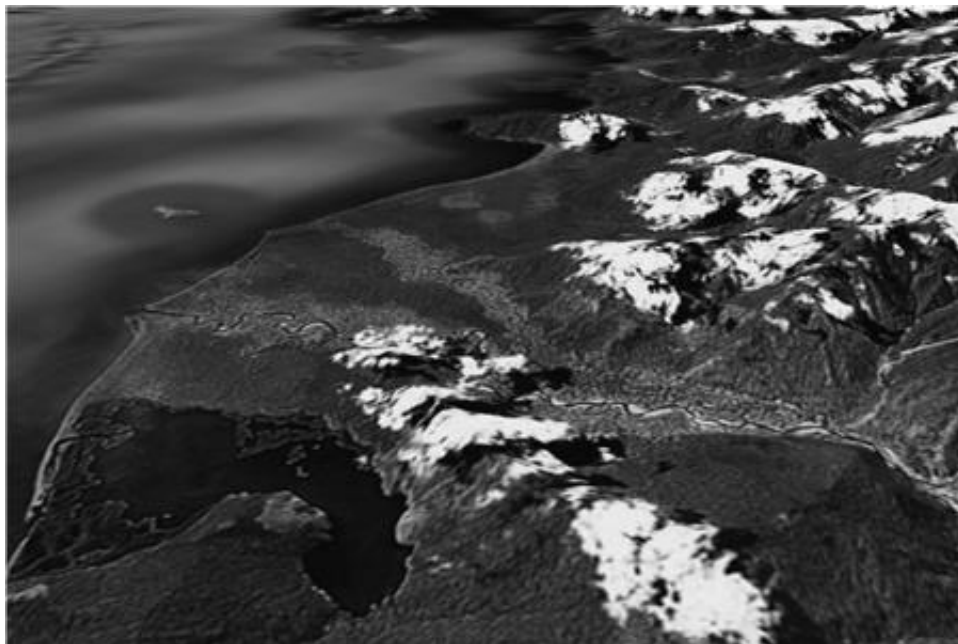


Description of Land Use and Livelihoods in a Village on the North Coast of Papua New Guinea

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Kamiali circa 1943 U.S. Airforce Mission



Kamiali circa 2010 via Google Earth

Introduction

In July 2011 Kamiali, Papua New Guinea, was visited by researchers as part of a project exploring the flora of Papua New Guinea. This was not the first time that Kamiali had been visited by researchers, nor is it the first time that the community's livelihood system has been explored. As explained in other places (Wagner et al. 2007), Kamiali, officially referred to as Lababia, organized its land into a Wildlife Management Area in 1995 (Bein et al. 2007). Shortly after that its livelihood system was investigated and a carrying capacity for the area calculated (Wagner 2002, Bein et al. 2007). This report represents an initial analysis of data collected regarding the livelihood system in Kamiali circa 2010 and the areas land use and land cover changes from the early part of the 20th century through the first decade of the 21st century. The data in this report comes from interviews and observations made by two researchers during July 2011. The data in this report will be analyzed in conjunction with data in a similar report on coastal resources in the wildlife management area and with land cover change data derived from multiple sources of remotely sensed imagery dating back to 1943 (of which the cover photo is an example) to develop a better understanding of why the village has succeeded to date in protecting its land resource base in the face of outside pressures and internal population growth pressures. Figure 1 shows the location of the area reported on.



Figure 1. Location of study.

Objectives and general methods

This research aims to identify and analyze livelihood strategies and the role that these strategies play in the village land-use system. The complex land tenure system and resource use systems investigated in this part of the research. The livelihood strategies studied include agricultural practices, land tenure systems and coastal, ocean, and forest resource use. These topics were explored using community based anthropological research methods which included oral histories, semi-structured interviews and structured surveys (Bernard 2006). The methods were incorporated into a Rapid Rural Appraisal (Freudenberger 1996) that was carried out in the community during July 2011.

To gain historical and contextual perspective of major events in Kamiali an oral history was conducted with community elders. Semi-structured interviews were conducted with different, knowledgeable community members to better understand land tenure, swidden practices (which takes the form of rotational shifting cultivation and is locally referred to as gardening), the fishing cooperative, coastal resource use and the community's social and economic structure. Besides gaining general information concerning these topics, it was of interest to gain insight on temporal resource changes as well.

Structured surveys obtained detailed information concerning past and present land and coastal resource use. The structured surveys consisted of 30 randomly selected Kamiali households and equal numbers of male and female informants were interviewed. The males were typically the head of the household, while the women tended to be the wives of the household's head. The aim of the structured surveys was to gain multiple perspectives concerning the location, quantity and methods used to harvest coastal, agricultural and other land resources, as well as any observed changes in land use and cover over time. It was also valuable to understand how individual responses differed based on age, gender, and economic underpinnings.

Transects were walked through the village areas. Specifically, they were walked through the living area, along the coast and through the garden areas. Individual garden areas were measured by pacing and when small enough using a tape measure. GPS receivers were used to record the location of gardens and of different land covers and land uses observed while walking the transects.

Oral history of Kamiali

Kamiali was originally known as Kamu Yali and translates roughly to spirit women. Kamiali is the local place name for the current village settlement. This name was not established until recently in the people's history. The ancestors of the people of Kamiali originated from an area northeast of Lae, known as Bukaua and traveled along the coast towards the present location. They first settled near the Busama and Buakap villages (Figure 2). During this time the population began to grow and internal conflicts split the clan into two groups. The two groups began to speak different languages to distinguish clan affiliation. As a result, when different clans crossed paths and the same language was not spoken a fight would ensue. The language of the ancestors became known as Gara, meaning *us*, as in the Gara people. Over time, as the Gara population grew, they continued to slowly migrate southward along the coast.

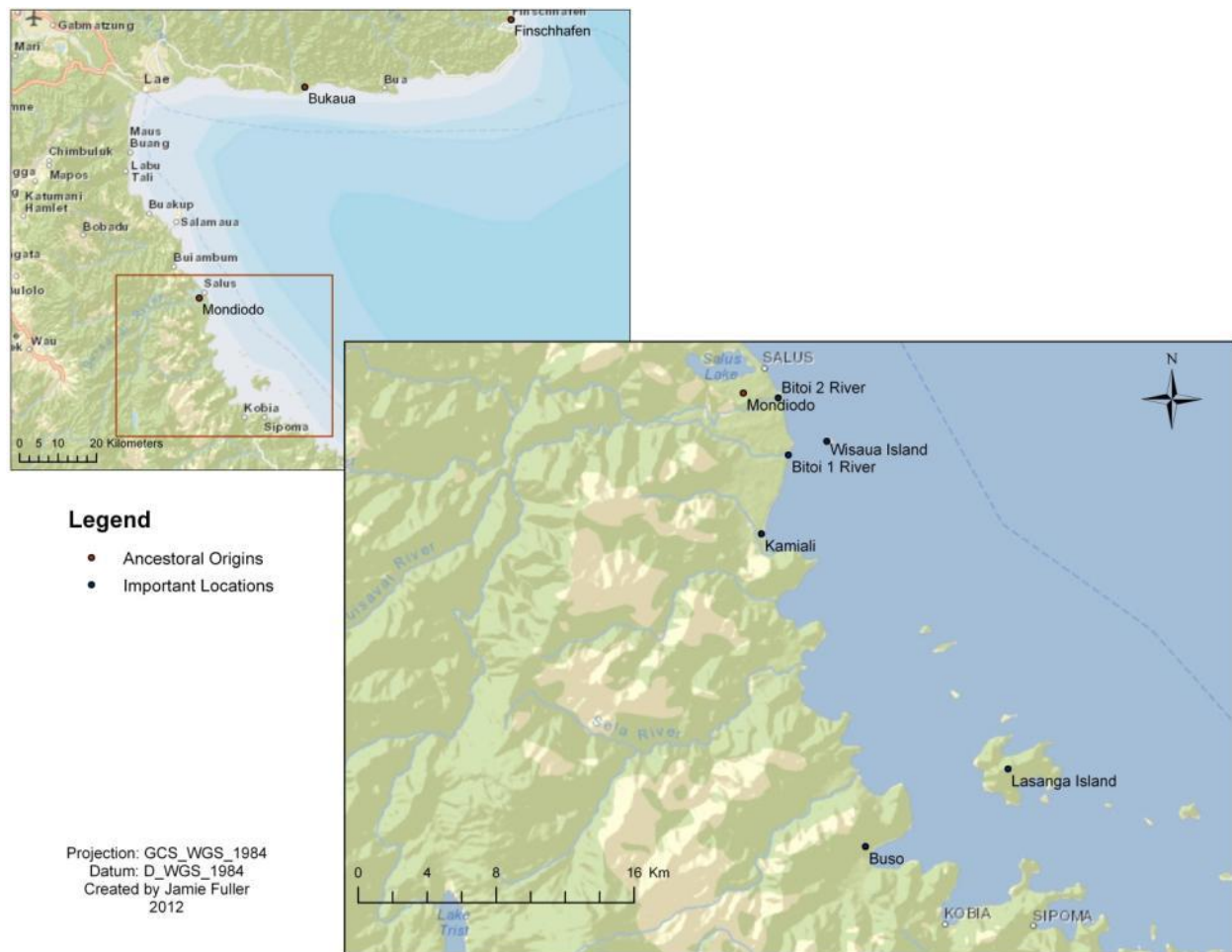


Figure 2. Reported origin areas of the Kamiali people.

One of the first settlements within the Kamiali region was known as Bulari Areta and was located near Bitoi 2, the river furthest north in the area claimed by the present-day inhabitants of Kamiali. Small temporary huts were built while the elders decided on a permanent location. The temporary huts flooded, so the group moved 1.5 km inland to a small hill located on the north bank of Bitoi 2, known as Mondiodo. Mondiodo became the first formal village of the Gara people.

A clan, known as Kiwa, was established further inland and began to raid the Gara settlement at Mondiodo to claim wives. The women and children were hidden from the Kiwa people in temporary huts while the Gara men looked for a new settlement. The temporary huts were on a smaller river named Aniaru, between Bitoi 1 and 2. While at Aniaru, malaria (or another mosquito illness) started to spread among the people so they crossed Bitoi 1 and settled at Ambra Lekini.

While the Gara people resided at Ambra Lekini the first Germans arrived. Initially, the villagers were afraid of the Germans because they had never seen Europeans before. The village was named Lapapia by the Germans, but due to translation errors became known as Lababia. Some of the Germans were missionaries and brought Christianity (Lutheran denomination) to the Gara

people. This interaction was estimated to be between 1907-1909, shortly after the Germans visited and introduced Christianity in Salamaua circa 1907. A few Gara individuals were taken with the missionaries to Finschhafen to be trained as missionaries. The informant's father was one of the individuals selected to become a missionary and began his preaching career in Wau.

