



Report of Partnership in Health Project (PiHP) 2011-2012



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Authors:

Dr. Hebe Gouda

hebe.gouda@pngimr.org.pg

Ms. Gwendalyn Vengiu

Gwendalyn.vengiu@pngimr.org.pg

Dr. Suparat Phuanukoonnon

suparatp@hotmail.com

Prof. Peter Siba

peter.siba@pngimr.org.pg

Edited by

Dr. Suparat Phuanukoonnon

Suparatp@hotmail.com

Phuanukoonnon@wehi.edu.au

Papua New Guinea Institute of Medical Research (PNG IMR)

P.O. Box 60

Goroka, EHP 441

Papua New Guinea

Phone 532 2800

Fax 532 1998

www.pngimr.org.pg

CONTRIBUTION AND DATA COLLECTION TEAM

Principle Investigator: Prof. Peter Siba

Head of Administrative office: Samson Akunaii

PiHP Scientific Co-ordinator: Dr. Suparat Phuanukoonnon

PiHP Administrative Co-ordinator: Jeff Lee

Scientific Support: A/Prof. Andrew Vallely, Dr. Hebe Gouda, Dr. Justin Pulford, Dr. Paul Horwood, Dr. Andrew Greenhill, Dr. Claire Ryan, Dr. Jo Wapling, Dr. Kevin Soli, Mrs. Lisa Vallely, Dr. Paul Harino

Hiri iHDSS: DSS team: Elias Namosha, (Co-ordinator) Benjamin Fasi, Lydia Kue

Clinical team: Dr. Patricia Rarau, Roselyn Nopa, Savarina Huliafi, Doris Manong, Theonilla Kware, Vicky Gabee, Sylvia Nao, Gary Neo, Morea Vaburi

Hides/Komo iHDSS: DSS team: Mexy Kakazo, (Co-ordinator), Michael Kapu, Biliam Degemba, Vilson Silas, Marryanne Hapolo

Clinical team: Emmanuel Hapolo, Gloria Munul

Asaro iHDSS: DSS team: Seri Maraga, (Co-ordinator) George Amorea, Jacob Kumai, Jacob Joseph, Alfred Alawaki, Rebecca Emori

Clinical team: Dr. Harry Poka, Margaret Lavuvur, Henny Andaken, Coroline Tomado, Janet Totave

Kar Kar iHDSS: DSS team: Penias Brown, (Co-ordinator), Nanim Brown

Clinical team: Dr. Regina Wangnapi, Ken Yaku

Nutrition: Gwendalyn Vengiua (Co-ordinator), Elizabeth Wawaga, Prisca Hezeri, Isabella Parapi, Noel Barry

Verbal autopsy: Miriam Vano, Helen Kave, Paul Kave, Nancy Kamil, Anne Wiwiao, Albert Sie, Sebeya Lupiwa, Irehe Vaigi, Sham Silas, Nancy Nabu, Naria Sukum

Administrative Office: Maria Gilpis, John Taime, Charles Pepe, Kim Papaso, Janice Gull, Lisa Kuvi, Nancy Iva, Samson Sasama, Rovleen Akunaii, Janice Gull, Onno Tai, Geua Diari, Nao Sibona

Driver: Johannes Haay, Gilbert Rodesi, Mao Mao Junior, Tom Jones, Masi Sima, James Wiluapa Samkui, Kudan Babu, Gerard Kaisom, Tom Frapo. George Aisa

Data management: Thomas Adiguma, Jacob Kumai, Douglas Diave, Lornah Samol

Data entry: Joanne Tibu, Collin Manase, Dorothy Leo, Deborah Harino, Susan Bebes, Jessica Kombeakali, Wati Kave, Morabi Joshua

LIST OF COLLABORATORS:

University of Queensland (School of Population Health)

Prof. Ian Riley; A/Prof. Geoffrey Marks

University of Tokyo (Graduate School of Medicine)

A/Prof. Masahiro Umezaki; Dr. Ayako Morita

University of Auckland (School of Population health)

Prof. Robert Scragg; A/Prof. Chris Bullen

University of Papua New Guinea (School of Medicine and Health Sciences)

Prof. Sir Isi Kevau

Walter and Eliza Hall Institute of Medical Research (Infection and Immunity Unit)

Prof. Ivo Mueller; Dr. Marc Pellegrini

University of Melbourne (School of Medicine)

Prof. Steve Graham

Mahidol University (Institute for Population and Social Research)

A/Prof. Sureeporn Punpuing; Dr. Malee Sanpuwan

Indepth Network

Prof. Osman Samkoh; Dr. Sanjay Juvekar

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A family in Hides shared and consumed food (garden food-vegetable and sweet potato) from the same pot

ABBREVIATIONS

CVD	Cardiovascular Disease
iHDSS	Integrated Health and Demographic Surveillance Survey
DSS	Demographic Surveillance Survey
EHL	Esso Highlands Limited
GDP	Gross Domestic Product
GIS	Geographic Information System
GPS	Global Positioning System
HIV/AIDS	Human Immunodeficiency Virus/Acquired Immunodeficiency Disease Syndrome
IMR	Institute of Medical Research
LNG	Liquefied Natural Gas
MDR-TB	Multi-drug resistant tuberculosis
NCD	Non-Communicable Disease
PIHP	Partnership in Health Project
PNGLNG	Papua New Guinea Liquefied Natural Gas
POM	Port Moresby
STI	Sexually Transmitted Infections
TB	Tuberculosis
VA	Verbal Autopsy

KEY FINDINGS

- This report presents preliminary data on:
  - West Hiri: Total Population 11,531
  - Hides/Komo: Total Population 13,220
  - Karkar: The first 5188 sampled
  - Asaro/Goroka: Total population 10,034
- Male to female ratios are high across all sites:
  - Hiri West 113:100
  - Hides/Komo 109:100
  - Karkar 110:100
  - Asaro/Goroka 103:100
- The mortality rate in Asaro (2011) of 10.96/1000 population is much higher than that observed in the Hiri West (2011) villages which was 5.98/1000 population.
- While TB and pneumonia remain leading causes of death, non-communicable diseases like cancer, diabetes and chronic obstructive pulmonary disease are causing significant burden in the populations studied thus far.
- All the sites studied are undergoing rapid population growth, in particular to Hiri. An increase in both the ratio of non-household structures and non-households structures per hundred villagers could potentially indicate an increase in economic activity in Hiri.
- Socio-economic indicators vary widely between sites. Educational attainment is higher in coastal populations. Hiri West has particular high levels of asset ownership most likely owing to its proximity to Port Moresby and a long-standing relationship with urban life.
- The nutrition transition is well underway in PNG, including some dietary habits that are potential risk factors for NCD. Hiri stands out for its considerable variety of food consumed. While Hides/Komo and Asaro report a similar dependency to garden food. However, Hides/Komo participants reported consuming far greater amount of soft drink and animal protein (chicken).

INTRODUCTION

The Esso Highlands Limited (EHL) led PNG Liquefied Natural Gas (PNG LNG) project is the largest ever resource project in the history of Papua New Guinea (PNG). Once fully operational, it will contribute more than a third of the PNG gross national product as well as provide royalties to landowners and taxes to the PNG Government. It is therefore expected that the project will contribute very significantly to the economic and social development of PNG.

A project of this size, however, is likely to have a significant impact on the way people live their lives in PNG and with lifestyle changes come changes in health. One key concern is the impact this project will have on those who reside nearest the sites of project activity. While the project is expected to raise standards of living through both employment and royalty payment in project impact areas, the project does also carry potential risk to the health of these same communities. During the construction phase (2010-2012), both the influx of a very large work force, significant movement of goods and people as well as the direct environmental impact of the construction may impact on the transmission and burden of malaria, TB or HIV/STI and other key health indicators in the project areas. Equally important, social changes such as the relocation of local residence and/or influx of migrants in the project areas may have a detrimental impact on the health and well being of affected population (Kitula 2006, Petkova *et al.* 2009).

Once fully operational the project is expected to produce gas and provide a stable revenue stream for a minimum of 25-30yrs. As has been observed in the context of other resources in PNG and elsewhere, significant changes in the life-style of project affected populations are likely to occur (Utzinger *et al.* 2005). Economic development typically leads to epidemiological transitions that see a decrease in infectious diseases like malaria and pneumonia and a simultaneous increase in non-communicable diseases like diabetes and cardiovascular disease resulting from changes in people's lifestyles (Amuna & Zotor 2008). Last but not least, the increasing economic activities in the project areas could result in a sustained in-migration and the establishment of settlements.

The PNG LNG project has recognised the potential health risks associated with the project and is determined to both monitor population health trends and conduct public health campaigns that both mitigate project impact and improve general population health status. For this reason,

PNG LNG has entered into a public-private partnership with the PNG Institute of Medical Research (PNGIMR) with the aim of monitoring the impact of the PNG Liquefied Natural Gas (PNG LNG) project on the health of population in project impact sites.

The PNG-IMR is monitoring the populations proximal to the two major impact sites in Hides and Hiri (impact sites), in order to assess the impact of the LNG project on the population's health status as well as provide the evidence-base for interventions targeting health problems attributable to PNG LNG studied while simultaneously helping to build the research capacity of IMR. PNG-IMR also monitors two other populations in sites distant from the impacts of the PNG-LNG developments. These are a highlands population in the Asaro Valley, Eastern Highlands Province and one coastal population in KarKar Island, Madang Province (comparison sites) (Figure 1). Changes over time in these populations will be compared to those observed in the impact sites (coastal to coastal and highlands to highlands).

The Partnership in Health Project (PiHP) was developed with the vision that EHL and the PNG-IMR will work together to develop a long-term collaborative relationship that facilitates innovation, new knowledge generation, education, training and sustainable capacity building for positively affecting health, social and economic development for Papua New Guinea.

Aims of the Partnership in Health Project (PiHP)

The purpose of the PiHP collaboration is to facilitate training, development and national capacity building of core scientific capabilities covering (i) demographic surveillance systems including monitoring and evaluation (ii) emerging infectious viral diseases, (iii) communicable and other vector-borne diseases (eg. Tuberculosis, malaria, sexually transmitted infections including HIV/AIDS), (iv) operations health care delivery and performance in rural settings, and (v) project management and financial stewardship.

Objectives of PiH Project

National capacity building: The long-term development and support of national scientific capabilities is essential for the future of Papua New Guinea. The PNGIMR has a strong established base of core scientific capabilities and has a goal of training and supporting national scientists in their research efforts. The scientific output of PNGIMR plays a key role in establishing national health policies and priorities. The PNG LNG Project potentially provides an opportunity to significantly expand the training and research opportunities for the next generation of Papua New Guinea scientists.

