication April 10, 2015). The inability to grow crops and the absence of the previously abundant fruits have negatively impacted the economy of Mangapwani and nearby villages.

Socially, the people of Mangapwani have been impacted by the dangers of the open and abandoned quarry. There have been several incidences when children have gone to swim in the quarry, and they have either contracted cholera or drowned in the standing water (Figure 8).

Children are also often the people illegally mining because it is a widely available way to help their family income, as was seen near Mangapwani in the town of Bumbwini (Shavonne Stanek, personal communication April 8, 2015). This is simply a new way for children to make money relatively easily, as collecting coconuts is no longer a feasible steady income. The average cost for an ox-cart of sand was reported to be approximately 4,000 Tsh in Mangapwani, while a truck with three tons of sand costs anywhere from 70,000 to 120,000 in Mangapwani. This method is also not necessarily cheaper, but supports a local family and allows for smaller amounts of sand to be bought (Mbarouk Khativ, personal communication April 9, 2015).



**Figure 8:** Responses at Mangapwani of the impacts of mining (number of responses does not match number of participants as they provided a multitude of answers).

In addition to this, many cows and other animals have been killed in the quarry when it floods during the rainy season. Approximately five years ago there was a flood that killed a large quantity of the community's livestock. There were also an increased number of car accidents

during the period of mining, due to the number of trucks and lorries passing through the area. These accidents have killed and injured children, people, and animals in the communities around Mangapwani. Reportedly, there also used to be a river flowing through the area that was destroyed by the sand mining processes and has since disappeared. Soil erosion has become a large problem near the quarries, and has caused trees to begin falling as their rooting structures become less stable, as well as destabilizing housing structures. Many of the economic and social issues are also signs of the environmental degradation that has taken place during and after mining. There were no signs of an effort to regenerate the area after mining was completed, and there were rumors in the town that it would start again in the near future.

The most surprising trend found was that while approaching Zingwe Zingwe, the opinions of mining were expected to become worse and worse. On the contrary, the people and sheha of the village of Zingwe Zingwe actually were the most ambivalent and neutral toward the impacts of mining. Each person interviewed agreed that it was having negative impacts on the environment, but that people were in need of money and the sand mining industry provided that. The people of the village would be paid to go out into the quarry and shovel the sand into the trucks, making them feel more ambivalent about the negative effects it has on the area.

The large difference in percentage vegetation cover is likely due to the difference in times that the sites were dug. It is encouraging to see that the sites re-generate much of the vegetation cover that was lost due to digging over time, though the diversity of plant life appears lessened. The environmental and social impacts that sand mining has on the community of Mangapwani is clearly negative, as many lives are lost and many signs of environmental degradation were observed. The economic impacts are slightly more complicated, as the villages closest to the



mining seem to benefit economically from the industry, though the further villages see a deficit in coconut, mango, and clove trees which impacts their economies negatively. The loss of animal life would also place a large deficit on the economy of Mangapwani, as cows are extremely valuable. Overall the general community of Mangapwani is being distressed by the evident impacts that the long term mining in the hinterlands has had. Economically, socially, and environmentally, the people of Mangapwani are aggrieved by the impacts of sand mining.

**Donge:**

Donge is the only current approved site for mining, located 25 kilometers north of Stone Town at S5°57'40.5", E39°14'00.0". There were two different primary quarries visited at Donge as well, Chechele and Mchangani. The mining at Mchangani began on April 8th, 2015, one week before the site was visited. The observations and impacts noted were very similar to those of Chechele, visited one month prior, during March 2015.

Sites are chosen when property owners notify the Department of Forestry that they are interested in having the government mine their land. Then several officials go to inspect the site in order to approve it, and digging can begin. They move from approved site to approved site at random, leaving currently unused sites abandoned. However, they may return to these sites at a later date if the property owner so desires.