The Gara population continued to grow over time, however, both malaria and intestinal illnesses were endemic and killed many people overtime. To seek refuge from these illnesses a large portion of the population moved to the island of Wisaua, which is located just off the coast from Bitoi 1 River. The island soon became overcrowded and the illnesses persisted. Some moved to southward to Yauami Island, in 2011 known as German or Hessen Island, and one family moved to Lasanga Island. The island dwellers traveled to the mainland to hunt and noticed the soil was good for agriculture. Many of the island dwellers moved to the mainland and founded Moklia and Buso villages. The overcrowding on Wisaua Island caused many people to return to the mainland as well and Kamu Yali was established. In Kamiali, the Gara people had a conflict regarding land rights so the clan split into two groups. The smaller group was Tabari who moved northward up the coast closer to the Bitoi Rivers, while the Gara remained further south.

When the Gara clan split into Tabari and Gara it was approximately the beginning of WWI, which was referred to as the *German War*. During this time a small boatload of 'whites' were traveling up a river near Kamiali and a man from Kamiali threw a spear at the boat. The boat flipped over and after it was righted the 'whites' returned to their larger ship in the ocean. The 'whites' later returned to the village with guns and fired excessively at the village. This caused the both the Gara and Tabari people to flee into the surrounding forest and avoid all contact with Europeans until the war was over. Once the war was over the Gara and Tabari returned to Kamiali and all lived in one location.

At some point between the late 1930's and early 1940's an airplane captained by 'Taylor' flew over the village and dropped papers. The fliers warned that a war had begun and they should hide. Soon after, Japanese airplanes raided the village and shot at people and houses. As a result, some people hid and some traveled to Buso or Kui villages to avoid attack. The Japanese confiscated food, stole crops, and destroyed gardens causing many people to go hungry. There was minimal food for the people hiding in Kui and Buso as well. As a result, most people survived on forest resources (game and edible vegetation), seaweed and some fish. The Japanese had many people stationed in Kamiali and had established ammunition storages and built gun emplacements. The Americans and Australians arrived (in 1943) and helped the villagers fight the Japanese. The Japanese were forced northward towards Madang and eventually out of Papua New Guinea. In 1947 the government told people to return to their villages. Supplies were distributed to many villages because most gardens had been destroyed. In Kamiali new gardens were established at Areta, north of the village.

At this time, although separate clan affiliations were maintained, both the Gara and Tabari lived in Kamiali as one clan. The first school was built in Kamiali in 1976 near the Areta area. The school remained open until 1983 when a flood destroyed it and a few houses at this location. The people displaced by the flood moved either to Kamiali or Wisaua Island and a new school was built in Kamiali.

Historical perspective of resources and population pressures

Additional information concerning population growth and the quality and importance of garden, reef and ocean resources were collected through the use of historical and resource ranking matrices. Table 1 is a compendium of the information collected. All the resources were rated equally for quality and abundance until the late 1970's when the population was about 200 people. After this point the ocean and reef resources became less abundant and the crops from the gardens were relied on more. The garden crops did not decline in quality or abundance until the early 1980's when the population was around 400 people. During this time an insect problem began to decrease the productivity of taro, a main staple crop and a large flood inundated much of the cultivated areas with salt water.

Areta was the primary area used for cultivation. However, due to population growth a new garden area was created in 1986 and named Dounoua (Figure 3). At this time all three resources, garden crops, reef, and ocean, were viewed as equally important. In 1996 the population was estimated at 600 people and the quality of all three resources was viewed to decrease again. In 1996 taro was not productive at all and to compensate, larger amounts of other crops such as cassava, banana and sweet potato were grown. In 2011 the ocean resource quality was reported to have decreased once again.

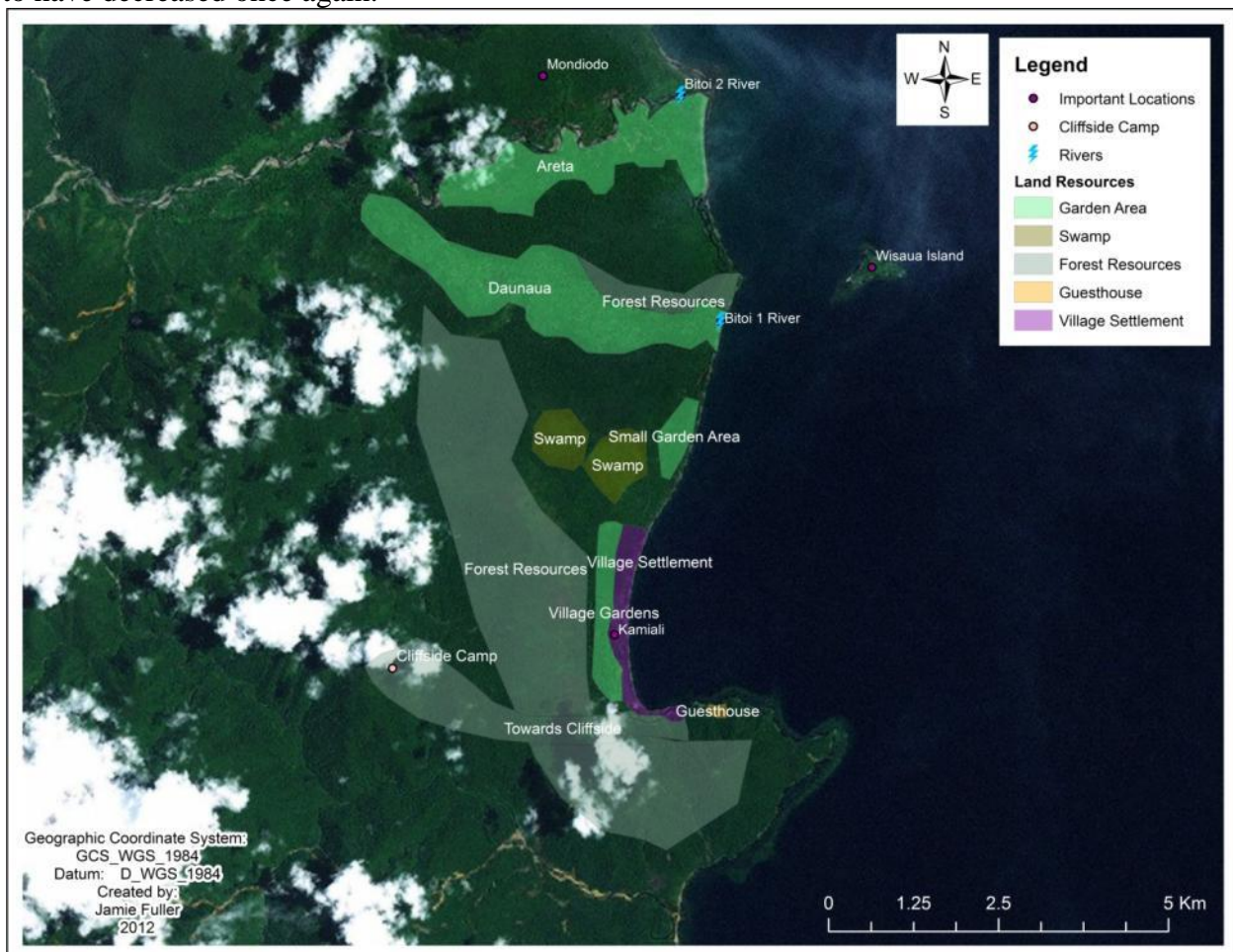


Figure 3. Land resources in the Kamiali area.

Overall, informants attributed the decrease in land, reef and ocean resource quality between 1996 to the present to population increases within the village and a corresponding increased pressure placed on the resources. Reef and ocean resource quality declines are believed to be caused by more children fishing at a younger age, which results in the fish population decreasing over time. Commercial fishing practices are also believed to have increased and to have resulted in fewer ocean fish. Since coastal resources have decreased rapidly, more emphasis has been placed on the importance of the garden areas and the resources produced within these areas. According to informants the reason that gardening has become more important is because one can work hard in the garden and ensure survival with harvested food, while it is not always so with fishing (there is more of an element of chance). When asked which of their resources they could “do away with”, ocean resources were selected. This was because protein could be provided by land animals and some reef fish. While a protein source is important, fishing is done when time permits and/or money is needed and is not a necessity.

Table 1: Observations of resource quality and importance, household organization and population growth over time as recalled during the oral history interview.

Approximate time or year	Households divisions	Garden	Reef	Ocean	Resource importance (among garden, reef and ocean)	Other observations and notes:
	Estimated Population					
Before WWII (early 1940's)	10 male households – usually 1-2 men (brothers) per HH / 3-4 women in HH/per 1 man Estimated 100 people	5	5	5	Equal importance	-could get reef/ocean fish along the coast easily -so many fish you could fill up a canoe -taro in gardens was very productive
Rubin marries (early 1960's)	Same as above Estimated 150 people	5	5	5	Equal importance	Same as above
Gabo was born (1969)	Same as above Estimated 200 people	5	5	5	Equal importance	-still abundant resources -same as above
School was built (1976)	3 bigger men HH – clans combined to reduce fighting caused by more people Estimated 300 people	5	3	3	Garden is more important	-population grows and more fish are fished so garden becomes more dependable
Flood 1983	Same as 1976 Estimated 400 people	3	3	3	Garden is more important	-taro is taken out by an insect problem -food is disturbed because the soil is inundated with salt from ocean flooding
Fight between Kamiali and Kiwa (1985)	Clans become one group Estimated 450 people	3	3	3	Garden is more important	-
Guesthouse built (1996)	Same as 1985 Estimated 600 people	2	2	2	Garden is more important	-population increases even more – many kids

In 2011 (2011)	<p>Family houses are built Gara and Tabari are recognized but considered one group</p> <hr/> <p>Estimated 1000 people (census year- 2011)</p>	2	2	1	Garden is more important	<p>-kids fish more by diving, pole and spear so fish population begins to go down</p> <p>- taro is totally gone and replaced by cassava, banana and sweet potato – these new crops also have bug problems</p> <p>-taro is traditionally the best because ancestors used it – the ancestors only knew how to plant taro</p> <p>- Many fishing techniques have changed: nets, hooks, poles are used more and boats are used more so access to on the reef and ocean is increased.</p> <p>-fish are frightened by boat motors and the petrol pollutes the water</p> <p>- nets bother the fish and catch turtles which is bad so many fish are scared of nets and goes to the ‘deep’ ocean</p> <p>-white man fishes too much – not enough for the locals</p>
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Land Tenure

The ancestors of the Gara clan were primarily agriculturalists and maintained the rights to a majority of the gardening areas. Since Gara ancestors used this land it has been passed down through the generations and the Gara maintain the rights to the land and who has access to it. In the past the Gara people maintained more garden area and fished infrequently, while the Tabari clan practiced the opposite: Tabari clan members had open access to reef and ocean resources and the Gara were limited to certain areas where they could fish. This also explains why the Gara clan maintains ancestral rights to more garden area. When Daunaua was developed as a garden area, the Tabari clan was able to claim portions of this land however, the Gara ancestors had original claims to most of this land (Figure 4).