(i) Demographic surveillance systems for longitudinal monitoring and evaluation: Gathering objective scientific evidence related to births, deaths, in-migrations, out-migrations, socio-economic status and causes of death is fundamental to the development of appropriate policies and programs that address critical public health and poverty surveillance platforms that can systematically and objectively obtain longitudinal data at both a household and community level.

(ii) Emerging Infectious Viral Diseases: PNG has an extremely complex and varied ecological environment that supports a variety of medically important emerging infectious viral diseases (e.g., Dengue, Japanese SB Encephalitis and other Arbovirus) that can dramatically spread and produce high levels of illness and even death. The population burden of disease produced by these viruses is largely unknown but probably significant based on some initial PNGIMR research. As PNG further develops its transportation infrastructure in the remote interior of the country, the spread of viral diseases is potentially a significant public health and development problem. PNGIMR has some existing laboratory capability that could support active research and monitoring of viral diseases; however, this capability is limited. In addition, the national pool of trained Papua New Guinea scientists in emerging infectious diseases biology is extremely small. EHL and the PNGIMR thus intend to work together to increase the PNGIMR's capacity to conduct virology research.

(iii) Communicable and other vector-borne infectious diseases: PNGIMR has important ongoing research efforts in communicable diseases. Active PNGIMR projects in STI research and HIV/AIDS control are also ongoing. EHL has specific interest in supporting sustainable efforts directed towards communicable diseases issues that affect both children and adults. EHL and PNGIMR intend to work towards strengthening internal PNG communicable disease research capacity and work together on projects assessing the importance of communicable diseases in the project impact areas.

(iv) Operations research for health care delivery in rural settings: PNG is an overwhelmingly rural country with almost 85% of the population living in a rural setting. Delivery of rural health care services is extremely difficult and recent national level surveys indicate that major health performance indicators are significantly worse in rural versus urban settings. Development of sustainable health delivery systems for the rural environment is an ongoing challenge. PNGIMR and the EHL recognise the need to undertake operational research and to analyse the modes of health care delivery to support optimising health systems functionality. EHL has specific interest in supporting research on how to improve rural health care delivery and system performance in a sustainable manner.

(v) Project management and financial stewardship: PNGIMR has been extremely successful in attracting large international donor and research granting body support and has produced a large volume of high quality scientific research. The complexity of performing 21st century science has significantly increased and the need for equally sophisticated project and financial management has become increasingly evident. As a science-based organisation, PNGIMR has naturally focused on quality applied research: however, there is recognition that the quality of the management and financial support systems must be equal too the level of the scientific output. EHL has expertise in all phases of management including financial stewardship. The development of an enhanced institutional capacity for project and financial management is necessary if the PNGIMR is going to continue to grow and attract long-term external funding for complex research projects the benefit the Country.

The integrated Health and Demographic Surveillance Survey (iHDSS)

The Demographic Surveillance System (DSS) is a longitudinal population based surveillance system that collects individual and household level data. Routine demographic surveillance in the DSS will monitor events in the community over time such as pregnancies, births, deaths, in migration and out migration. A series of separate surveys will assess changes in the population. These surveys will consist of questionnaires designed to assess socio-economic status, reproductive health, diet and nutrition. Together these surveys make up the Health and

Demographic Surveillance Survey (iHDSS). Furthermore, through surveys as well as clinically-based studies, the project will focus on the burden of key infectious (incl. respiratory illness (pneumonia, TB, multi-drug resistant (MDR-TB) and influenza), vector borne (malaria, dengue), diarrhoeal and sexually transmitted disease (HIV/STI) and non-communicable diseases such as obesity, diabetes and heart disease.

The PiHP Progress Report

This report will summarise the most significant findings of the DHSS in all four sites to date and includes an update of the mortality surveillance results. This report will also present the results of two small pilot studies. A social and economic survey (SES) trial intended to test the survey in the field and a preliminary nutrition study which was designed to assess the range of foods consumed by the communities in all four sites.

Aims of PNGIMR/LNG iHDSS

There are three aims of collecting census data:

- To monitor the populations in all four sites (two project impact sites and two comparison sites) over time and monitor pregnancies, birth outcomes, in and out-migration, deaths and changes in educational, employment and marital status.
- To provide context, baseline data and a denominator for all other population-based studies conducted in the PiHP sites.
- To enable data linkage between studies not only at the individual level but also by household, geographic position and wealth quintiles

Ethics approval and community awareness

The project obtained ethical approval from the PNG Medical Research Advisory Committee (MRAC 10.17) and all amendments of future investigation will be reviewed by the MRAC.

Prior to commencing field work in each site approval was obtained from the Provincial Administrator and meetings were organized between a team from PNGIMR and the village leaders (councilors, etc) of each village. The overall aims and objectives of the project were communicated and any questions or concerns the village representatives had were addressed. Dates were set for more detailed awareness to be conducted within the respective communities where informative pamphlets were distributed and field staff answered any further questions.

The reporter system

The census survey is carried out by trained reporters (Figure 2). Reporters are individuals hired from the villages under surveillance that have attained at least a grade ten level of education and who are recommended by leaders in their community. Employing this system means that those conducting the census are people who know the community well and are themselves well known by the community.

Figure 2. Reporters in Asaro iHDSS Site



Training

Work in an area begins with at least three days of intensive training of village reporters by field managers and field research officers. One day is spent reviewing the Interviewer's Manual and conducting mock survey interviews amongst the trainees. The following two days are spent conducting the survey interviews in large groups (including at least one senior staff member) followed by extensive discussions about the problems during interviews and of any mistakes made in filling out the forms. Reporters are then encouraged to work in teams of two until they are fully confident to work alone.

Global Positioning System Mapping

Figure 3. Staff undergoing GPS training



A hand held global positioning system (GPS) receiver (Gamin GP 12 Personal Navigator) is used to obtain co-ordinates of households and road networks within the iHDSS study areas. All households and physical features captured by GPS are compiled into different data layers (spatial data layers) for the development of a GIS system. A topographic and administrative map (digital copy) of the study area has also been obtained from the National Statistical Office. The census data (containing individual information) will later be linked or geo-coded to household location and detailed maps of the study area will be created.

Socioeconomic Surveillance

The socioeconomic survey was adapted for PNG from an INDEPTH¹ questionnaire (www.indepth-network.org). Focus group discussions with PNGIMR field researchers provided a rich background to some of the current and prevalent issues concerning rural Papua New Guineans today. Drafted questionnaires were piloted in each field site by scientific officers.

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¹The International Network for the Demographic Evaluation of Populations and Their Health

Mortality Surveillance

Deaths are recorded by reporters at each census (once a year) and follow-up (three times a year). The baseline census in each site asks the respondent to recall all deaths that have occurred in the home since the 1st of January 2010. To ensure that all events are identified church registries and healthcare facilities are also checked for records of deaths. Each death is then followed up by nurses who conduct a structured interview known as a 'verbal autopsy'. This questionnaire is then reviewed by a physician to ascertain the cause of death.

Quality Control

All forms are checked upon arrival in the office and mistakes are highlighted; questions from the supervisors are followed up in the field the next day. Ten percents of all households are randomly selected and are interviewed a second time to crosscheck the quality of the data collected.

Data Analysis

The census forms are then sent to data entry clerks who enter the information into a PHP/MySQL Database program. Currently data is entered into a MySQL database at PNGIMR Goroka and Madang, and analysed with STATA 11 statistical software (StataCorp LP, College Station, TX).



Boera village: a view from the road approaching to the coastal road between Boera and Perebada villages

Brief Background

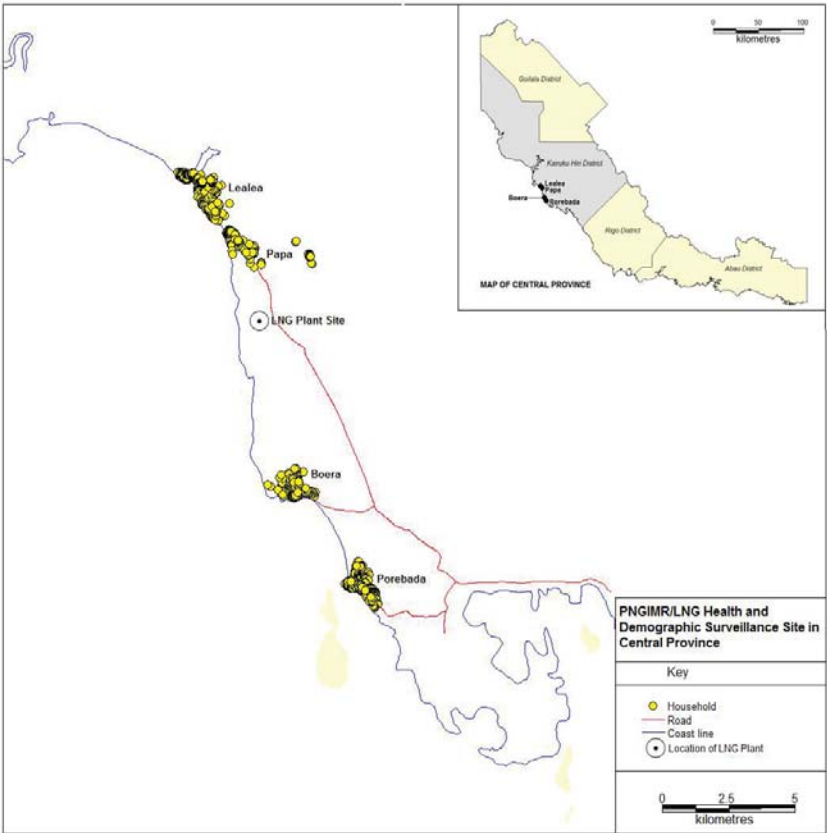
The DHSS covers four villages in Hiri West. Of these four villages, three are Motuan and one, Papa, is Koita (who are referred to as Koitabu by the Motu).

The Motu are an essentially maritime people. They were part of an Austronesian migration, which colonised the Papua dry belt – an area with limited agricultural potential - only a few centuries ago. Having settled in the area, the Motu formed alliances with the Koitabu, an inland people who lacked the technology to exploit the area's maritime resources. The Motu then established trading voyages, the Hiri, to the Gulf of Papua. They were expert in the production of clay pots and were able to exchange these for logs suitable for the manufacture of their huge canoes and of sago which provided reserves of a staple carbohydrate (Goldman 2008).

The area was attractive to Europeans, also a maritime people, who appreciated the low endemicity of malaria and took advantage of the safety of Fairfax Harbour. The result has been that the Motu have had longer and more intense contact with Europeans than any other group in the country. The colonial authorities suspended the trading voyages in the 1950s. The villages have been affected by their proximity to Port Moresby and traditional skills in fishing, gardening and other areas have been eroded (Dutton 1982).