No permit or process is required for the miners entering Donge, anyone who owns a truck and any helpers they hire may go to the sites at Donge and dig until the truck is full. No record is kept of the individuals or how many times per day the same truck leaves and returns, though a record is kept of how many tons are leaving the site per day. At the new site, Mchangani,

roughly 1,500 tons are recorded leaving the site every day, and the former site approximately 2,000 tons were removed each day. However, over a course of twenty minutes, 68 tons of sand were observed leaving the quarry at Mchangani. If this rate were to continue throughout the day, almost 2,500 tons would leave the site each day, as it is open for legal mining from 6 am to 6 pm. However, additional people come and mine sand after hours, usually bribing an officer or doing whatever is necessary to gain access (A. Chaga, personal communication April 5 2015). There were no fences or structures in place to restrict access to the quarry at either site.

As the trucks leave, a certain amount of money is paid to forestry in exchange for a permit and receipt of where the sand was mined: two tons cost 2,000 Tsh, four tons cost 3,000, and 10 tons cost 7,000 Tsh. An average price for 10 tons of sand at Mwana Kwerekwe would be approximately 200,000 shillings, while at any site further from Donge it would be over 300,000. For example, at Makunduchi 10 tons of sand costs approximately 350,000 to 370,000 shillings.

Depending on the customer, sand is ordered in different ways. Generally, if it is a company ordering sand for construction, they will call the drivers ahead of time and have it delivered directly there, while an individual order will go to Mwana Kwerekwe or a different site where sand is sold and order it there.



**Figure 9:** View of the depth of mining at Donge Chechele (person for scale)

At Chechele, there were several small pits on the road into the site, approximately 10 meters by 20 meters by 2 meters. These were usually bordered by cassava or sugarcane fields. There were two larger pits further into Chechele: the first appeared to have been mined previously but not currently, while the second was being actively mined. The pit being actively mined ranged in depth from 2 meters to 5 meters (Figure 9). There was no effort to regenerate vegetation in the already extracted areas, and there was no security to ensure that community members could not go into the pit and become injured.

At Mchangani and Chechele, there was abundant standing water at the site in the deeper pits, which miners said was groundwater that had come up while they were digging (Figure 10). The open pools of water could have been



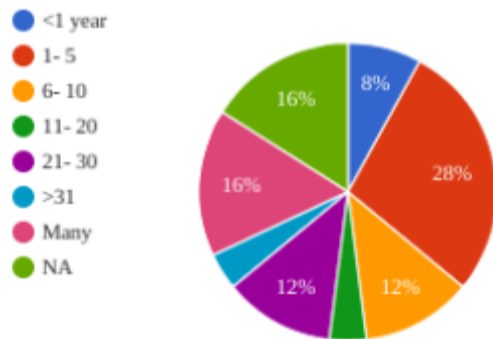
**Figure 10 :** The Chechele site at Donge, an example of groundwater intrusion into the quarry.

contaminating the source of groundwater, and could be providing a breeding ground for mosquitoes in the area. There was also severe erosion especially during the heavy rains of the season. The area was surrounded by cassava and rice farms, and all trees were absent from the area being dug. There were several clumps of sand that had been left, filled with tree roots making them inefficient to utilize. It is clear that the lack of vegetation and abundant erosion around Donge are having negative environmental impacts.

Interviews with locals and forestry officials provided a great range in the duration of time that mining has been occurring, ranging from one week to over 50 years (Figure 11). Even