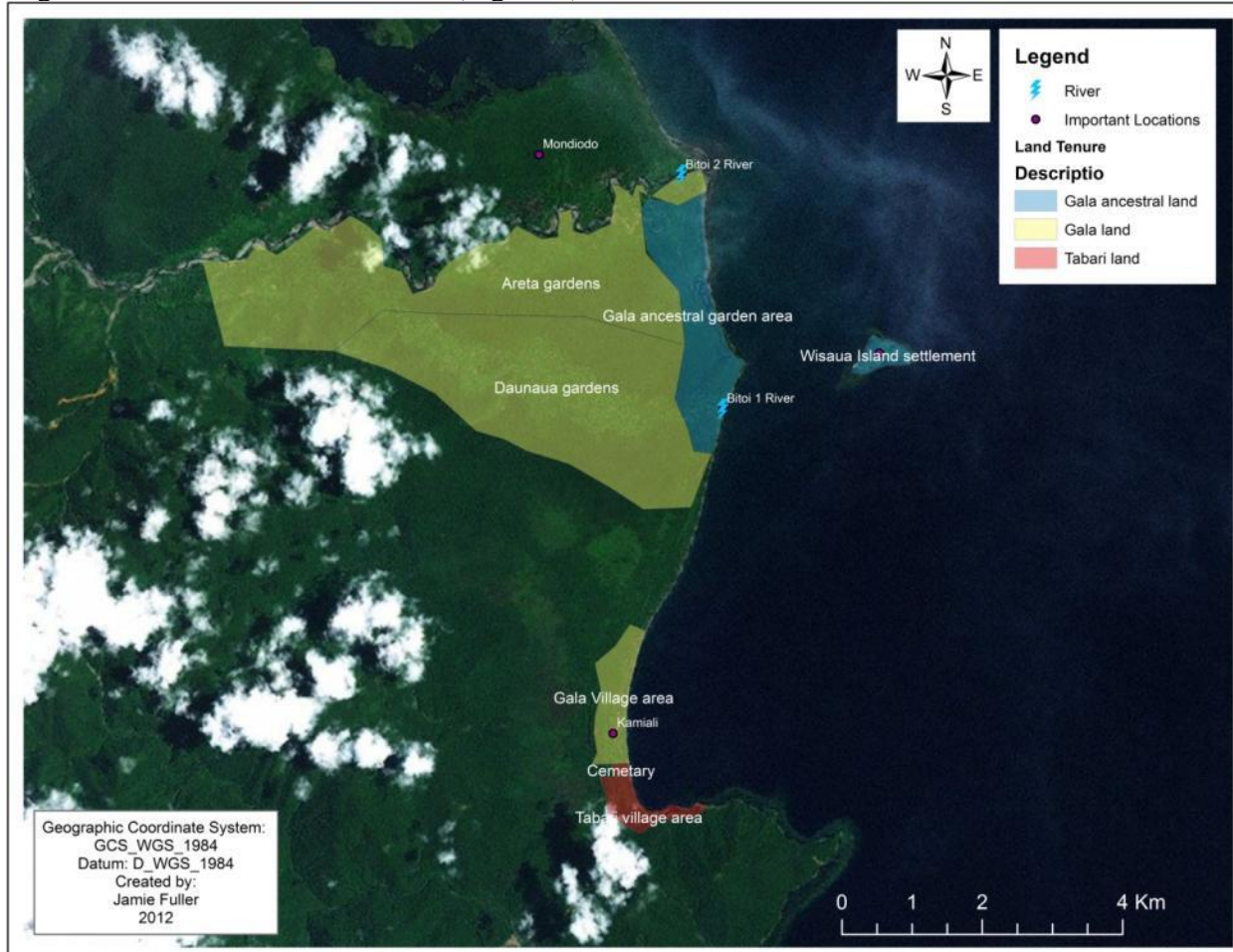


Figure 4. General land divisions within the Kamiali Community.

The Gara ancestral land does not include all land available for cultivation, community land is also available. Community land is land that was not used by the ancestors when the village was originally settled. The community land extends back to the mountains and towards the swamps and is available to be cultivated by either Gara or Tabari clans. If someone with Gara or Tabari heritage desires to cultivate on Gara ancestral land or community land, the Kamiali community must be consulted prior to clearing the existing vegetation. Younger family members or newlyweds can (1) receive a portion of the garden area that the family has use rights to, (2) be

allowed to use other family's plots or 93) may claim, clear, and cultivate a new garden plot if the community agrees. In 2011 a large portion of community land open and cultivatable if someone desires to claim a new plot.

In 2011 both clans are virtually one, having in many senses merged together. Members from both clans practice gardening and fishing in approximately equal amounts and so access to resources for either clan is not strictly prohibited or as strictly regulated between clans as it was in the past. Previously, there was a dividing line in the village that delineated the 'ownerships' / clan use rights and ancestral rights. Although the line is still recognized, access to resources is not forbidden between the clans. The only land that has restricted use is the area surrounding the cemetery. In addition, no one farms in the swamps due to excessive soil moisture and the presence of large crocodiles. When asked what would happen when all land was claimed and a community member/new family needed land, the general response from informants was that a community discussion would occur first. Informants believed that most likely this discussion would result in all families subdividing their land for the family or community member who desired a garden plot.

Ocean and reef resource tenure in 2011 is thought to extend into the ocean approximately 100-200 km, and prohibits commercial fishing companies or other clans' access. Forest resources have been and still are unrestricted for anyone in the community to use. Forest resources include building materials (e.g., for houses), fishing equipment, firewood or any other forest materials. Likewise, hunting practices are open to any area within the bounds of the Kamiali property, but it should be noted that a few community members practice hunting. The land boundaries encompass all property claimed and owned by the Kamiali community. The boundaries are well known by everyone in the community and neighboring villages, although occasionally boundary feuds occur.

Other resources available for community use are wild growing plants such as fruit, nut, and palm trees and any other edible plant. The only restriction is if the plants were planted and/or cultivated by an individual or family, and in such case the use/management of the resource is limited to the planter/cultivator. If growing wild, the trees used to make canoes also are considered available for anyone to use. However, some trees used for canoes can be planted and tended and are owned by the planter/cultivator. Sago and coconut palms are usually planted as well, but do not have to be planted within the confines of family-owned garden. These palms are only tended to and harvested by the owners.

Natural resource base

The people in Kamiali are dependent on many of their local resources to fulfill their subsistence and livelihood needs. In general, these resources include agriculture (cultivated crops, palms and trees), ocean and reef resource collection (fish, shells and coral), and forest materials (building materials, firewood, wild game, herbs and edible vegetation). The following sections describe the methods used to harvest these resources, frequency of harvest and amount collected. In light of understanding how resource use has changed over time many questions were tailored to compare practices of in 2011 to those of the past. The past was indicated as 1996, the year a new church was built, to create a frame of reference for recall. Informants also were free to describe past resource use as they saw fit and the time frame was noted.

Livelihood system

Garden resources

The main crops grown are sweet potato, cassava, banana, corn, sago, sugar cane, coconut, yam, taro, pitpit, wild betel nut, and greens. Other crops which were also mentioned, but not as frequently, include pineapple, tomatoes, papaya, watermelon, mango, wild onion and cucumber. Informants suggest that these crops are mentioned less frequently because they are not main staple crops and are cultivated to a lesser extent. However, a seasonal effect also may have caused these crops to be listed less frequently resulting from the timeframe of the interviews and seasonal rotation of certain crops.

Since scales were not available crop harvest totals were reported in bilums per unit of time. A bilum is a net bag used to collect and transport garden harvests, fire wood, or other items. The weight of each bilum varies depending on the mass of the item collected. On average, the approximate weight of a full bilum is around 20 kg each (Figure 5). The handles of the bilums are placed on one's head to carry and, in general, 1-2 bilums are transported at a time. The bilums shown in Figure 2 contained multiple crops in one bilum, which is usually how crops are transported. However, when harvest amounts were described the bilum amount was estimated for a single crop.



Figure 5: Women carrying bilums filled with items harvested from the gardens.

The gardens are cultivated by both men and women and the number of days the gardens are visited has not changed over time. Women work in the gardens 4-6 days per week, while men work in the gardens 2-3 days a week. Due to fishing responsibilities, men visit the gardens less frequently. The number of gardens each household maintains ranged from 1 to 9, though the average was 4 gardens. The average area for each garden was 30 m². Below each crop will be described in the amount harvested and any changes in productivity over time. A table has also been developed to summarize the details of each crop (Table 2).

Sweet Potato: On average sweet potatoes are planted with 1.5 m spacing. A small mound is created and small holes dug using a thin stick so that vines cut from other sweet potato plants can be transplanted (Figure 6). Minimal shade is provided for sweet potatoes because this crop grows better in drier soils. When sweet potatoes are ready to harvest approximately 2 bilums per week are collected. Half of the informants interviewed reported selling half of their harvests and

consuming the remainder, while the other half kept all of the harvest for personal consumption. When asked if the amount harvested had changed since 1996 half of the informants reported growing the same amount and the other half had mixed responses. A quarter of the people reported growing more sweet potato in order to replace lower taro harvests. Others, although growing more sweet potatoes in 2011, reported the soil as drier in 1996, which is better for sweet potato growth. Because the soil is wetter in 2011 harvests are smaller. One individual had added sand to the soil to aerate and dry the ground but the soil was still too wet and cool to grow a lot of sweet potato. Another individual described that the soil was better in 1996 because the fallow period was 3 years, in 2011 their fallow period has been shortened to 1 year and the harvests are less. Another individual reported that due to land constraints, caused by an increasing population, fewer sweet potatoes per garden are grown in 2011.



Figure 6: Recently planted clusters of sweet potatoes. Vines will eventually grow outward and entirely cover the ground.