Global Positioning System Mapping Results

Figure 4. Map of Households covered in the Hiri West iHDSS 2011



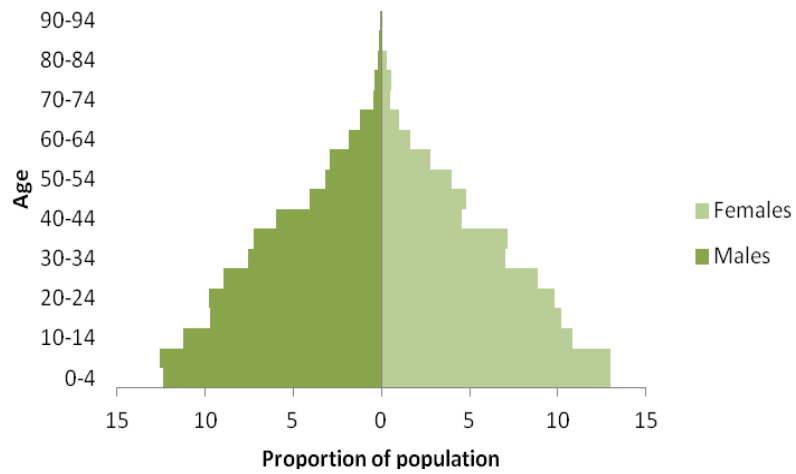
The Population

A total population of 11,531 has been recorded by the Hiri iHDSS.

Table 1. Total Hiri West (iHDSS 2011) population distribution by age and sex(%)

Age	All	Males	Females
All Ages	11531	6129	5402
0-4	1412 (12.3)	729 (11.6)	683 (12.6)
5-9	1475 (12.8)	775 (12.6)	700 (13.0)
10-14	1276 (11.1)	697 (11.4)	579 (10.7)
15-19	1134 (9.8)	582 (9.5)	552 (10.2)
20-24	1138 (9.9)	603 (9.8)	535 (9.9)
25-29	1031 (8.9)	548 (8.9)	483 (8.9)
30-34	856 (7.4)	475 (7.8)	381 (7.1)
35-39	829 (7.2)	449 (7.3)	380 (7.0)
40-44	627 (5.4)	371 (6.1)	256 (4.7)
45-49	505 (4.4)	251 (4.1)	254 (4.7)
50-54	419 (3.6)	196 (3.2)	223 (4.1)
55-59	330 (2.9)	178 (2.9)	152 (2.8)
60-64	208 (1.8)	118 (1.9)	90 (1.7)
65-69	129 (1.1)	74 (1.2)	55 (1.0)
70-74	59 (0.5)	33 (0.5)	26 (0.5)
75-79	51 (0.4)	22 (0.4)	29 (0.6)
80-84	30 (0.3)	15 (0.3)	15 (0.3)
85+	22 (0.2)	13 (0.2)	9 (0.2)
0-14	4163	2201	1962
15-64	7077	3771	3306
>65	291	157	134

Figure5. Population pyramid of the total Hiri West (iHDSS 2011) population



The population pyramid for Hiri West presents a picture of a society undergoing rapid population growth (Figure 5) with large numbers of namely young adults and children. This figure also reveals a larger number of young males compared to females of the same age groups.

Table 2. Population distributions by age and sex in four villages in Hiri West iHDSS 2011

	Porebada				Boera				Papa				Lealea			
	All	Males	Females	All	Males	Females	All	Males	Females	All	Males	Females	All	Males	Females	All
All Ages	5109	2700	2409	1733	936	797	1675	900	775	3014	1593	1421				
0-4	593	294	299	218	117	101	211	113	98	390	205	185				
5-9	651	332	319	203	104	99	233	131	102	388	208	180				
10-14	541	295	246	186	110	76	196	111	85	353	181	172				
15-19	508	260	248	168	96	72	179	83	96	279	143	136				
20-24	503	263	240	178	89	89	159	90	69	298	161	137				
25-29	458	252	206	161	90	71	146	71	75	266	135	131				
30-34	390	219	171	124	69	55	113	62	51	229	125	104				
35-39	376	208	168	111	58	53	129	70	59	213	113	100				
40-44	248	146	102	106	60	46	103	66	37	170	99	71				
45-49	228	116	112	75	35	40	65	31	34	137	69	68				
50-54	204	96	108	74	31	43	45	22	23	96	47	49				
55-59	147	73	74	50	31	19	46	21	25	87	53	34				
60-64	99	61	38	40	22	18	22	12	10	47	23	24				
65-69	67	36	31	19	14	5	15	9	6	28	15	13				
70-74	37	20	17	10	7	3	4	1	3	8	5	3				
75-79	28	13	15	5	1	4	6	5	1	12	3	9				
80-84	17	7	10	3	1	2	3	2	1	7	5	2				
85+	14	9	5	2	1	1				6	3	3				
0-14	1785	921	864	607	331	276	640	355	285	1131	594	537				
15-64	3161	1694	1467	1087	581	506	1007	528	479	1822	968	854				
>65	163	85	78	39	24	15	28	17	11	61	31	30				

Table 3. Description of age structure in Hiri West villages in iHDSS 2011

	Boera	Porebada	Papa	Lealea	2000 Census
Proportion of population aged 0 to 14 (%)	34.9	35.0	38.2	37.5	40.0
Proportion of population age 15 and 64 (%)	61.9	62.7	60.1	60.5	57.6
Proportion of population aged 65 and over (%)	3.2	2.3	1.7	2.0	2.4
Median age (years)	21	21	19	20.5	19.6
Dependency ratio	61.6	59.5	66.4	65.3	73.6

Table 4. Description of villages in Hiri West in iHDSS 2011

	Number of Households in 2000 census ²	Number of Households in 2011 DHSS	Population in 2000 census	Population in 2011 DHSS	Population Growth rate
Boera	155	245	1310	1733	2.8
Porebada	479	582	4510	5109	1.3
Papa	114	177	959	1675	5.7
Lealea	212	343	1978	3014	4.3

Table 5. Male to female sex ratios in the iHDSS 2011

Age (yrs)	Boera M:F (iHDSS 2011)	Porebada M:F (iHDSS 2011)	Papa M:F (iHDSS 2011)	Lealea M:F (iHDSS 2011)	Hiri M:F (iHDSS 2011)
0-14	107:100	120:100	125:100	111:100	112:100
15-64	115:100	115:100	110:100	115:100	114:100
>65	109:100	160:100	155:100	103:100	117:100
All ages	112:100	117:100	116:100	112:100	113:100

The proportion of the population between 0 and 14 is between 34% and 40.2% suggesting that the population of Hiri West is likely to grow rapidly over the coming years (Table 3). The dependency ratio provides an indication of the number of economically active people in relation

²National Statistical Office Census 2000

to those who depend on them. There are very few individuals over 65 in all these communities, so the high dependency ratios observed in this region is indicative of the high proportion of those under 14 to those between 15 and 64. Compared to national averages obtained from previous surveys and the 2000 national census, Hiri has a lower proportion of the population under the age of 14 (Table 4).

When the population of the four villages is compared over the 11 year period 2000 (as measured by the National census) and 2011 (iHDSS), all have experienced population growth with Lealea and Papa having grown more rapidly than the other two villages (National Statistic Office 2003).

A particularly striking result is the male to female ratios present in Table 5. For all four villages the ratio is about 112:100 males to females. In Porebada the ratio is as high as 117:100.

Births and deaths

Mortality rates in Hiri West vary across ages groups and averages 5.98/ 1000 population (Table 6).

Table 6. Number of deaths and mortality rates (/1000) by age in Hiri West iHDSS (2011)

Age (yrs)	Population in 2011	Number of deaths in 2011	Mortality rate /1000
0-4 ³	1412	10	7.08
5-14	2751	1	0.36
15-44	5615	27	4.81
45-59	1254	15	11.96
60-69	337	9	26.71
70+	162	7	43.21
All ages	11531	69	5.98

³Including stillbirths

Porebada has the lowest crude birth rate while at the same time exhibiting a relatively high crude death rate (Table 7). For these reasons Porebada has the lowest rate of natural increase amongst the four villages (15.1). The data also indicates that Papa and Lealea have the highest rate of increase and population growth. Further analysis of migration is necessary to better understand these trends and this is explored in subsequent sections of the report. Additional analysis will be made when data from the follow-up surveys is available

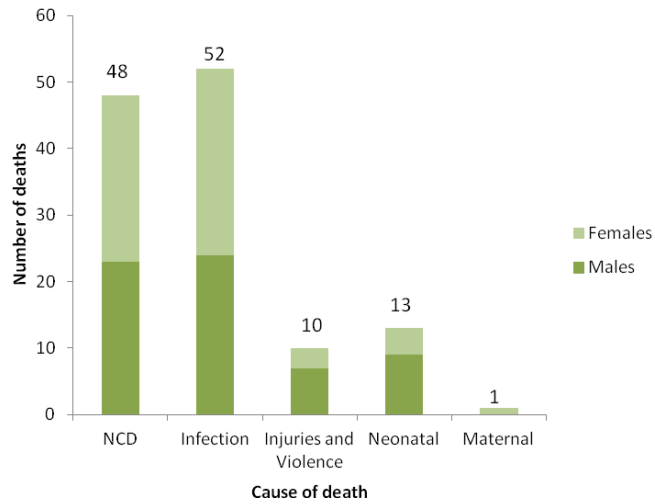
Table 7. Rates of birth, death and natural increase by village in Hiri 2011.

	All	Boera	Porebada	Papa	Lealea
Births/100,000 population	29.2	34.1	21.7	33.4	36.5
Deaths/100,000 population	6.3	9.2	6.7	4.2	5.3
Rate of natural increase	22.9	24.8	15.1	29.3	31.2

Causes of Death

A total of 125 completed verbal autopsy interviews from the Hiri West iHDSS have been reviewed by physicians and causes of death has been assigned. These deaths occurred between 2010 and 2012. While the majority of deaths in Hiri are caused by infectious diseases, they are closely followed by non-communicable diseases (Figure 6). Neonatal deaths, including stillbirths, are the third most common cause of death in this community. Only one maternal death has thus far been identified. In general, PNG has an extremely high maternal mortality rate.