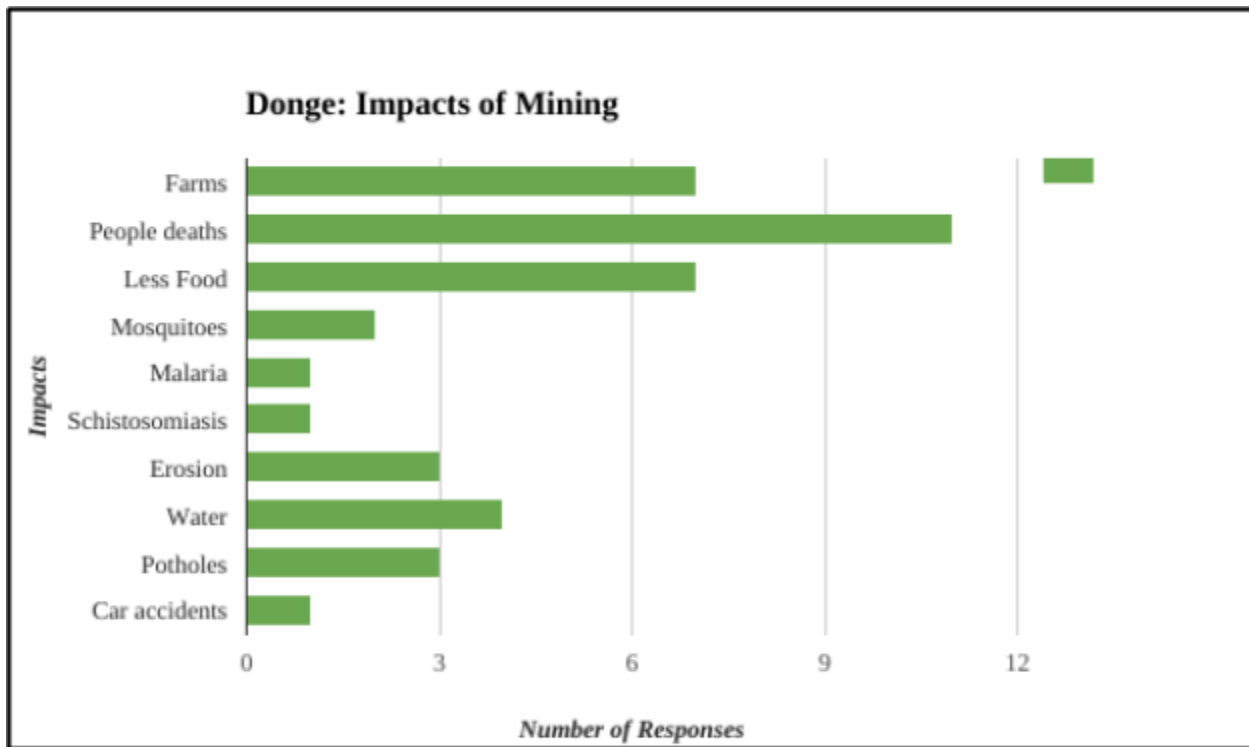
amongst the forestry officials, the time given ranged from six months to four years. The people of Donge have had a variety of experiences with the mining in the area; some have been very positive while others have had very negative involvement with the industry. These incidents range from families who have begun to earn their living mining sand and profiting from it, to those who have had their farms taken away to be used for mining.

**Donge: Number of Years Ago Mining Began**



**Figure 11 :** Pie chart showing the number of years people believe mining began in Donge.

As in Mangapwani, many children have been killed when they went to the quarry to swim, as they often drown (Figure 12). Community



**Figure 12:** Responses of the impacts of mining at Donge (number of responses does not match the number of participants due to the multitude of responses provided).

members had also noticed a decrease in coconuts, mangoes, and cloves in addition to increased erosion, car accidents, and mosquitoes in the village. Schistosomiasis was also said to have been contracted from the water in the mining area of Donge. Overall, however, the results of interviews in Donge were much more ambivalent toward the mining there. Four of twenty-five people interviewed were of the opinion that the mining was both good for the economy and benefiting the community in general. Another five people interviewed were neutral towards mining, acknowledging that it had negative influences but that people needed it to make a living.

The three examples of illegal mining in Mwana Kwerekwe, Saateni, and Kwarara have been observed to have severe social and environmental impacts on the nearby communities in Unguja Island. In Mwana Kwerekwe, both cemeteries are being desecrated and disrespected, in addition to the soil erosion and loss of vegetation occurring due to mining. Saateni, though it also has not been very affected economically, shows a village that has been very impacted environmentally as the mangroves and homes have been destroyed by the mining and socially with the injuries and deaths that have occurred. Kwarara is an example of a village in which the people are all very aware of the illegal mining and would like to do anything to stop it. The people in the nearby homes have been threatened continually, creating a very negative social atmosphere in the community. The government has attempted to stop the illegal mining by filling the area with trash, which raises new issues of pollution and an influx of flies to the area. Environmentally, the mining in Kwarara has caused substantial soil erosion, changing the path of water flow. Kwarara was also not affected substantially economically, only socially and environmentally.