Cassava: Cassava is a tuber planted on average 1.5 m apart. It is planted by digging a hole with a stick and transplanting cutting from another cassava plant. One planted stem will produce multiple tubers underground (Figure 7). Larger tubers can be grown when the above ground vegetation is cut one to two times before harvest. Cassava is continually rotated among the gardens and grows well in wetter soils, thus it is commonly planted during the wet season. Cassava does not keep for very long after it is harvested and as a result smaller amounts are harvested more frequently. In general women claim to harvest 1 bilum per week and almost all the women reported keeping all the harvests for consumption. The men estimated weekly harvests to range between 1 and 4 bilums per week, with an average of 2 bilums per week and reported selling $\frac{1}{4}$ of the cassava harvests. Both men and women had begun using a strain of cassava from Rabul during 1996/1997. The new strain has a higher yield compared to the traditional variety and is now planted more often, comparatively. Because of the higher yields, most informants reported more cultivated and harvested cassava in 2011 compared to 1996. The individuals who reported growing less cassava in 2011 and more in the past attributed this change to their having less of a need for the cassava, e.g. the number of children in their household has decreased as their children have grown up and established their own households.



Figure 7: Drawing of a cassava plant above and below ground (left) and a small garden area of cassava (right).

Banana: Bananas are one of the main staple crops and are grown around 2 meters apart (Figure 8). New banana trees are established by transplanting the suckers that grow near the base of an existing tree. The number of bananas grown is dependent on the number of people in each family, when this number changes then more or less bananas are grown and harvested. Also, the quality and abundance of taro, sweet potato and cassava dictates how much banana is harvested. If the productivity of these crops is lower, then bananas are planted and harvested to a greater extent and vice versa. In 2011, the amount of banana collected per week ranges from 2 to 10 bilums. A majority is kept for consumption or shared with other family and community members, while around $\frac{1}{4}$ is sold. In general the informants report that the same amount of banana is grown as was grown in 1996. However, a few of the informants have noticed less space is available in 2011 to grow bananas, and they attribute this land shortage to the increase in population.



Figure 8: A banana garden with multiple banana tree ages, mature trees growing at approximately 2 m spacing.

Corn (maize): Corn was introduced in approximately 1987 and has slowly gained a foothold as one of the staple crops. Corn is sometimes planted in rows but usually planted in clumps of 3-5 stalks at a ½ a meter spacing. Corn can be planted and harvested twice a year, in January and September. Harvest usually lasts 2-3 weeks and will result in an average of 1-3 bilums per week depending on the amount planted. Corn warrants a good price at the local and Lae markets. While some corn is kept for consumption, most people sell ¾ of their harvest. Children were said to like corn a lot so most of corn kept for consumption is fed to the children. In 1996 less corn was grown over all because fewer seeds were available, in 2011 more is grown to sell and to satisfy children's craving.

Sago: Prior to the introduction of different types of vegetables, Kamiali ancestors only ate sago and fish. In 2011 sago is still a staple crop and used for celebrations, festivals, and funerals. Sago is considered the most resilient crop and can survive almost any natural disaster. If all crops are destroyed or garden space becomes too limited, people will survive on sago alone. When taro began to decrease in productivity sago was relied on and people started planting different crops. Sago palms take about 8-12 years to mature and are usually family-owned and shared or gifted to younger family members. One sago palm, when mature can be ground into flour to produce 20-30 loaves of sago bread. These loaves can feed about 10 people for 2 weeks.

Sago palm spacing is usually around 10 m due to the size of the palm and area needed to cut and harvest the plant. Sago are planted near the fringes of the garden areas or scattered along the rivers (Figure 9). The number of trees reported by men ranged from 5 to 200 and averaged 70 sago palms per owner. Women, on the other hand, reported 1 to 22 and on average had 6 palms, but do not directly maintain them. Men typically plant, maintain, and cut sago palms due to their large weight and size and because it requires minimal maintenance. The most common response of informants to the semi-structured interview regarding the amount of sago harvested per month was 1 palm, however, according to the results of the structured survey, the average number of palms harvested per month was 2. Sago is not usually sold; after being processed into flour it is usually kept or shared with family members. Many of the men claimed to have fewer sago palms in 2011 compared to 1996 because they have given an equal number of palms to each of their children.



Figure 9: A sago palm located across the river and indicated by the arrow. This sago is not at maturity and likely 2-3 years of age.

Taro: Taro was the main crop of the ancestors and indicated a hard working person. Taro is rarely grown in 2011 due to an insect infestation that began in 1982 and increased in severity so that by 1992 almost no one could grow taro. Many different techniques have been used to decrease the pest problem. These include longer fallow periods, rotating crops and, by one family, using pesticides once. A different cultivar of taro, called Singapore taro, is currently being planted by some in the community. It is unknown if Singapore is the origin of the cultivar. The new taro cultivar was introduced to Kamiali during the early 2000's. Singapore taro is also susceptible to the insect pest, but it is more resilient. In 2011, only four of the informants reported growing Singapore taro (3 female, 1 male) and no one reported growing the traditional taro cultivar. One informant claimed this was the first year she has attempted to grow the new taro cultivar. The spacing of the taro is about 1 m and it is planted by transplanting a stem cutting from another plant. Taro is planted during the dry season and one plant will produce 6-10 tubers. The number of plants grown in 2011 ranges between 10 and 100, with an average of 45 taro plants per farmer. All taro grown is kept for personal use and shared among community members for celebrations and festivals.

Yam: Yams are not grown as widely as most other crops and they are not considered a staple food. Fewer yams are grown because there are a lot of other crops to grow. Also, seeds must be acquired through purchase or trade to grow yams. After one harvest, seeds can be saved but are frequently lost. Informants noted two reasons for cultivating yams: (1) to have a larger variety of food; (2) yams can be stored for a long time. Twice the number of women reported growing yams compared to men. Women, on average, grow around 25 yam plants, while men reported growing an average of 55 plants, which provides an overall average of 35 yam plants. An informant described that in one season 20-30 bilums of yam can be harvested from about 10 plants. However, on average one bilum per week is harvested, only about 1/3 of the individuals

reported selling their crop and all others kept the entire harvest for household consumption. Those who sell a portion of their yam harvest usually sell ½ of a bilum per week.

The majority of informants growing yams have not noticed much of a change in yam production however; the remainder described a decrease in yam productivity. Decreases in productivity were attributed to changes in the climate and more and larger ocean floods (higher tides and storm surges) which have led to increased salinity in the soil and the resulting destruction of crops.

Coconut: Coconut palms are scattered throughout the village, along the rivers and near the gardens. The ownership of these palms is well established. A few coconuts are collected each day, totaling approximately 10-12 coconuts per week (roughly one bilum per week). Coconut water is usually consumed or added to food. The meat of the coconut is used to flavor food either as creamed coconut (grated and mashed) or made into copra (dried). Occasionally coconuts are sold, however most coconuts are for personal or family use. No one has noticed any changes in coconut productivity or palm growth over time.

Sugar cane: Sugar cane is cultivated by transplanting a portion of a live cane (by cutting). The plant spacing ranges from 2 to 10 meters apart. There are approximately 4 stalks per bilum and these stalks are cut and bundled into 40 cm lengths. The informants reported growing on average 17 sugar cane plants and collecting about 2 bilums per week. Of the 2 bilums collected most people sell about half of their harvest each week. Sugar cane is grown because it sells for a good price and children really like it. The amount of sugar cane grown was closely related to the number of young children in the family or extended family. For example, when there are numerous young children in a family more sugar cane is grown to satisfy their cravings and sold to help pay for school fees. Overall, no one had noticed any changes in the productivity of sugar cane. However, since it is planted close to fresh water sources (rivers) seasonal flooding is occasionally problematic.

Pitpit: Pitpit (local name) is a thinner, spongier cane plant that is sweet and similar to sugar cane. Pitpit can be eaten alone or mixed with other foods and cooked. Plant spacing can range from 3 to 8 meters and it is usually planted close to streams and rivers. Pitpit canes are cut into 40-60 cm lengths and bundled, each bundle is comprised of 12 pieces and 5 bundles make up a bilum. Approximately 1.5 bilums are collected per week. Like sugar cane, pitpit is sensitive to stream and river flooding, decreases in productivity occur when plants are continually saturated. No one mentioned any issues with pitpit productivity changes over time.

Betel nut: The Areca palm fruit are small seeds known within PNG as betel nut or buai (pronounced b-why). This palm takes approximately 3 years to mature and bear fruit. There are local varieties of betel nut that are grown and found growing wild around Kamiali (Figure 10-left). The wild betel nut growing in Kamiali has been almost completely destroyed by insect infestation that began in 2000. In 2006 the severity of the infestation had increased to the point that almost no wild betel nut trees bear fruit. In 2011 only 3 informants maintain betel nut palms and harvest less than 1 bilum per month. Many people have planted new palms but are doubtful the new crop will survive. Other varieties of betel nut, not as affected by the insects, are extensively cultivated, widely distributed and sold across the country (Figure 8-right).

The betel nuts are shelled and chewed casually or during special occasions. The process includes chewing the nut into a pulp and then adding lime powder that is made from ground coral. The lime powder is added using a bean-like stalk known as mustard stalk. The result of chewing these ingredients together causes a chemical reaction and is a mild stimulant. The extra saliva produced from chewing betel nut is spit out, much like chewing tobacco but turns one's saliva, mouth, lips and teeth a red color.



Figure 10: Native Kamiali betel nut variety shelled (left) and betel nut sold in markets with husk (right).

Greens: Greens are leafy green edibles and names for these plants are in the local language. There are various types of greens collected and consumed; however only a few are described here. Some of the greens are grown as ground cover to reduce weed growth, while others are found growing wild and harvested for consumption. One fern-like species, called ibeka, is grown in gardens or grows wild and is collected in the surrounding area. Another species, called kumu, is similar to squash (vines and leaves) and only the leaves are consumed. The bundle of kumu in Figure 11, is approximately 2 bilums worth. Tuleep greens are edible leaves collected from a small tree. Tuleep bark is also used to make traditional fabrics. Approximately 12-14 bundles of greens (1 bilum) are collected each week (per household). About half of the informants keep all the greens they collect and half sell half of their weekly harvest.



Figure 11: Kumu, a leafy green vegetable, where the leaves are consumed and stems discarded. It is wrapped in large leaves and bound together with a vine for transport.

Table 2 lists the dominant crops grown in Kamiali and includes detailed information concerning each crop. Averages are stated for the number of plants grown, crop spacing, the amount collected and the amount kept for consumption or sold. Other information includes the planting techniques for each crop and the main reasons for cultivation.

Table 2: Listed are the most common crops grown in the Kamiali region. Details of each crop are based on overall averages from the structured surveys. In addition, the most common responses for planting technique and main reasons for cultivation are included.