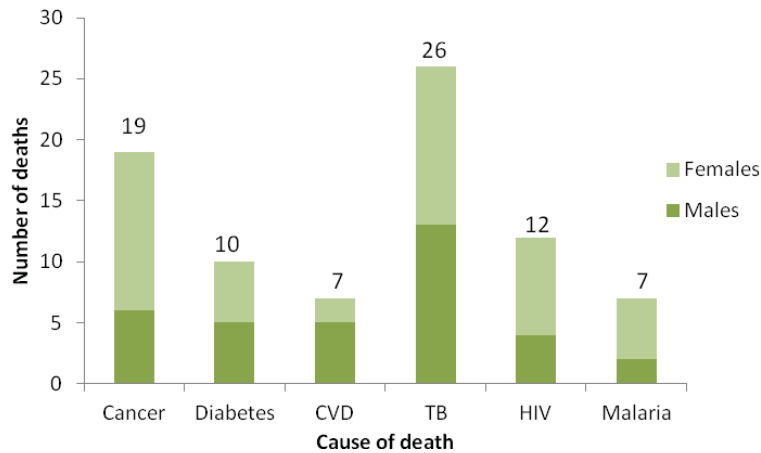
Figure 6. Number of deaths in the Hiri West iHDSS 2010 -2012 population by disease categories and by sex (N=124)



NCD = non-communicable diseases

The most common cause of death in the Hiri West iHDSS between 2010 and 2012 is tuberculosis. A total of 12 HIV/AIDS deaths were identified (Figure 7). Of the non-communicable diseases identified cancer was the leading cause of death. 46% of female cancer deaths were diagnosed with cervical cancer. Ten diabetes deaths were identified.

Figure 7. Six most frequent causes of death in West Hiri iHDSS 2010-2012, by sex (N=81)



TB = Tuberculosis

CVD = Cardiovascular diseases

Morbidity report

PNGIMR has established morbidity surveillance at Papa Clinic beginning in April 2011. The Salvation Army (SA) operates Papa Clinic; however, PNGIMR has a formal cooperating agreement with the SA that allows for active participation by IMR researchers. By mid-2011, the IMR morbidity surveillance expanded and now includes both the Boera Aid Post and Porebada Clinic. Both Porebada Clinic and the Boera Aid Post are operated by the Hiri provincial health service. PNGIMR has recruited 1 physician, 1 HEO, 6 nursing officers and 4 community health workers (CHW) in order to run the morbidity surveillance at the three clinics. PNGIMR provides assistance and technical guidance but does not have overall primary responsibility for operating the clinics and delivering clinic services to the communities. PNGIMR works within the formal health information system (HIS) established by the National Department of Health (NDoH). Through its in-house technical and laboratory capability, PNGIMR is able to provide a higher level of objective, laboratory diagnosis and confirmation. The routinely reported clinic data are a combination of laboratory verified diagnoses and syndromic clinical diagnoses. Syndromic diagnoses do not have objective laboratory confirmation and may over or underestimate the “true” burden of disease.

Over the 2011-2012 timeframe, there has been a significant increase in the overall utilization at the Papa and Boera clinics (Figure 8). The presence of PNGIMR staff has significantly augmented the clinics ability to efficiently and accurately evaluate, diagnose and treat patients. The caseload at Porebada Clinic (Provincial health management) has not increased overtime despite the large population who live in Porebada. PNGIMR believes that the lack of patient load change at Porebada Clinic is due to the management and staff attendance issues that have chronically impacted this clinic for many years. PNGIMR cannot partner with the Porebada Clinic due to these staff and management issues. Porebada residents likely seek needed medical care in Port Moresby, although some “spillover” to Papa is possible. However, PNGIMR review of Papa Clinic records does not indicate that Porebada residents are heavily utilizing the Papa Clinic.

Figure 8. Total Cases Seen at the Clinics in Hiri iHDSS

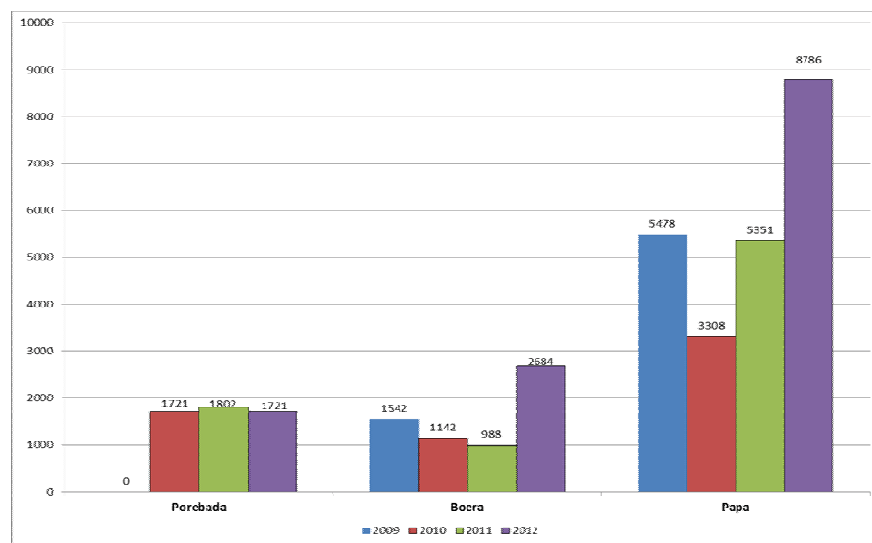
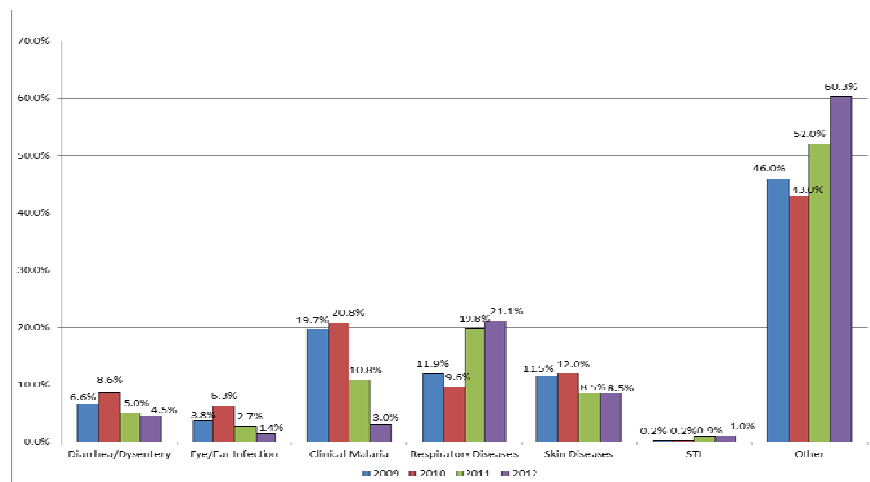


Figure 9 shows the decreased of clinical malaria cases reported by all Hiri clinics. Rapid Diagnostic Tests (RDTs) have become available and have been used at these clinics beginning in December 2012. Since December 2012, seventy-two (72) “fever cases” were tested with an RDT for malaria and all were negative. In the past, many of these cases would have been reported as “clinical malaria” based on typical syndromic presentation, i.e., presence of fever for three days.

The 2012 percent of skin diseases (8.5% of the recorded new patient load) has remained constant over the 2011 to 2012 time frame. The diarrhoea percentage has fallen overtime, i.e., 2010 (8.6%); 2011 (5%) and 2012 (4.5%). There was a major cholera outbreak in Hiri District in 2009-2010 that significantly increased the number of reported diarrhoea cases. PNGIMR can perform accurate microbiological diagnosis of cholera cases and continues to monitor the diarrhoea cases for a possible upsurge in cholera. In the PNG health reporting system, cholera cases are likely reported as “diarrhoea.”

The burden of respiratory disease is high and rising, i.e., 11.9% in 2009 to 21.1% in 2012. The cause of this rise is unknown; however, it may reflect a reclassification of clinical (fever) “malaria cases” to non-specific respiratory diseases. Diagnosed sexually transmitted infections (STIs) remain quite low at 0.2% to 1%.

Figure 9. Morbidity as percentages of overall case load at all Hiri clinics

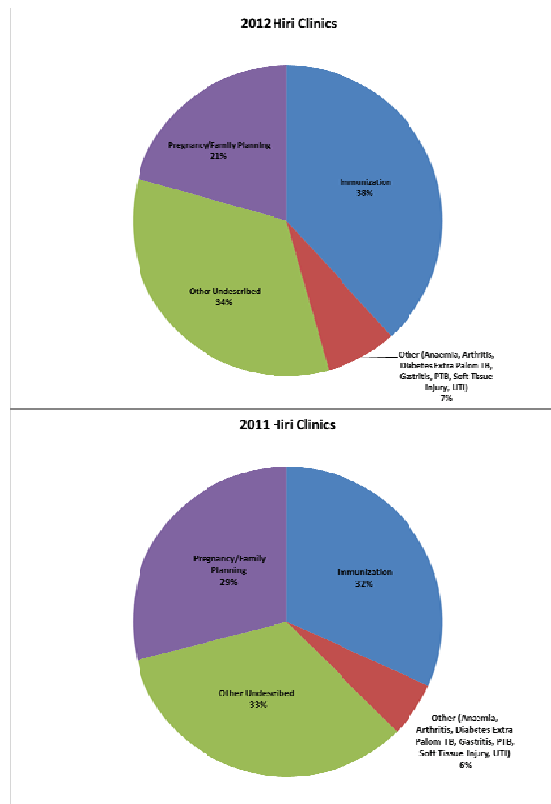


There is still a large number of “miscellaneous diagnoses” that are reported, accounting for almost 50% of the overall caseload. This extremely high miscellaneous caseload level is ubiquitous across the PNG reporting system and is observed at virtually all health centres across PNG. Overtime, PNGIMR can begin to improve this situation but it is a long-term issue and not amenable to a “quick fix.” PNGIMR will be able to make diagnostic improvements, as the POM Infectious Diseases Research Laboratory is able to receive and process clinical

samples from the Hiri clinics. This enhanced diagnostic/laboratory capability should make a significant difference. As observed with the simple addition of malaria RDTs, accurate diagnostic capability has an enormous impact on understanding the “true” (underlying) burden of disease in the community.

Figure 10 shows the percentages of “miscellaneous” that are routine services such as immunization and pregnancy related services (ante-natal, labour, post-natal cares). There is a small percent of other medical/injury diagnoses. Routine preventive and antenatal services are very common and represent an important and critical service of the clinics.