An assessment of Mangapwani, a site that was previously legally mined, showed negative impacts on the economy, community, and environment of the surrounding villages and area. Economically, the rapid decrease in available fruit-producing trees has impacted sales of this produce. Stagnant water in the area could be responsible for an increase in mosquitoes, and soil erosion has damaged houses and destabilized more trees. The land is also much less fertile, having stripped the topmost meters away, and the vegetation regenerating is not as dense or as biodiverse as the surrounding vegetation. Socially, the people of Mangapwani have suffered huge losses of animal and human lives, as the pits can suddenly flood and children and animals drown. Mangapwani has been heavily impacted by the legal mining that occurred there in the past.

The mining at Donge, the active Mchangani and Chechele sites, has had very similar impacts on the surrounding communities. They have not been reported to be quite as severe or as extensive as in Mangapwani, possibly due to the timing or to the size of the sites. The loss of coconuts and mangoes, less fertile land, loss of farms, an increase in mosquitoes and disease, loss of life, and car accidents were reported as the most common impacts of legal sand mining in the area. The effects of legal mining at Mangapwani and Donge are overall more extensive and severe than illegal mining due to the scale of the industry.

Another severe issue associated with mining is the abundance of trash in each location adding to the environmental destruction of the area. Without the presence of the pit from mining, it is unlikely that so much trash would be located in the areas. In addition to this, erosion at each site due to the elevation gradient and decreased vegetation from mining has increased greatly,

and thus would carry trash along with it to the coastal environments and ocean. This erosion also destabilizes homes and trees, destroying the areas surrounding the abandoned quarries.

Though the sites at Mangapwani showed plant regeneration, the presence of regrowth does not demonstrate that the vegetation is of the same quality or quantity (Masalu, 2002). The plants regrowing after mining are more likely to be invasive species, and not of the same variety as prior to mining at the site. The Department of Forestry, after completing mining at a site, mentioned planting Casuarina, Acacia, Sena, almond, and coconut trees (H. Is-hak, personal communication April 22, 2015). At the sites visited in this study, none of the plants mentioned were seen. A possible explanation for this could be that the Department of Forestry has not concluded quarrying sand at Mangapwani at this time.

The current system in place for legal mining has the potential for more sustainable practice. The sites, as they are approved and utilized, could be improved by maintaining detailed records with the start and end date of mining. The system currently is such that no one in Forestry is aware of how long any of the sites have been mined, making them unable to accurately assess the damage and use of the site. Even the members of the surrounding communities gave incredibly varied responses to the amount of time the area had been mined. With accurate records, the Department of Forestry would be able to better assess how long a site should be mined, without doing so much damage to an area that it cannot recover. There could also be regulations on who is able to mine in the area in addition to the cost of sand. Currently, as sand is so much more expensive in areas further from Zanzibar Urban West, it encourages the purchase of illegally mined sand. Regulating and creating a management plan for the legal sand

mining in Unguja would likely decrease the demand for and the prevalence of illegal mining in the area as well as decrease the longer lasting effects that legal mining has on the environment.

This study had certain limitations and was unfortunately not able to appropriately assess some of the impacts of mining due to the language barrier, the time available, and the resources available. The language barrier simply was overcome using translators in different villages, though translators change the dynamic of interviews had with community members. With only one month to complete the study, the available time to collect data in many locations was too brief. This leaves many additional unanswered questions left at the end of the study, which require future research. The resources available for this study, if extended, would have allowed for a more in depth study of the thought processes behind the forestry policy and the process involved in mining legally, in addition to an extensive study of illegal mining. If possible, this study would have looked into the lives of illegal miners, how long they have been doing this work to earn money, and the other side of this fascinating topic. With additional resources, time, and knowledge of kiswahili this study could have assessed much more fully the holistic story of sand mining throughout Zanzibar.