Crop	Average number of plants grown	Crop spacing in meters	Amount collected per week	Average amount kept (sold)	Planting technique	Reason for growing
Sweet potato	100	1.5	2 bilum	1 bilum (1 bilum)	Transplant cutting of vine	Staple crop
Cassava	55	1.5	1.5 bilum	$\frac{3}{4}$ bilum ($\frac{1}{4}$ bilum), remainder shared with family	Cut a stalk and transplant	Staple, high energy, good to eat
Banana	80	2	3 bilum	1 bilum, (1 bilum), remainder shared with family	Transplant suckers	Staple, easy to grow
Corn	100 stalks	0.5	3 bilums when harvested	1 bilum (2 bilum)	Put 3-4 seeds into one hole	Good to eat and sell
Taro	45	1	1.5 bilums	All (none)	Transplant stem cuttings	Traditional, staple food
Sago	70	10	2	All (none)	Transport suckers or just let grow	Staple food for survival when other crops fail
Yam	35	0.75	1 bilum	$\frac{3}{4}$ bilum ($\frac{1}{4}$ bilum)	Plant seeds	Good for variety; stores well
Coconut	25	3-10	10 nuts	1.5 bilum ($\frac{1}{4}$ bilum)	Plant a sprouted nut	
Sugar cane	17	2-10	1.5	Half (half)	Cut a stalk and transplant	Sweet; kids like it, good price in market
Pitpit	22	3-8	1.5	Half (half)	Cut a stalk and transplant	Sweet; kids like it

Betel nut	10	5-20 wild	1 bilum per month	$\frac{3}{4}$ bilum ($\frac{1}{4}$ bilum)	Plan seed	Cultural activity; nice buzz
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Swidden / gardens

The first step in establishing a new garden plot, one that has not been cultivated before, is to discuss the location with the community. Once everyone agrees that no one has previous use rights to that parcel of land or the previous 'user' agrees to allow use of that parcel the plot can be cleared. Plot clearing begins in January during the dry season for either a plot has never been cultivated or one that has lain fallow for a set period of time. It is the man's job to cut brush and smaller trees within the plot, the vegetation is then left to dry for 1-2 weeks. Once this vegetation has dried, bigger trees are felled and allowed to dry for around 1 month. This time frame can range slightly because it is dependent on dry weather and the amount of sun. It is at this time that the plot is burned. After the burn, once the debris (e.g. rocks, burnt logs, larger branches, etc.) has been cleared, it is the women's job to begin to plant.

First seeds for greens are sprinkled across the entire plot to minimize weed growth. These greens include ibeka, green beans, tomatoes and corn. Once the greens have begun to grow sweet potato are planted and allowed to establish for a few weeks. At this time the first round of greens can be harvested and cassava, banana and more greens are planted. Banana suckers and cassava stems are cut and transferred from another garden to the new garden. Corn and tomatoes take longer to grow (4 months or so) by the time these crops reach maturity the second round of greens can be harvested. At this time light weeding is necessary.

The sweet potato is ready to harvest when leaves rise, fall and then turn yellow. Once all of the sweet potato has been harvested the banana and cassava should be ready to harvest. The banana and cassava plants are now established in a plot so their suckers and stems can be rotated around the plot. However, the sweet potato has to be relocated to a new area entirely because it requires more soil nutrients. Sweet potato requires drier soils, while cassava and bananas can tolerate wetter soils, so plots are rotated accordingly. The processes stated above are in a rotation of planting, harvesting, and rotating crops and within one year the cycle is completed 3-4 times. During the second year, the rotation of planting, harvesting and rotating crops continues as mentioned above. In addition, sugar cane, pitpit, and yams are planted. See Table 4 for additional seasonal and environmental characteristics.

During the third year the plot can either be planted again or left fallow, however after the third year the plot is usually left to fallow. In 2011, average fallow periods are 1-2 years long and during the fallow period bushes grow back and trees can reach 5-6 meters in height. When the ground cover and leaves become dry the soil is believed to have regained fertility and is ready to be planted again. If you let the plot fallow 3 years or more, the soil becomes even more fertile. If there is a disturbance such as a flood or salt water has inundated the garden then a plot is left to fallow no matter what year of growth. In the case that the river washes away a portion or someone's entire garden those individuals are relocated into the middle of the gardening area pending no one else have use rights of the plot. When the river bows away from the gardens and creates new land, that land is available to anyone.

Everyone in the community is aware of who has user rights to each plot and no one will cultivate someone else's plot without getting permission. In 2011, there is still ample area available to cultivate crops (Maps 3 and 4). However, in the future, if all cultivatable land has been claimed the community will discuss how new plots will be allotted.

Coastal resources

Fishing cooperative and coastal resource generalities

The Village Development Trust, International Christian Community Organization, and Green Peace organized and funded multiple projects in Kamiali. The projects all began in 1996 and included building the guest house, developing a fishing project and creating a women's group. The fishing project consisted of purchasing an outboard motorboat that was to be owned by the community and 3 iceboxes for the preservation and sale of fish. After 4 years the fishing project was discontinued due to financial corruption and the motorboat was repossessed. After seeing the value and gain from owning an outboard motorboat a villager applied for and received a personal loan in 1999. Eventually the loan which was used to purchase a boat and an icebox were successfully repaid through the fish sales. Informants explained that the difference between the funded project and the individual loan was the level of responsibility. When an individual had ownership of all materials and finances the business venture was successful and the loans were repaid. When compared to the fishing project, supported and funded by the organizations mentioned above, a group was responsible, instead of an individual, and misuse of funds by the group, since no one was specifically responsible, resulted. The success of the individual venture has resulted in others copying the first individual and a total of 6 individuals with boats and iceboxes are present in the village and transport and sell fish in Lae in 2011.

Many aspects of the individual fishing venture are similar to the project developed by the donor organizations. Basically, other village fishermen sell fish to the person with the icebox and then these fish are taken to Lae and sold. An icebox filled with fish will gross anywhere from 600 to 1000 kina depending on number and size of the fish. The boat owners make, on average, 2 trips to Lae per week. Betel nut purchase and sale along the coast between Kamiali and Lae also occurs. Selling fish and betel nut in Lae is profitable and will likely continue to be so into the future. The fisherman interviewed believes that even if fish become less abundant the fish prices at the market in Lae will continue to be good.

Ocean resources

The ocean resources collected are primarily fish, although turtles, shark and dugong are also caught. These resources differ in the ease of catch, abundance, market value, preservation length, quality and taste. Fish with the highest overall ranked importance within the village are snapper and red emperor due to the high market resale value and quality of meat. These fish are the easiest to catch as well and on average 12-13 fish can be caught per day which totals around 100 kilos of fish per month. The third ranked most important fish include rainbow runner, large tuna, big mouth, and mackerel. When compared to the fish ranked as being of 'first' importance, the quality, market value, catch frequency and abundance is lower. Details of ocean resources caught can be reviewed in Table 3. Map 5 shows locations of the coastal resources and immediate ocean resources.

Table 3: Ocean resources ranked according to importance and the frequency of catch.

Rank	Fish name	Catch frequency	Reasons for ranking
1	Red emperor	2nd	<ul style="list-style-type: none"> -Best quality -highest value in markets -Tasty fish to eat -Can sell to other villages and/or Lae markets <hr/> <p><i>Catch frequency/amount:</i> 12-13 fish caught in one day – fish school in one area 1 fish weighs 8-9 kg -easiest to catch during the new moon Approx. 100 kilos in one month</p>
2	Snapper	1st	<ul style="list-style-type: none"> -Same as red snapper but slightly less <hr/> <p><i>Catch frequency/amount:</i> 12-13 fish caught in one day Approx. 100 kilos in one month</p>
3	Rainbow runner	10 th	<ul style="list-style-type: none"> -Quality less than the first 2 -Tastes good -sells for less than snapper or red emperor <hr/> <p><i>Catch frequency/amount:</i> Rainbow Runner: catch 3-4/day, 1day per month Mackerel: catch 2/day, 5 days/month - when one can find these</p>
	Tuna – large	9 th	
	Big mouth (ikura)	6 th	
	Mackerel	8 th	
4	Yellow fin	3 rd	<ul style="list-style-type: none"> -taste is ok -Selling price is lower -Doesn't preserve on ice very long <hr/> <p><i>Catch frequency/amount:</i> -catch 10/day -Fishes for yellow fin 2-3 times/month -one school is about 800-900 fish and are easily caught</p>
5	Trevally (imangari)	5 th	<ul style="list-style-type: none"> -Same as qualities as yellow fin <hr/> <p><i>Catch frequency/amount:</i> -Catch fewer than large tuna about 2-3 fish/day -1 fish = 10 kg -better fishing during a full moon</p>
6	Emanu	7 th	<ul style="list-style-type: none"> -Low quality

			-Low price -Soft texture when eating <hr/> <i>Catch frequency/amount:</i> -Catch 10-12/day -fish about 2 ft long and weigh 10-15 kg -better with new moon
7	Tuna - medium	4 th	Same as Emanu
	Tuna - Small		<hr/> <i>Catch frequency/amount:</i> -catch 8-9 per day, about 4-6 days/month
8	Sail fish (blue marlin)	11 th	-Same as Emanu <hr/> <i>Catch frequency/amount:</i> -Catch 1/year -really big fish need thick lines and a big boat
9	Turtle	12 th	-Just for eating – not sold <hr/> <i>Catch frequency/amount:</i> -Occasionally caught 3-4/year
10	Shark	13 th	-Eats the meat -Sells the fins for a high price <hr/> <i>Catch frequency/amount:</i> -Catch 1/ year – big fish
11	Dugong	14 th	-Eat the meat – tastes like pig Not sold <hr/> <i>Catch frequency/amount:</i> -catch <1/year (not any more)

Men, for the most part, are the ones who ocean fish and women rarely venture to the ocean. The number of women who fish in the farther out ocean area has increased over time, but is still rather limited. The main types of fish caught are red emperor, snapper, yellow fin, and tuna. The total number of fish collected ranges from 5 to 80 fish per day, where the average number caught is around 21 per day. The average number of fish caught per day in 1996 was 43, which is double of what is caught in 2011.