Figure 10. Disaggregation of Miscellaneous Category 2011 and 2012 from Hiri Clinics



Education

Table 8. Educational attainment amongst males by age in Hiri iDSS 2011 (%)

Age (yrs)	No Education	Some				National				Don't know or NA ⁴		Total
		Primary	Complete Primary	Some Secondary	Completed Secondary	High School	Vocational	Tertiary				
5-14	50 (3.4)	708 (48.7)	6 (0.4)	10 (0.7)	-	-	-	-	-	672 (46.3)		1,446
15-24	20 (1.7)	413 (34.8)	134 (11.3)	352 (29.7)	132 (11.1)	38 (3.2)	24 (2.0)	45 (3.8)		28 (2.4)		1,186
25-34	7 (0.7)	153 (15.2)	90 (8.9)	301 (29.8)	195 (19.3)	39 (3.9)	80 (7.9)	123		21 (2.1)		1,009
35-44	2 (0.3)	170 (21.2)	71 (8.8)	186 (23.2)	142 (17.7)	18 (2.2)	83 (10.3)	98 (12.2)		33 (4.1)		803
45-54	6 (1.4)	78 (17.8)	34 (7.8)	96 (21.9)	67 (15.3)	8 (1.8)	36 (8.2)	90 (20.6)		23 (5.3)		438
55-64	3 (1.1)	36 (12.5)	12 (4.2)	67 (23.3)	27 (9.4)	6 (2.1)	36 (12.5)	80 (27.9)		20 (7.0)		287
65-74	4 (3.9)	13 (12.5)	5 (4.8)	17 (16.4)	5 (4.8)	1 (1.0)	13 (12.5)	32 (30.8)		14 (13.5)		104
75-84	-	14 (37.8)	4 (10.8)	2 (5.4)	-	-	6 (16.2)	3 (8.1)		8 (21.6)		37
85+	-	3 (23.1)	-	1 (7.7)	-	-	1 (7.7)	1 (7.7)		7 (53.9)		13
All	92 (1.7)	1588 (29.8)	356 (6.7)	1032 (19.4)	568 (10.7)	110 (2.1)	279 (5.2)	472 (8.9)		826 (15.5)		5,323
NA =NA applicable												

⁴Not applicable here also refers to those children who have not started primary school.

Table 9. Educational attainment amongst females by age in Hiri iHDSS 2011 (%)

Age (yrs)	No Education	Some			Completed			National			Don't know or NA			Total
		Primary	Some Primary	Completed Primary	Some Secondary	Completed Secondary	High School	Vocational	Tertiary	NA				
5-14	30 (2.4)	644 (50.8)		5 (0.4)	6 (0.5)	-	-	-	-	-	580 (45.7)			1,269
15-24	14 (1.3)	395 (36.7)		133 (12.4)	323 (30.0)	101 (9.4)	32 (3.0)	14 (1.3)	35 (3.3)	29 (2.7)				1,076
25-34	11 (1.3)	184 (21.7)		93 (10.9)	247 (29.1)	149 (17.5)	28 (3.3)	33 (3.9)	71 (8.40)	34 (4.0)				850
35-44	6 (1.0)	177 (28.0)		73 (11.5)	151 (23.9)	94 (14.9)	10 (1.6)	44 (7.0)	60 (9.5)	18 (2.8)				633
45-54	15 (3.2)	127 (26.9)		75 (15.9)	72 (15.3)	48 (10.2)	-	43 (9.1)	64 (13.6)	28 (5.9)				472
55-64	6 (2.6)	79 (33.6)		22 (9.4)	46 (19.6)	22 (9.4)	1 (0.4)	21 (8.9)	22 (9.4)	16 (6.8)				235
65-74	3 (3.7)	29 (35.8)		9 (11.1)	5 (6.2)	3 (3.7)	-	4 (4.9)	7 (8.7)	21 (25.9)				81
75-84	2 (4.9)	18 (43.9)		3 (7.3)	-	-	-	2 (4.9)	-	16 (39.0)				41
85+	-	5 (55.6)		-	-	-	-	1 (11.1)	-	3 (33.3)				9
All	87 (1.9)	1658 (35.5)		413 (8.9)	850 (18.2)	418 (9.0)	71 (1.5)	164 (3.5)	260 (5.6)	745 (16.0)				4,666

NA = Not applicable

Employment

Table 10. Occupational types amongst males in Hiri IHDSS 2011 (%)

Age (yrs)	Professional	Skilled	Unskilled	Subsistence	Current Student	Unemployed	Military	Don't know or NA	Total
15-24	10 (0.8)	18 (1.5)	261 (22.0)	117 (9.9)	471 (39.8)	234 (19.8)	1 (0.1)	72 (6.1)	1,184
25-34	72 (7.2)	68 (6.8)	463 (46.1)	126 (12.5)	29 (2.9)	227 (22.6)	10 (1.0)	10 (1.0)	1,005
35-44	83 (10.3)	65 (8.1)	360 (44.8)	122 (15.2)	15 (1.9)	131 (16.3)	11 (1.4)	16 (2.0)	803
45-54	73 (16.6)	42 (9.6)	143 (32.6)	82 (18.7)	5 (1.1)	72 (16.4)	6 (1.4)	16 (3.6)	439
55-65	60 (20.9)	23 (8.0)	57 (19.9)	78 (27.2)	2 (0.7)	59 (20.6)	-	8 (2.8)	287
All	298 (8.0)	216 (5.8)	1284	525 (14.1)	522 (14.0)	723 (19.5)	28 (0.8)	122 (3.3)	3,718

NA = Not applicable

Table 11. Occupational types amongst females in Hiri iHDSS 2011 (%)

Age (yrs)	Professional	Skilled	Unskilled ⁵	Subsistence	Current Student	Unemployed	Military	Don't know or NA	Total
15-24	11 (1.0)	16 (1.5)	447 (41.6)	10 (0.9)	420 (39.1)	127 (11.8)	1 (0.1)	43 (4.0)	1,075
25-34	34 (4.0)	37 (4.4)	649 (76.7)	17 (2.0)	17 (2.0)	77 (9.1)	1 (0.1)	14 (1.7)	846
35-44	43 (6.8)	29 (4.6)	493 (78.0)	16 (2.5)	10 (1.6)	30 (4.8)	-	11 (1.7)	632
45-54	40 (8.5)	20 (4.2)	348 (73.7)	30 (6.4)	3 (0.6)	23 (4.9)	1 (0.2)	7 (1.5)	472
55-65	11 (4.7)	4 (1.7)	182 (77.5)	23 (9.8)	-	5 (2.1)	-	10 (4.3)	235
All	139 (4.3)	106	2119 (65.0)	96 (2.9)	450 (13.8)	262 (8.0)	3 (0.1)	85 (2.6)	3,260

NA = Not applicable

⁵Includes home duties

Table 12. LNG employees by sex and age in Hiri iHDSS 2011 (%)

Age (yrs)	Porebada			Papa			Lealea			Boera		
	Males	Females	All	Males	Females	All	Males	Females	All	Males	Females	All
15-24	33 (6.3)	9 (1.9)	42 (4.2)	42 (23.9)	12 (7.8)	54 (16.4)	36 (11.7)	9 (3.2)	45 (7.6)	57 (33.3)	30 (18.1)	87 (25.8)
25-34	100 (21.6)	4 (1.1)	104 (12.2)	61 (48.8)	16 (12.9)	77 (80.9)	65 (25.7)	16 (7.4)	81 (17.2)	84 (53.2)	24 (20.2)	108 (39.0)
35-44	81 (23.8)	4 (1.5)	85 (8.4)	49 (38.0)	11 (12.0)	60 (27.1)	56 (27.1)	8 (4.6)	64 (16.8)	74 (63.8)	26 (26.5)	100 (46.7)
45-54	34 (16.3)	3 (1.4)	37 (4.4)	16 (28.1)	2 (3.4)	18 (15.7)	13 (11.6)	2 (1.8)	15 (54.7)	35 (54.7)	7 (8.3)	42 (28.4)
55-64	13 (10.2)	3 (2.9)	16 (2.7)	5 (17.2)	1 (3.0)	6 (9.7)	8 (11.4)	0 (0.0)	8 (31.4)	16 (31.4)	3 (9.1)	19 (22.6)
Total	261 (15.7)	23 (1.6)	284 (9.2)	173 (33.5)	42 (9.1)	215 (22.0)	178 (18.7)	35 (4.2)	213 (11.9)	266 (47.5)	90 (18.0)	356 (33.6)

In Hiri, a very small proportion of the population have no formal education (less than 2%). Most attend some level of primary with substantial numbers completing secondary school and going on to tertiary. This trend is similar for both males and females (Tables 8 and 9).

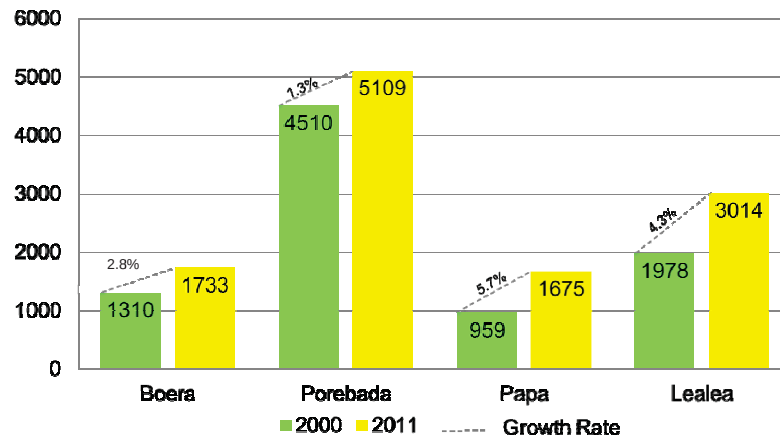
Only 14.1% of males report subsistence farming as their main occupation (Table 10). Almost 20% of males considered themselves unemployed. Only 2.9% of women report that they consider themselves to be fully “occupied” by subsistence farming. However, this may be due to the inclusion of these tasks in ‘home duties’ that falls under the unskilled category (Table 11).

Most of the individuals who report having worked or currently working for PNG LNG are males from Papa village and Boera village where almost half of the males of working age state having worked for the LNG project (Table 12). Project work also includes the numerous “Landcos” which supply labour to the PNG LNG project.

In-migration

From 2000 to 2011, Hiri District’s growth rate mirrors that of the PNG national average, 2.8% for Hiri District compared to a national average of 2.7%. However, if the district growth rate is disaggregated by village, an entirely different pattern emerges. Figure 11 shows the population counts based on year 2000 and year 2011 PNGIMR census data, as well as the associated growth rates using the “start” as January 1 and “end” as December 31st. Both Lealea and Papa have growth rates that are substantially higher than the national average; Boera is near the national average, while Porebada is far lower.

Figure 11. Hiri District Census Population and Growth Rate Comparisons-by Village



The individual growth rates over time and in comparison to the 2.7% national average are shown for Papa and Lealea in Figures 2 and 3. Growth rates were calculated based on start of the calendar year, i.e., January 1st. It is unlikely that either Papa or Lealea have had a sustained growth rate above the national average for 10 years. These graphs assume and present a “smooth and continuous” growth rate pattern rather than discontinuous jumps. A potential explanation is that there has been a surge of in-migration from other parts of PNG that occurred in relation to the start of the PNG LNG major construction activity beginning in 2010.