## Conclusion

The demand for sand for construction purposes throughout Zanzibar has been increasing exponentially without any change in the availability of the supply. Utilizing non-renewable natural resources is one of the most challenging problems for a government to address, and the Revolutionary Government of Zanzibar has made policy developments that would lead to the successful betterment of their resource use. The forestry policy in place suggests moderate consumption and rehabilitation of the area after use, which would be an effective method of utilizing sand in the most beneficial way for all parties involved. However, the scale and importance of the industry are such that creating a proper management system has become increasingly difficult. The Revolutionary Government of Zanzibar lacks key enforcement capabilities that could successfully control the issue of non-renewable resource use. Possibly the most difficult aspect of attempting to manage sand mining is that the industry has become a vital component throughout Zanzibar and is a part of so many people's livelihoods (Masalu, 2002).

Overall the economic, social, and environmental impacts of legal mining are more severe than those of illegal mining, as the scale is exponentially larger. Without a controlled and managed system for the Revolutionary Government of Zanzibar to legally mine, the effects it is having on the community are too severe to continue in the same manner. The sites could have a more controlled method of mining- ensuring that only a certain amount is removed per day, and a fence or protective structure could be put in place at all legal sites to prevent any more deaths in the community. However, they face many challenges such as the vast size of the industry, corrupt enforcement officers, violent miners, and the time of day mining is done (Masalu, 2002).

Sand is also most likely the cheapest and most ecologically friendly construction material available to the people of Zanzibar (H. Is-hak, personal communication April 22, 2015).

A further investigation of the impacts of sand mining is necessary because currently nothing is being done to mitigate the problems. The severe social harm and permanent environmental damage being incurred on the people of Zanzibar needs to be noticed and managed, as the industry has become so extensive throughout Zanzibar that it has begun to severely impact communities. Without the implementation of mitigation practices, the communities throughout Zanzibar will begin to be permanently and severely affected by both illegal and legal mining practices.

#### Future Recommendations

Any future study of sand mining in Unguja would benefit greatly from more extensive interviews with government officials at the beginning of the research. An awareness of the factors required to mine legally and knowing more of the process of legal mining would allow better and more specific questions for interviewing throughout the research. In future studies, an in depth survey of the community of Kwarara and the other communities along the powerline from Mtoni to Fumba would provide critical information about the more aggressive illegal mining.

In addition to this, looking into the specific species of plants that are re-growing in certain areas compared to the plant species in the surrounding lands would provide much better data about the amount of harm being done to biodiversity throughout Zanzibar from mining practices. Another location to be studied would be the sand mining occurring along the

mangroves from Maruhubi to areas further south, as the environmental effects on the mangroves and the erosion of the coastline are likely severe.

One future study that needs to be done is a comparison of the construction materials used throughout Zanzibar such as coral rag, limestone, and sand. A comparison of the environmental and social implications of each of these materials would prove most beneficial to the communities of Zanzibar because it could impact future construction.

Having a translator who is familiar with both the topic and the study area would be helpful, as many of the community members may have provided more answers and information if they had been familiar with the translator.

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## Appendix A

### Survey 1: Community Members

1. **How old are you?** (Una miaka ngapi?)
2. Where do you live? (Unaishi wapi?)
3. Do you or anyone you know mine sand?
4. When did mining begin occurring here? Where is it? (Uchimbaji mchanga umeanza lini? Na wapi?)
5. How has the economy been affected by mining? Who buys the sand? Who is doing the sand mining? (Uchumi wenu umeaffirika na uchimbaji wamchanga? Nani ananunua mchanga? Nani ambao wanafanya shughuli ya uchimbaji mchanga?)
6. Have there been any incidences at the mine here? (Kuna matokeo ambayo yameleta athari jiu ya uchimbaji mchanga?)
7. How do you feel about having mining in your town? (Mnaliona vipi jambo hili?)
8. Have you noticed any environmental impacts? (Jee kuna athari zo zote zile mnoziona kotokana na uchimbaji mchanga?)
9. Are there any NGOs that deal with environmental issues here? Can I see them? (Kuna NGO yeyote ile inafanya kazi ya mazingira? Naweza kuwona?)