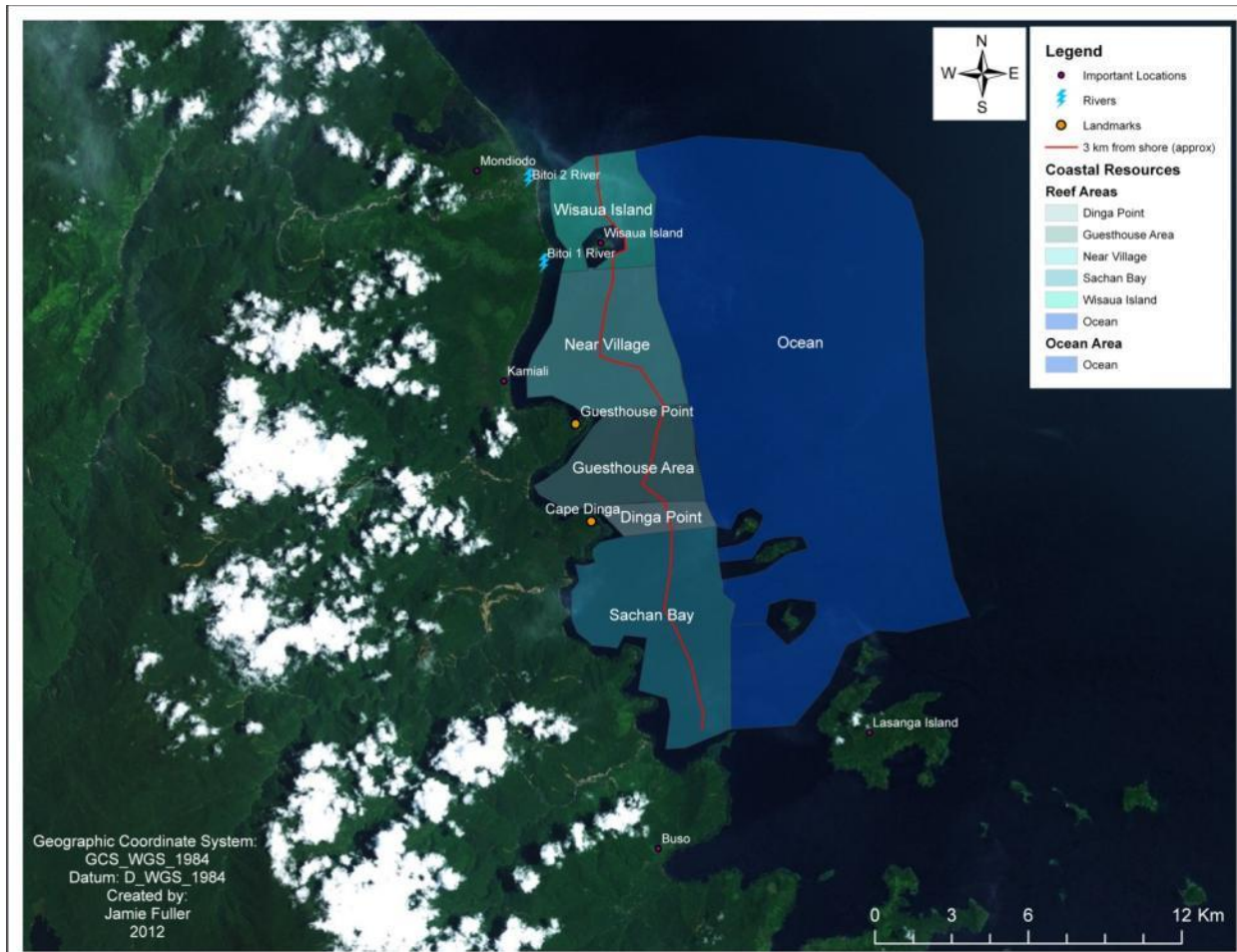


Figure 12. Kamiali coastal resources.

The majority of men have noticed a decrease in the abundance of ocean fish and, to make up for this, most indicated they fish more days per week. In 2011 most men fish 2-3 times per week and during 1996 it was more common to fish 1-2 days a week. Some men reported fishing the same number of days but noticed the fish are harder to catch in 2011 so they must work harder. Another way to make up for the decreases in fish abundance is by navigating to different and more distant locations. The areas in the adjacent ocean that are fished in 2011 vary among the fishermen, but all reported traveling distances exceeding 3 km and others claimed to travel over 30 km away. The direction of travel is past Cape Dinga towards Sachan Bay or seaward of Wisaua Island (Figure 12). In the past, circa 1980, ocean fish could easily be caught within 3 km of the village, and all informants reported that in 1996 they fished much closer to the village area than they do in 2011.

The percentage of fish kept for consumption or sold has changed minimally since 1996, however almost all informants reported selling some percentage of their ocean fish. Only a few informants reported selling more fish in 2011 than in the past and the remainder reported no change in the number of fish they kept or sold. One reason for the slight increase in fish sales was due to the availability of ice and freezer boxes used to preserve fish so they could be sold in Lae or other markets. However, in 1996 the fishing project began and other individuals began to purchase

boats and iceboxes. It is likely that a larger change in fish sales would occur if a day prior to 1996 was chosen as the reference date for the survey questions. Another reason given by informants for selling more fish in 2011 than in the past is for households to have more money to buy goods such as kerosene, clothes, fishing supplies and other store-bought items.

Informants unanimously reported their view that the cause for the decrease in fish was due to an increase in the number of fishermen and young boys, who have started fishing at an earlier age. Other reasons cited for ocean fish having declined over time are: improved fishing techniques, technologies, better bait, more outboard motor boats, and more commercial fishing companies frequenting the waters off of Kamiali.

Changes in ocean fishing equipment

While many of the fishing techniques used to catch fish have remained similar over time the materials used to make spears, hooks and nets have changed. Hooks and nets are used in both the ocean and reef areas, while spears are only used in shallower sandy or reefed areas. Hooks that were traditionally made from shell and turtle bones were previously replaced with an upward bent nail. In 2011, the 'bent nail' is considered a 'traditional' hook (Figure 13). Over the past 10 years manufactured hooks have become more available and are increasingly used. The advantage to the manufactured hooks is the variety of sizes (01 - 08) (Figure 13). This change allows the fishermen to adjust the size of the hook to the size of the fish they desire to catch. In addition, the manufactured hooks are more efficient at keeping the fish hooked. As a result, various ages and sizes of fish can be caught according to hook size. Manufactured sinkers are also more readily available and more efficient when sinking a line because a loop is engineered to the top. The traditional sinker used was by affixing a rock with additional string to the line, the rock would frequently come loose and fall off. The weight and strength of the fishing lines have also increased over time and are readily available.



Figure 13: From left to right a manufactured sinker, 5 fishing hooks used currently with the various sizes written below, and 2 'traditional' hooks. The pen and notebook paper indicate relative size.

Last, traditional nets had 3–4-inch gapped netting and were made from local materials, while the newer nets, introduced during the early 1990s, have 2 inch gapped netting and are made of nylon or a similar material.

The use of outboard motorboats, stronger lines and bigger hooks has made it possible to catch more and larger fish. The larger, more stable boats allow for larger fish and the motor allows longer distances to be covered in a shorter period of time. Trolling techniques are also more successful with outboard motorboats. In 2011, for example 1-2 sharks are caught per month, whereas in 1996 no one reported catching sharks. The fishermen consume the shark meat, but the fins and tails are sold in Lae for a high price, around 200-300 Kina/100-150 USD.

Reef resources

The reef resources collected are fish, sting ray, turtles, sea cucumbers, sea urchin, and puffer fish. When the informants were asked to list reef fish only the most common species were listed due to numerous species inhabiting this coastal area. The local language was used to name each species and when possible, the common and scientific names were also added. Fish naming schemes in the local language can be difficult to interpret because sometimes one species has multiple names or multiple species have the same name. For example, the local language can have different names for fish of a different sex, age or color while the species remains the same. The local language can have one name for different fish species that all have similar body types and coloring. In some cases, the local naming scheme may have little regard for what the fish looks like, but instead is based on where in the reef the fish resides.

Reef resources collected range in local importance according to the ease of catch, quality of meat, size, market value, and abundance (Table 4). The highest ranked group included only fish; these fish are larger, have better quality meat and are easiest to catch / more abundant. The second group includes stingray and turtles and the quality of the meat, market prices and ease of catch are lower. While turtles are consumed, the leatherback turtle is not. The leatherback turtle comes to the beaches of Kamiali to nest and has been protected since 1996. Local and international involvement and protection has influenced the village to cease the traditional consumption of these turtles and their eggs. The third ranked group is all fish as well, however these fish are rarely consumed by people and usually used as fish bait or to feed animals (e.g. dogs, cats, pigs). The last group includes sea urchins, sea cucumbers and puffer fish. Sea urchins and puffer fish do not hold a high market value but are accidentally caught when fishing. Sea cucumbers are valuable to sell in the market and are sought after, but are not very abundant in 2011.

Table 4: Reef resources ranked in order of importance and the reason for their ranking, each species is listed with their local, common and scientific name when possible.

Rank	Fish (local name)	Common name	Latin name	Reasons for rank
1	Imawe		<i>lutjanus semicinctus</i>	-Easy to catch
	Godobo			-Good meat
	Imongi (long nose)		<i>lethrinus harak</i>	-Larger size
	Ingwa		<i>pseudocheilinus hexataenia</i> ,	-Easy to find and usually can catch a larger number

			thalassoma jansonii, chlorurus bleekeri, bodianus mesothorax	-All get good prices (similar to red emperor) -Sells to Lae, other villages and community members
	Indu		pempheris oualensis	
	Bya (long nose)			
	Imogo leng		lethrinus harak	<hr/> <i>Catch frequency/amount:</i>
	Taru-lumwa		cheilinus fasciatus	
	Uarwe			-Usually fish the reef 1 day/week
	Ibubui		choerodon anchorago	
	Inato			-Catch per month: Approx. 30 fish weighing about 40 kg (by one person)
	Malisa – ikwa			
	Imogo		lethrinus harak	-If fishes 3 days/week or 12 days/month fish weight will total around 90 fish weighing about 120 kg (by one person)
	Iwangari		parupenous multifasciatus	
	Rabacule	Giant trevally	<i>Caranx ignobilis</i>	
		Octopus		
	Inasui		lutjanus gibbus	
	Inga (bobo, yaya, tra)	--(brown, yellow, green)	pseudocheilinus hexataenia, thalassoma jansonii	
	Baboula		lutjanus carponotatus	
	Iobwa			
	Arlowea		acanthurus pyroferus	
	Kumbu			
	Emungi			
	matapua			
2	Ouolo	Stingray		-Pretty good meat -Not good market value -Not as easy to find -Dangerous tail <hr/> <i>Catch frequency/amount:</i> -Catch 3-6 per year - Usually eat them or trade with someone in the village
	Do	Turtle		-Don't find as many -Traditional beliefs: 1 st born in the family shouldn't eat it