Figure 12. Lealea Population Growth Rate Over Time

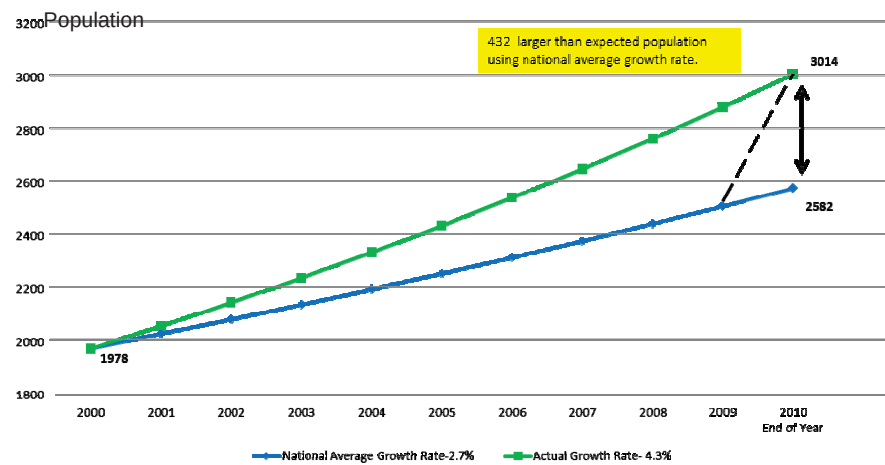
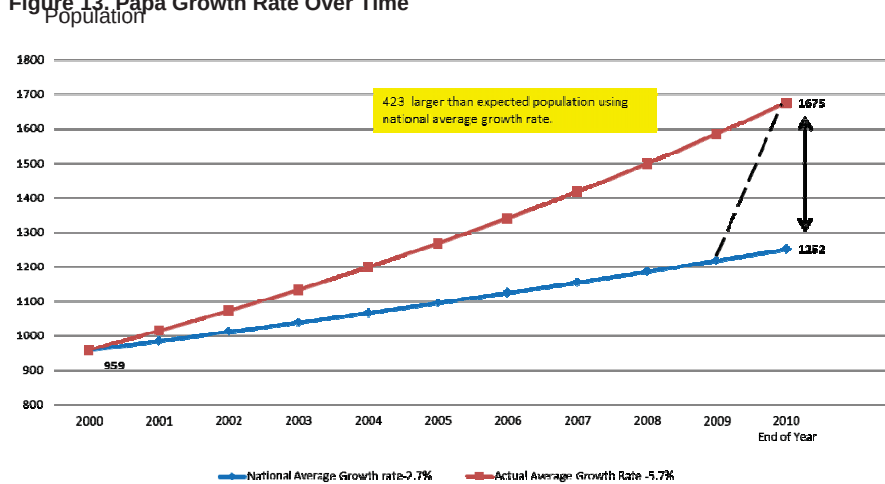


Figure 13. Papa Growth Rate Over Time



If in-migration is a possible explanation of the observed data, it is necessary to understand why Boera and Porebada have seemingly not been equally affected. There are several potential explanations including: (i) availability of actual expansion land within the geographical boundaries of the specific village; i.e., as illustrated by high-resolution satellite imagery of the

individual villages, (shown in Figures 14-17) the geographical restrictions and density of household structures within Porebada and Boera are 'greater' than the other two target villages; and, (ii) villagers from Papa and Lealea were given priority regarding hiring for LNG employment, followed by Boera; Porebada residents benefitted by simple geographical proximity to the work site. A free bus system was established by the Project that allowed for local workers to live at home and "commute" to work on a daily basis. Both factors, plus other unquantifiable effects undoubtedly influenced the observed patterns.

Figure 14. Porebada Structures by Year Erected

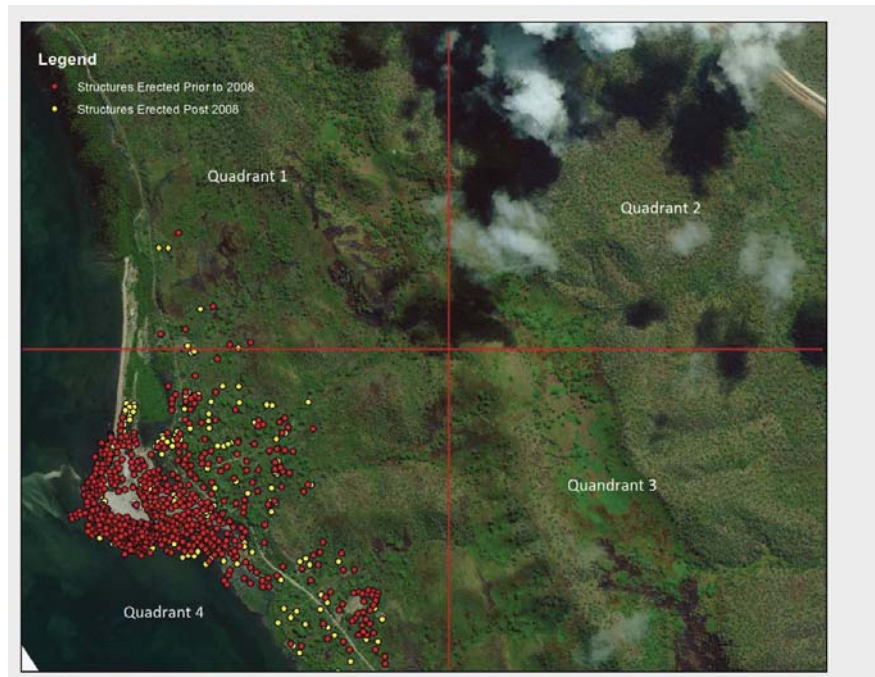
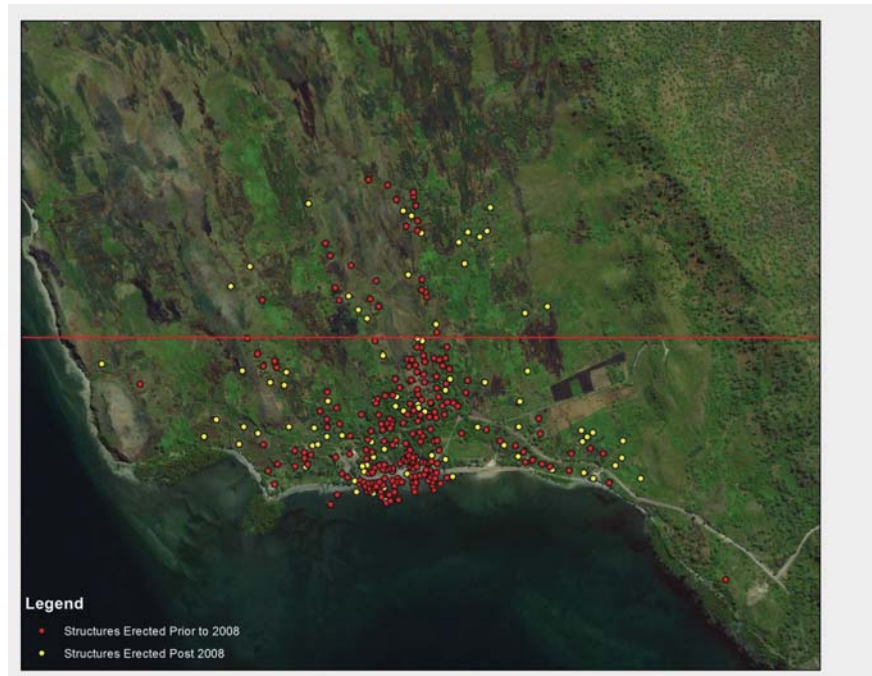


Figure 15: Boera Structures by Year Erected.



As Figures 14 shows, the majority of Porebada's structures are located in Quadrant 4. Though lush and verdant, the other Quadrants are not as favorable for residence construction due to variable access to piped water and land condition and ownership issues. Thus, new development appears to be occurring in the previously existing, dense housing area that has likely limited the amount of in-migration over the past four years.

Unlike Porebada, Boera has much more land to accommodate additional structures and residents. Boera's growth rate mirrors the national average.

Figure 16: Lealea Structures by Year Erected

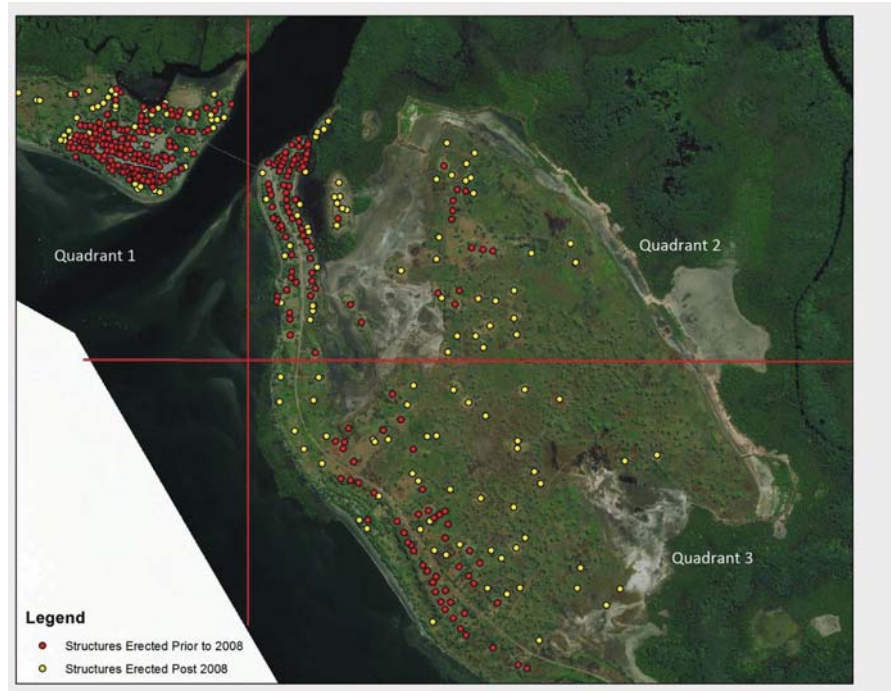
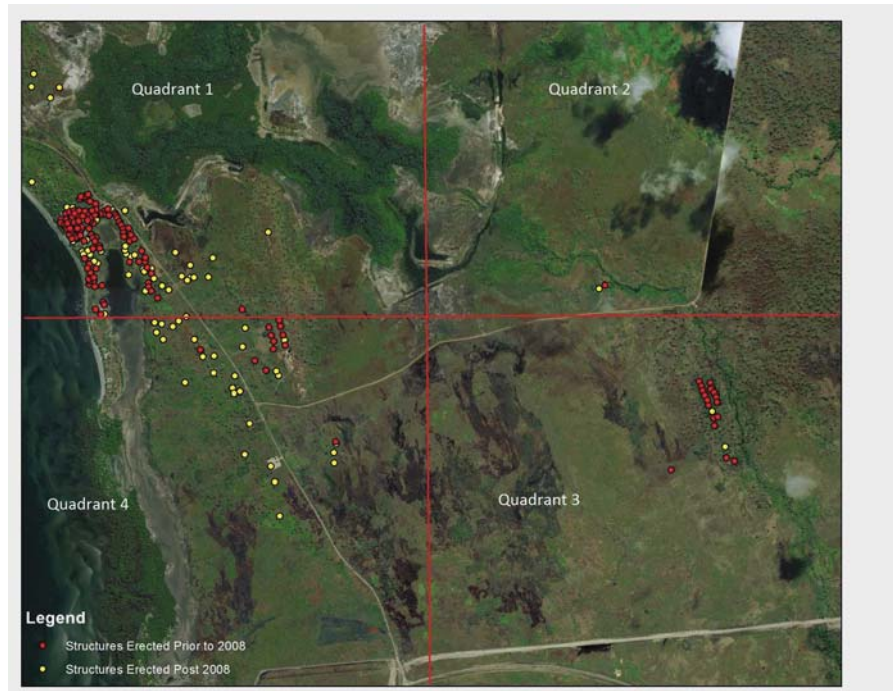


Figure 16 shows that the majority of structure growth for Lealea is occurring in Quadrants 1 and 2. The bulk of growth in Papa is occurring in Quadrant 4 and the southern end of Quadrant 1.