### Survey 2: Forestry officials

1. **How long has mining been occurring here?** (Uchimbaji mchanga umeanza lini?)
2. Where were you digging before Donge? How long did you mine there? (Wachimbaji walikuwa wanachimba wapi kabla ya Donge? Mumechimba muda gani?)
3. How much money does each truck pay? (Kila gari inalipa bei gani?)

4. Have you noticed any environmental changes? (Kuna athari zo zote zile kwenye mazingira?)
5. Have there been any incidences here? (Kuna matokeo ambayo yameleta athari jiu ya uchimbaji mchanga?)
6. Who digs the sand here? Is a permit required? (Nani anatumwa uchimba mchanga?)
7. How do the nearby villages feel about this mine? (Wanaliona vipi jambo hili?)
8. Are nearby farms affected by the sand mining here? (Shamba wetu ameffirika na uchimbaji mchanga?)
9. How many tons go out per day? (Kila siku, wanaondoka tani ngapi?)

**Survey 3: Sand miners**

1. **How old are you?** (Una miaka mingapi?)
2. How long have you been doing this work? (Muda gani unafanya kazi hi?)
3. How many times per day do you come to fill your truck at Donge? (Unakuja Donge mara ngapi kwa siku?)
4. Where do you go to sell your sand? (Unakuenda wapi kuuza mchanga wako?)
5. How much do you sell sand for? (Mchanga unauza bei gani?)
6. How much of that money goes to the forestry officers? (Bei gani inakueanda kwa afisa kwa msiti?)
7. How many days per week do you work? (Kazi hi unafanya siku ngapi kwa wiki?)
8. Have you noticed any environmental changes? (Kuna athari zo zote zile kwenye mazingira?)
9. How do you feel about the mining industry? (Mnaliona vipi jambo hili?)

## Appendix B

GPS Points along the outer edge of the quarries in Mangapwani:

<b>Site #, Point #</b>	<b>GPS- South</b>	<b>GPS- East</b>
1, 1	5°59'48.5"	39°12'34.8"
1, 2	5°59'50.6"	39°12'35.4"
1, 3	5°59'52.0"	39°12'35.8"
1, 4	5°59'53.8"	39°12'35.4"
1, 5	5°59'55.3"	39°12'35.5"
1, 6	6°00'00.9"	39°12'33.9"
1, 7	6°00'03.4"	39°12'32.1"
1, 8	6°00'03.5"	39°12'26.8"
2, 1	5°59'35.3"	39°12'39.8"
2, 2	5°59'35.1"	39°12'38.8"
2, 3	5°59'35.1"	39°12'37.3"
2, 4	5°59'34.6"	39°12'35.9"
2, 5	5°59'34.9"	39°12'34.8"
2, 6	5°59'34.8"	39°12'33.8"
2, 7	5°59'33.2"	39°12'33.7"
2, 8	5°59'32.0"	39°12'34.1"
2, 9	5°59'30.0"	39°12'34.5"
2, 10	5°59'26.8"	39°12'33.3"
2, 11	5°59'23.4"	39°12'32.7"
2, 12	5°59'21.8"	39°12'32.8"
2, 13	5°59'20.8"	39°12'35.3"
2, 14	5°59'19.9"	39°12'35.6"



2, 15	5°59'17.2"	39°12'36.2"
2, 16	5°59'15.9"	39°12'38.6"
2, 17	5°59'15.5"	39°12'42.6"
2, 18	5°59'16.0"	39°12'44.4"
2, 19	5°59'18.7"	39°12'44.5"
2, 20	5°59'21.6"	39°12'44.5"
2, 21	5°59'25.4"	39°12'46.5"
2, 22	5°59'28.7"	39°12'45.4"
2, 23	5°59'33.6"	39°12'46.1"
2, 24	5°59'34.0"	39°12'46.7"
2, 25	5°59'36.7"	39°12'48.9"