				<p>-Pregnant women will become very tired if they eat it</p> <p>-Doesn't sell well – price is too low</p> <hr/> <p>Catch frequency/amount:</p> <p>-Rarer to find</p> <p>-Usually just eat them or trade with someone in the village</p>
3	Gonibio (? ,brown, ?, blue, yellow)		amblygobius rainfordi, gomphosus varius, halichoeres puperescens, halichoeres hortulanus, halichoeres, prosopoeion	<p>-smaller fish</p> <p>-Used for bait</p> <p>-Used to feed animals (pigs, dogs, cats)</p> <p>-Does not sell them</p> <p>-Food for bigger fish in the reef</p> <hr/> <p>Catch frequency/amount:</p> <p>15-16 fish per week</p> <p>-too small to eat, usually just bring back for animals or for bait</p>
	Imakwa (long nose)			
	Bwamea		scolopsis ciliate, scolopsis bilineata	
	Ela			
	Golili			
	Gandanga (long nose) (Gankara?)		pteroaesio tile, pterocasesio trilineata	
	Gillimata (long nose)			
	Imwangi (bote, yaya)		carangoides feradai Carangoides, orthogammus	
	Nambidi		cheilodipterus quinquelineatus	
	Ikura		paracirrhites arcatus	
	Iyaya		lutjanus fulvus	
	Tomunduo		thalassoma amblycephalum	
	Iwagea			
	imbili			
	Baniga			
	Lalabe		odonus niger	
	Mandamua			
	Rabaika		macolor macubris	
	Iwili			
	Iking			
	Imala			

4	Krakbwa			
	wakeda			
	Tambulaun	Sea urchin	meiacanthus grammistes, meiacanthus grammistes, cheilinus fasciatus	-only older people are really allowed to eat it -spikes are poisonous Sleepy fish -feed to animals (pigs, dogs, cats) <hr/> Catch frequency/amount: By mistake 5-6 fish in a day
		Sea cucumber (many types – usually referred to by color)		-Usually just sell (except for the black one – eat) -ancestors ate it more -Sells for high price <hr/> Catch frequency/amount: 2-3 times per year – usually go searching if want to sell to market and make some money
	Inamboy	Puffer fish?		-poisonous -causes you to be too cold Disturbs bait and accidentally catch them <hr/> Catch frequency/amount: -Once in a while, on accident

Both men and women harvest resources from the reef. The main resources include fish and shells and who collects them is gender specific. Men mainly collect fish, however sea cucumbers, crabs, octopi, squids, and lobsters were also reported, but to a lesser extent, as being collected by men. Shells are generally collected by women in 2011, however in the past both men and women collected shells.

In 2011, men travel to the reefs about 2 days per week and anywhere from 10 to 250 reef fish are caught each day, with an average of around 35 fish. In 1996 the average number of days spent fishing on the reef was 3 and approximately 85 fish were caught per day, a decrease of over half. A small portion of the informants were young boys during 1996 and reported that they fished 5-6 days per week. Now they report that they fish the reef fewer days per week. Reef fishing locations have only slightly changed between 1996 and in 2011, but in general, the men travel further to fish at other, less frequented, reefs.

About a quarter of the people interviewed do not sell any of their reef resources, while the remainder sold about half of their fish to the local and Lae markets. In 1996 more fish were retained for personal use. The cause for this change was attributed by informants to the desire to buy more commercial products and, because there are fewer fish, it has become easier to sell fish for money.

Shells are usually collected on and around the reef areas and are easily seen on the sea floor in sandy or sea grass areas. One can walk or paddle a boat in shallow areas and look into the water to grab the shells or use a spear to pierce the soft side of the shell (Figure 14). The meat of the shell is eaten and the shell is used to make jewelry or it is traded.

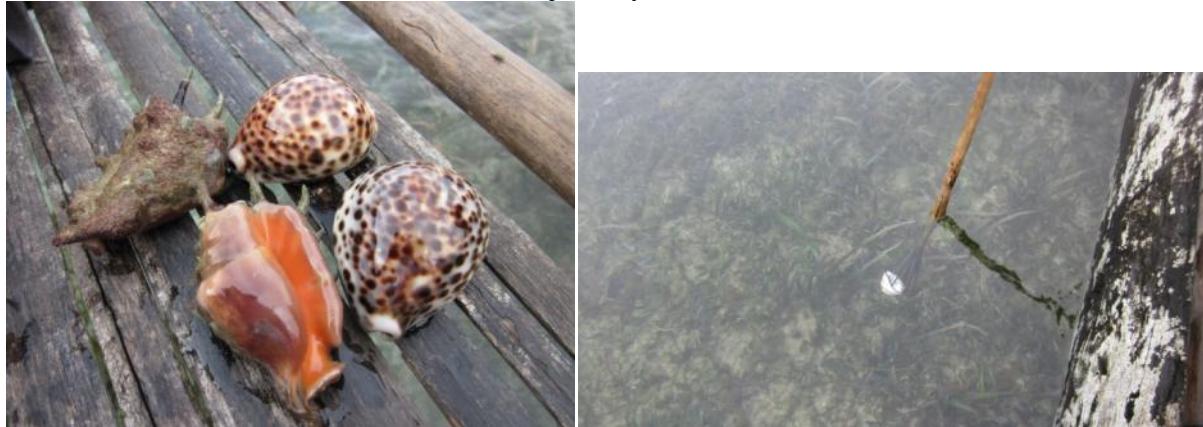


Figure 14: (Left) spider conch and tiger cowrie shells; (right) piercing a cowrie shell with spear.

In 2011 women collect shells 1-2 days per week and on average harvest 20-30 per day. In 1996 very few women dove for shells, but those who did so the same number of days per week as they do in 2011. Harvests in 1996 and earlier were nearly double compared to in 2011; some informants reported collecting over 100 shells per day. One contributing factor to the decrease in shell abundance has been the availability of goggles, which has made diving for these resources easier and their use has steadily increased since the 1980's. In general, shells have not been and are not sold in markets. Again, it was universally apparent to informants that the abundance of reef resources has declined and this decline was attributed by the informants to a larger population and more people frequenting the reef.

Changes in reef fishing gear

The methods used to collect reef resources include poison rope, spear (single and multi-pronged), and hook and line. The techniques for collecting fish have remained relatively similar between 1996 and 2011, however the materials used to make fishing equipment have changed. The traditional method for night fishing and diving for shells or crustaceans was to use the full moon for light. Items that are used more often in 2011 are flashlights and propane lanterns and these have made night fishing and shell diving more successful. Spears also have changed over time due to metals available from urban centers. There are two types of spears, one with a single point and one with multiple prongs at the tip. The single pointed spear (Figure 15) was once made from bamboo or other cane materials. In 2011 many of the spears have a metal spear point affixed to them. The time at which this improvement was used by a majority of fishers is unknown. The second type of spear has multiple prongs (Figure 16) and was traditionally made from cane or bamboo. In 2011 these prongs can be made from metal (Figure 11). Many

individuals use both the traditional multi-pronged spear and the metal multi-pronged spear. There is also a trigger style spear made from a long, pointed metal bar and a strip of rubber, which is used to shoot the pointed bar at fish visible in the water (Figure 17).



Figure 15: Long pointed spear used for spearing fish and moving a boat in shallow water.



Figure 16: Spears made from different materials, (left) traditional cane constructed multi-pronged spear and (right) a multi-pronged spear made from metal tongs.



Figure 17: Long metal bar spear with rubber trigger system.

Another method used to catch reef fish is known as poison rope, dynamite leaf or dynamite, however it is not an explosive of any sort. Instead, it is made from a tree that is lethal to reef fish. The thinner branches of the tree are twisted and mashed until a white milky liquid is produced. The liquid is then released into the water near the reef where fish seek refuge. Once the liquid comes into contact with the fish they die instantly, float to the surface and are collected. Poison rope is not thought to affect the people who consume the fish, do permanent damage to the water, or kill the coral. Poison rope is used as regularly in 2011 as it was in the past. A few of the informants understood that poison rope kills the baby fish in addition to the desired adult fish and this was not good for fish populations. Nonetheless the method is still used frequently due to its effectiveness.

Animal Husbandry

The majority of people have dogs for protection, hunting and as pets. Cats are also common as pets and help reduce pest problems (e.g., cockroaches and rodent). Both dogs and cats eat bait fish and extra tubers and vegetables from the gardens. Pigs are also kept to eat, breed and sell. The pigs are usually penned but allowed to roam freely in the village area during the day. Pigs are penned at night so that crocodiles do not eat them. Male pigs are usually sold either as a piglet or full grown for 400-800 kina, while female pigs are kept to breed. In 1996 approximately 6 households had pigs and in 2011 that number is 7. Many people like to have pigs for the meat and for the large sums of money they can get when sold. The money from selling a pig is usually put towards school fees or other commercial goods. Pigs are also eaten during festivals, celebrations, and weddings. Other animals, such as chickens, are present in Kamiali but are not common. Three of the households interviewed raise chickens, which are bred for meat and eggs. Chickens are not penned and roam free all the time. There have not been many changes in animal husbandry over time, except for a slight increase in the number of families who take care of pigs.

Forest Resources

Forest resources collected include house materials, firewood, canoe trees, bark fibers, and small game. All of these resources were reported to be from the forested areas near to the village. In

2011, the locations used to collect these resources include the lower mountains behind the village, 5 km towards Blue Mountain, on the track towards the Cliffside camp, and some reported traveling to Sachan Bay and carrying the materials home by boat. While most of these locations have remained relatively the same since 1996, almost all people noticed an increase in the distance traveled to harvest timber. Informants attributed the cause for increase in distance traveled to the increase in population and the number of houses that have been built in the village recently.

Houses were described to have changed in many ways since the ancestors' time and additional changes have occurred since 1996. The ancestors lived in gender specific houses with most of the extended family. Increasingly over time the nuclear family has begun to build multiple separate houses, an influence from western culture. Since 1996 houses have become larger to accommodate larger families, extended family and in-laws who visit from other villages (Figure 18-right). In 2011 even smaller houses have grown in size, as seen in the left image in Figure 18, a growth that has occurred in a relatively short time period. A house can last anywhere from 4 to 12 years depending on how much maintenance is conducted over that time. Sago palms are used for roofing materials and these must be replaced about every 2 years. Another observed change is the access to and money for nails. Cane stems are still used for strapping and binding a structure but are used to a lesser extent in 2011 due to the availability of nails. In general, the average house uses over 300 trees, canes and other plants to initially construct and this doesn't include additional materials needed for maintenance over time.



Figure 18: (Left) an old house and new house constructed side by side showing the size increase. (Right) a larger house built to accommodate many people.

Another forest resource that informants believe has been greatly influenced by population growth is the amount of firewood collected. The amount of wood collected in 1996 was 3 bundles per week (per household) and in 2011 4-5 bundles are collected per household. Figure 19 shows two women with firewood bundles collected from the beach (drift wood) and garden area. The woman on the left is carrying approximately one bundle, while the woman on the right has two bundles of wood and a bilum of vegetables.