Figure 17: Papa Structures by Year Erected



Structure Analysis

Structures other than households are likely to be commercial/small-scale enterprise buildings or temporary structures. High-resolution remote sensing imagery can identify individual structures but cannot always differentiate between a household and a commercial/small-scale enterprise. Imagery is available beginning in 2008 and was regularly collected on a quarterly basis beginning in 2010. If there is a large “gap” between identified physical households and total physical structures it might be indicative of the amount of commercial activity that exists in each village.

Figure 18 shows the remote sensing count of the total number of structures and households for the four villages in the Hiri impact site as of 2011 IMR census. A count of all structures is done by using remote sensing imagery coupled with object-based analysis software. The total number of households was determined by the 2011 IMR household census/registration. Since the household census recorded GPS measurements for each household, these coordinates can be cross-correlated against the remote sensing imagery and specific household counts.

Figure 18. 2011 Comparison of Household Structures to Total Number of Structures.

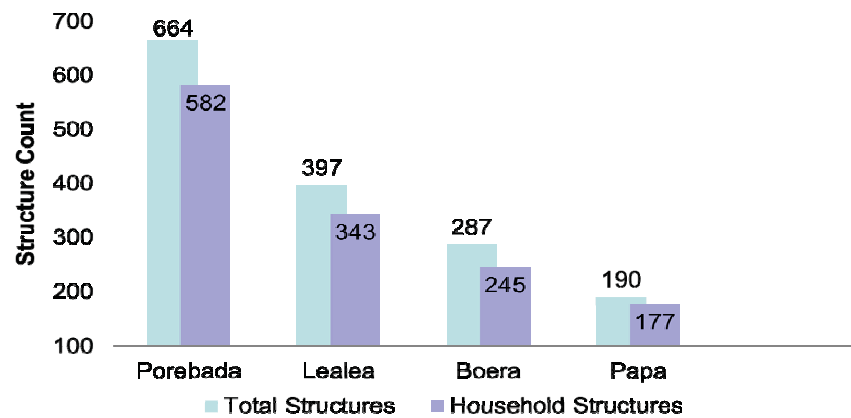


Table 13. Comparison of All Structures to Non-Household Structures

Village	Ratio of Non-Household Structures to Total Structures	Rate of Number of Non-Household Structure per 100 Villagers
Lealea	0.14	1.79
Papa	0.07	0.78
Boera	0.15	2.42
Porebada	0.12	1.63

Table 13 shows the initial results in the structure analysis. The ratio of non-household structures to total structures, as well the number of non-household structures per 100 villagers is shown.

An increase in both the ratio of non-household structures and non-households structures per hundred villagers could potentially indicate an increase in economic activity; however, an increase in only one of the indicators may mean that any change is more demographic, such as an increase in people per household, rather than an economic related increase that would point toward a more prosperous village. Additional ground-truthing and comprehensive household-level socio-economic surveying would clarify the situation. These activities are currently being actively performed by IMR iHDSS survey teams.

Sequential, time period (2008-2012) remote sensing data are available and have been analyzed. The population distribution by structure age is listed in Table 13. Structure age is divided by those that are under three years of age (2009/10- 2012, thus created after the LNG project began, and those that are older than 3 years of age (before 2008), i.e., before the LNG project began active large-scale construction.

Papa has the highest percentage of villagers in new structures followed by Lealea. This should not be surprising as both Papa and Lealea have the highest levels population growth. Data for Porebada is not available due to field loss issues that IMR hopes to recapture in subsequent survey efforts.

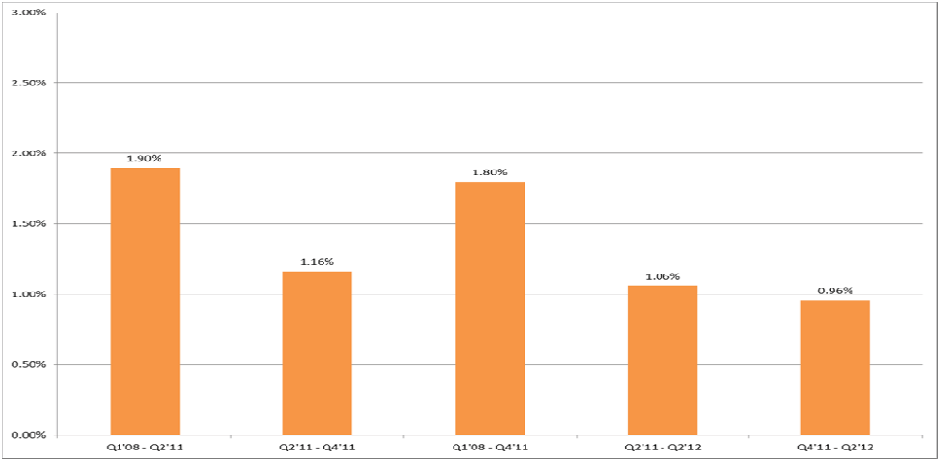
Table 14. Count of Structures Detected by Remote Sensing

TOWN	Q1 '08	Q2 '11	Q3 '11	Q4 '11	Q2 '12
KIDO*	75	100	100	100	101
LEALEA	279	397	404	409	417
PAPA	135	190	193	200	205
BOERA	222	273	277	283	293
POREBADA	561	664	668	670	678

*Kido is a small, relatively isolated (no direct/connecting roads) district village that is not part of the iHDSS; however, Kido is a part of other potential benefit streams due to its proximity (within 5 km) of the undersea pipeline.

Table 14 shows the count of structures by quarter as measured by remote sensing flyovers. The majority of the construction occurred between the first quarter of 2008 and the second quarter of 2011. It appears that a substantial portion of the in-migration may have occurred before major construction of the LNG project site began. Figure 19 shows the average compound growth rates per quarter for the Hiri impact site as a whole

Figure 19. Average Compound Growth Rate per Quarter and between Remote Sensing Activities- for all Hiri Villages



Figures 20 and 21 show the compounding growth rates of structures in each village. Papa and Lealea had the highest structure growth rates; this is unsurprising, as these villages also have had the highest population growth rates; similarly, Porebada has both the lowest structure growth rate and the lowest population growth rate.

Figure 20. Structure Growth Rate Comparisons- Average Compound Growth Rate per Quarter

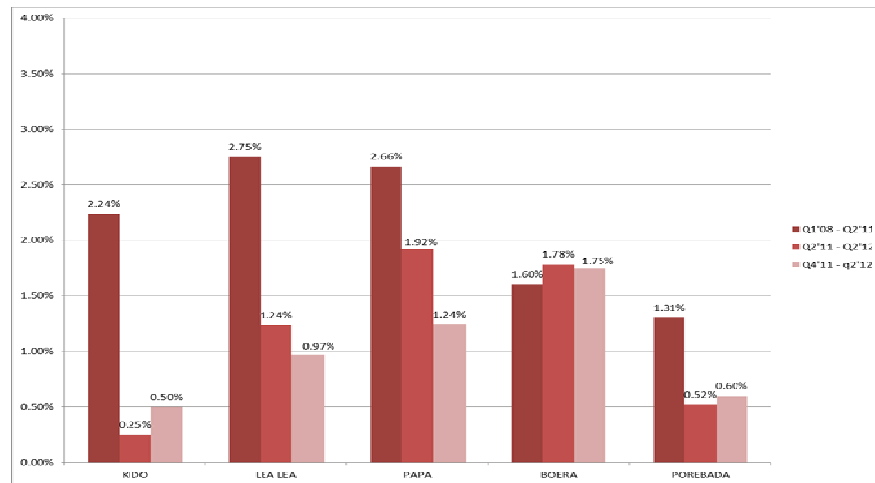
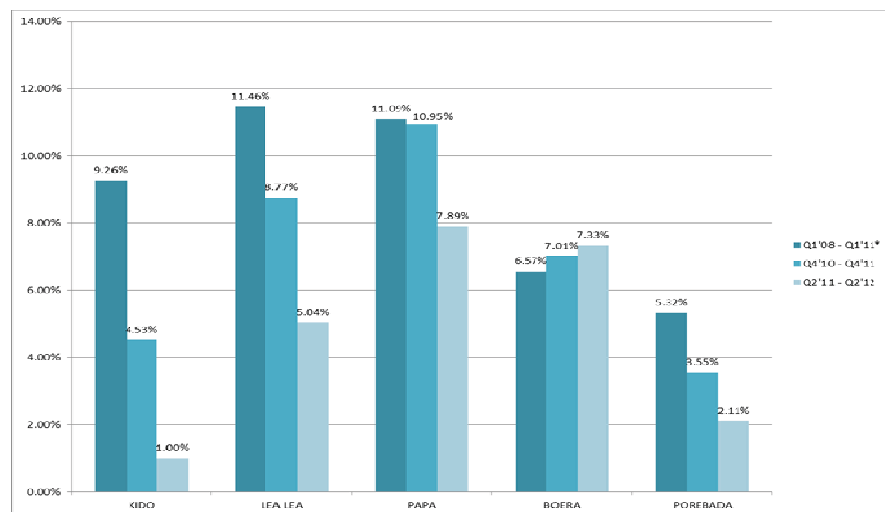


Figure 21. Structure Growth Rate Comparisons- Average Compound Growth Rate per Year



The slowdown in the structure growth rate beginning in the latter half of 2010 adds credence to the assertion that the bulk of the population growth had occurred before the major construction phase of the PNG LNG project began.