Figure 19: Two women carrying firewood back to the village that had been collected from the garden and beach areas.

Canoe trees are culled from various areas around Kamiali. All canoes have a small platform to make additional space for transporting goods and an outrigger for stabilization. Canoes can vary in size and the duration of use (Figure 20). A smaller canoe used for 1-3 years is made from a tree that has grown for 8-9 years. A canoe that can be used for 5-8 years is carved from a large tree that has grown for 12-15 years. Larger canoes are also more stable on rough seas. The left image in figure 15 shows an average sized canoe carrying garden harvests to be paddled to the village and the image on the right in figure 15 is a large canoe. Just over half of the informants reported planting canoe trees in or around their garden area or near the swamps, while the others harvest wild growing trees from the surrounding area. Since many of these trees are planted a family as a whole tends to them and will use them according to the tree age and family's needs.



Figure 20: (Left) a medium sized canoe with outrigger and platform carrying garden harvests; (right) large canoe in foreground and two smaller canoes in the background.

Small game hunted in the forest includes echidna, wild pig and wallaby; however cassowaries are also caught for meat and eggs occasionally. Dogs are usually used to track and hunt most of these animals, otherwise traps are set. Although very few of the informants reported hunting, those that did said they catch around 4 echidnas and about 2 wallabies per month. Wild pigs root around and destroy gardens so they are caught by setting wire traps. In general, the average number of wild pigs caught per year is around 7 for the whole village. The pigs are eaten and

shared among the family and friends. Overall, no changes have been observed in the abundance of small game over time the reference time period.

Seasonal Calendar of subsistence tasks and events

The subsistence and livelihood tasks vary throughout the year and are driven by seasonal and environmental factors. An educational tool used to teach the children in the elementary school concerning typical seasonal activities and tasks was provided by one of the teachers (Table 5). This table indicates the typical environmental and seasonal characteristics associated with agricultural processes, fishing and animal husbandry cycles, and community events in a typical year. Since this table was created through extensive environmental and subsistence knowledge and it is a useful guide for assessing any changes in the village's livelihood system that may occur over time.

Table 5: A seasonal calendar delineating environmental characteristics, livelihood tasks and community events.

Month	Season	Environmental changes	Agriculture processes	Hunting, fishing and animal husbandry	Sporting and other community events
January	Normally wet and dry	-plants getting new leaves and flowers	-cut new gardens and harvest food	- new moon -small fish swim ashore -yellow fin in deep blue sea	-parade for schools, aid post cemetery and community
February		-High tide during day/low tide at night – usually calm sea	-clear and clean gardens to get ready for planting -cut bushes in gardens -burn, harvest and clear garden areas for planting new suckers	-dog mating	-enrollment for workers, school and collect school fees
March			-chop down trees for canoes -chop other trees in gardens to burn	-good time for fishing in the ocean -fishing, searching for yellow fin -animals mating -hunting in the jungle	-fishing, selling and buying food stuff

April	Wet only	-plants loose leaves and flowers -low tide at day/high tide at night	-light gardening	-turtles stop laying eggs -fishing within the shore	-village funeral feast -house building
May		-rough seas	-some gardens usually destroyed by flooding	-catching fish by nets along shore	-school cleaning activities -birth (human)
June			-weeding, harvesting and planting only -collect tulip along brush (leaves for consumption)	-hunters in the nearby forest only	-village cleaning -water supply visits and fixes
July		-erosion and plant damage	-visit gardens	-mosquitoes spread -hungry animals looking for food	-mini games every noon -marriage
August			-inspection of gardens -collect greens -food consumption -harvest pitpit		-practice for independence events
Sept.	Normally wet but mostly dry	Plants putting on leaves and flowering again	-clear and cut gardens again		-sing-sing (traditional dance) -friendly games or tournament
October		-fine clear weather during day and night -calm sea, still rivers and streams		-enjoy fishing, diving and hunting again	-graduation preparation -other activities stop
Nov.			-cut new gardens -harvest food	-turtles laying eggs again -dogs birth puppies	-preparation -new songs composed

December		-high tide at mid-day/low tide at mid-night	-transfer veggies to homes in preparation for Christmas	-gardening, fishing and all activities end	-Christmas eating and praying -friendly tournament/games - sing-sing (traditional dance)
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Socio-economic information

From the survey data and informants interviewed it is apparent that there are approximately 6 different economic classes within the village. The socio-economic status of a household is strongly related to work ethic and only slightly related to education. The drive to work hard enough to have surplus resources (fish and/or crops) provides families with additional monetary income to purchase other resources such as a metal roof, nails for house construction or the ability to pay school fees (Table 6). The largest economic class is group 3, which is characterized as relying mainly on gardens and each household has about one half of a hectare garden.

Other status symbols are store bought items such as kerosene lanterns, canned meat, axes and additional clothes. Interestingly, while fish and other protein sources are relatively abundant, many people purchase canned meat products. The most common canned meats are fish and corned beef. In addition, the canned meat is seen as a delicacy because of the flavoring and high salt content.

Table 6: Socio-economic divisions of the Kamiali community information from the semi-structured interview.

Economic Rank (approx. number of households)	Identifying factors	House construction/materials	Schooling	Other
1 (6)	Owns a village store	-Most have sago palm roofs, one has a tin roof -All have nails	Most went to school, some finished grade 6	-Sell tin meat, rice, sugar, biscuits, tea, coffee, matches, noodles
2 (5)	Fishermen with iceboxes – fish most days and buy fish from villagers and sell in Kamiali and Lae	-Most have sago palm roofs, one has a tin roof -All have nails	All have finished secondary school, none have gone to university	-Travel to Lae twice a week; -Have started selling betel nut as well.
3 (1/2 of village~21 households)	Have more gardens and travel to the gardens 4-5 times a week – sells some of the harvest	-All sago palm roofs -All have nails	Most have completed primary school and go on to secondary school	-Usually sells 1 bilum of banana, cassava, and sweet potato -Most of their children go to secondary school

				-Live in separate family houses
4 (15-16)	Gardeners – travel to the gardens 2-3 times per week – and sells some of the harvest	-All sago palm roofs -Most do not have nails	Usually complete primary school and only a few completed secondary school (2-3 adults) -Most of the children do not go on to secondary school	-Sells a few sweet potato, bunches of banana and cassava -Live together in the family house/s
5 (8)	Fishermen who have very few gardens and rarely tend to the garden	-All sago palm roofs -no nails	-All have finished primary school	-Sell 1 basket/bilum of fish per week -Live in their own houses
6 (3-5 people)	Do not work much And only have 1 garden which is rarely tended to	-All sago palm roofs	-Most have finished secondary school	-Live with family or alone -Try to get free meals from community activities or invites to another house

Discussion

The people of Kamiali rely on a livelihood system that is based on subsistence production with some surplus that can be sold. The system is dependent upon ocean/reef and land resources. Informants report that the land, reef and ocean resources were once equally used to fulfill subsistence needs. However, over time, the quality and quantity of these resources has changed. These changes have been observed by the elders in the community who have the longest perspective of environmental changes. In addition, most of the other individuals interviewed have noticed similar environmental changes and degradation over the past 15 years.

From the interviews it appears that the resource that has experienced the largest degree of change are resources collected from the ocean, specifically it is noted that there has been a decline in the abundance of ocean fish caught by the village. Reef resources have also experienced declines in quantity and quality, but to a lesser extent. The change in abundance and quality of reef resources are believed by informants to be directly related to local fishing practices. The main explanation for both ocean and reef resource declines were human population increases over time. The population increases have resulted in large numbers of young boys who have begun to fish at a younger age. The ocean fish declines were also attributed to an increase in the number of outboard motor boats in the village, more commercial fishing in nearby, offshore, waters, and better fishing equipment. Another possible driver causing ocean and reef fish quantities to decline is the increased desire for monetary wealth and commercial goods. Access to markets and the availability of refrigeration (iceboxes) for fish preservation allows more people to sell

their fish at local and Lae markets. Thus, if market prices rise there will be more of an incentive to sell fish than to keep them for consumption.

Informants report that the garden area has also experienced declines in crop productivity, but not to the same extent as ocean and reef resources. The changes in garden crop productivity are related to insect infestation, soil quality and seasonal changes. For example, taro, a traditional and staple crop has been almost completely destroyed by an insect problem that began in the early 1980's. Initially, fallow periods were lengthened in an attempt to eradicate the insect, however the change was not effective. To maintain comparable harvests, additional new crops (corn and yam) and other crop varieties (Singapore taro and a cassava variety from Rabul) have been introduced. In addition, staple crops such as banana, sweet potato and cassava have been planted to a greater extent. Some of the informants also reported the shortening of fallow periods so that more crops could be produced, although this reduced soil fertility it is still practiced. Soil quality and moisture changes were observed most likely due to reported increases in ocean water infiltration and flooding events. Also, many comments were made by villagers concerning unpredictable seasonal changes that they attribute to climate change.

All informants interviewed regard the garden as a more stable resource than ocean or reef resources. The meaning of this comment is that villagers believe that they are always be rewarded with good harvests if they work hard in the gardens, but one can work hard at ocean or reef fishing and not realize good results. This view suggests that it is likely that agriculture will become more and more depended upon over time by the Kamiali community. In 2011, no additional irrigation, aeration, soil amenders, chemical fertilizers, or pesticides are used. However, if harvests continue to experience insect problems, decreased soil fertility and diminished productivity, it is possible that chemical additives or irrigation/aeration techniques may be introduced by the villagers to maintain or improve harvests. One can easily imagine this happening as the community becomes more connected with Lae and other locations via the nascent commerce that is taking place via the motorboats that have been purchased by members of the community.

The subsistence livelihood is heavily dependent upon the availability and quality of local resources. There have been numerous independent and collective observations of resource declines in Kamiali by the community and the responses by the community to these declines include traveling further afield from the village area in order to obtain quality resources, working harder to achieve returns similar to those achieved in the past, and altering resource collection methods. All of these modifications to livelihood activities indicate resources are being used at a rate that may not be sustainable over a long period of time. Population growth is attributed by the community as the most significant reason for coastal and forest resource declines. Population growth is thus also attributed as the reason for the community having an increased dependence on agriculture, on their garden area. According to the informants the point at which coastal resource quality began a downward trend was during the early 1970's when the population was estimated to be 200 people. Decline in the productivity of the individual gardens was reported to be the early 1980's, 10 years later when the population was around 300. The population has increased at a more rapid rate over time and the resource quality declines have followed. The current population is estimated to be at 1000 people and resources are perceived to be in a degraded state when compared to the condition of each resource in the past.

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