Table 15. Population Count by Age of Household Structure

Village	Total Population in New Structures (<= 3 years old)	Total Population in Old Structures	Total Population
Boera	298	1482	1780
Lealea	597	2456	3053
Papa	407	1221	1628

Table 16. Occupation by Structure Age

Occupation	Boera		Lealea		Papa	
	New (<3 years)	Old	New (<3 years)	Old	New (<3 years)	Old
Small business owner, legislator or senior manager	0.3%	0.7%	0.5%	0.4%	1.5%	1.0%
Professionals	0.7%	0.9%	0.5%	0.9%	1.0%	0.2%
Technicians and associate professionals	2.0%	2.8%	2.2%	1.6%	0.5%	0.9%
Clerical support workers	3.7%	2.0%	1.0%	1.0%	2.7%	1.0%
Skilled agricultural, animal, & fishery workers	0.0%	0.0%	0.0%	0.0%	0.2%	0.0%
Skilled craft & building trade workers	0.0%	0.1%	1.5%	1.3%	1.5%	1.1%
Plant & machine operators & assemblers	0.0%	0.1%	0.2%	0.2%	0.2%	0.5%
Elementary occupations:	0.0%	0.1%	0.0%	0.2%	0.0%	0.2%
Military occupation	0.7%	0.7%	0.0%	0.2%	0.0%	0.1%
Student	9.1%	10.8%	19.5%	21.1%	21.3%	15.4%
Unemployed	11.6%	14.4%	8.8%	9.0%	5.2%	7.7%
Sales and services	0.3%	0.3%	4.5%	3.6%	5.0%	5.4%
Agricultural, fishery and related labour (wages)	0.0%	0.1%	0.0%	0.0%	0.2%	0.2%
Labourer in mining, construction and transport	17.2%	18.5%	6.7%	5.7%	8.7%	10.0%
Subsistence based farming, gardening or fishing	2.7%	4.1%	8.9%	11.3%	4.2%	2.9%
Home duties	11.4%	10.8%	21.0%	18.1%	17.8%	19.3%
Not relevant	38.7%	32.9%	23.7%	24.8%	29.5%	34.0%
Don't know	1.3%	0.7%	0.8%	0.5%	0.5%	0.4%

Population comparison

Figures 22 and 23 show population pyramids of the Hiri villages against both urban and rural averages. The rural pyramid has a very wide base of children under the age of 15; this is quite different from the total Hiri district which is much more similar in demographics to the average PNG *urban* (as opposed to a rural pattern) population distribution. The urban pattern is most likely due to the close proximity to the National Capital District (Port Moresby). There is

longstanding bus service between Hiri District and Port Moresby that facilitates an urban pattern of day commuting. Improvements in the road system will likely reinforce this trend.

Figure 22. Population Pyramid Comparison between Hiri Villages and PNG Rural Averages

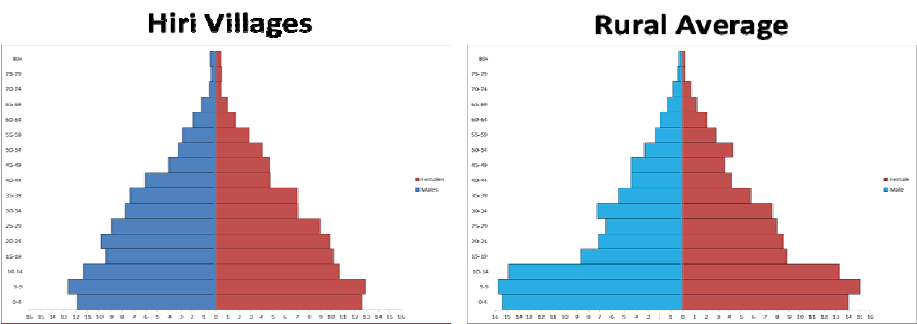


Figure 23. Population Pyramid Comparison between Hiri Villages and PNG Urban Averages

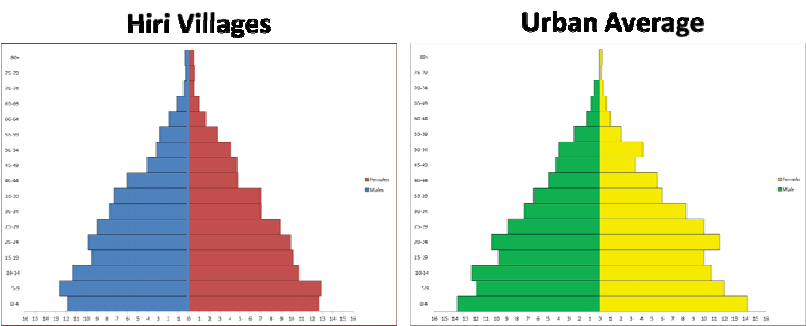


Figure 24. Lealea Population Pyramid compared to Urban Average

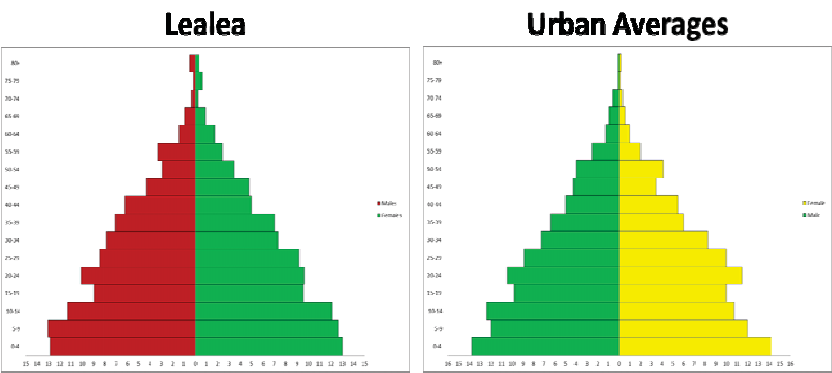


Figure 25. Lealea Difference in Count of Males per Hundred Females compared to Urban Average

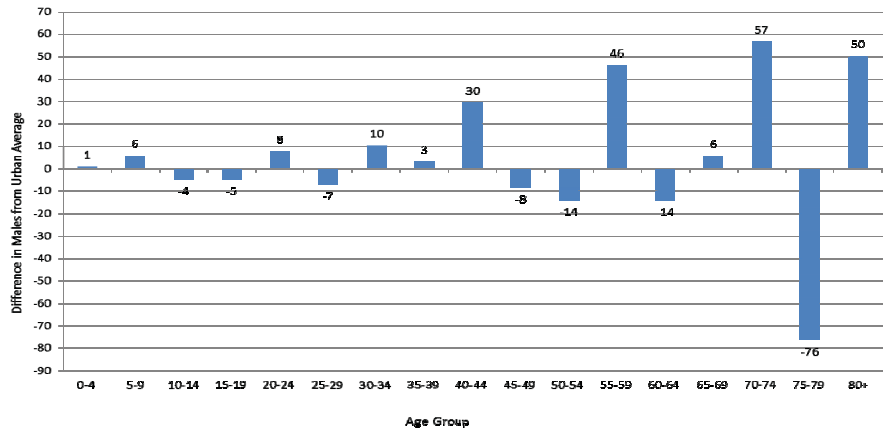


Figure 26. Papa Population Pyramid compared to Urban Average

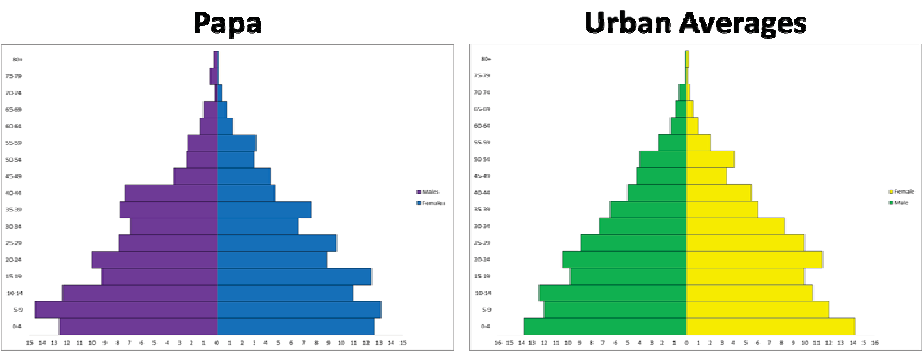


Figure 27. Papa Difference in Count of Males per Hundred Females compared to Urban Average

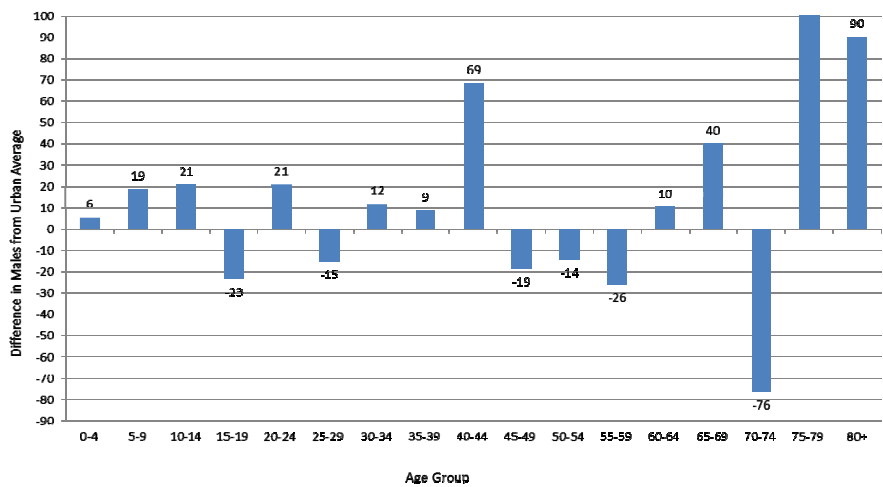


Figure 28. Boera Population Pyramid compared to Urban Average

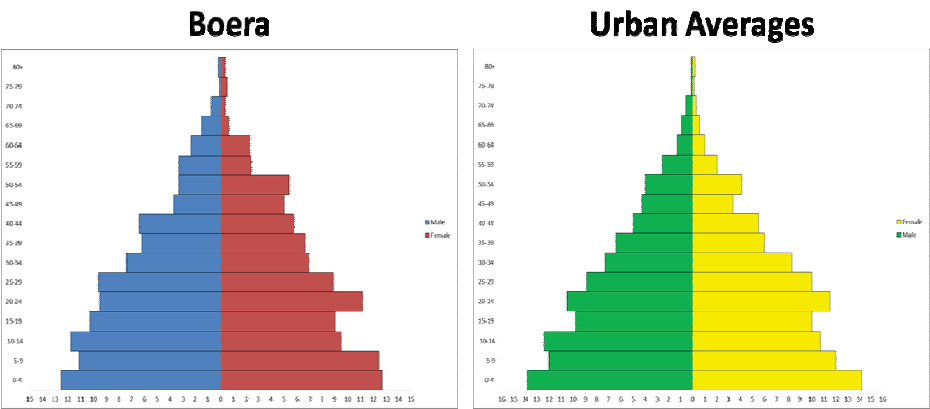


Figure 29. Boera Difference in Count of Males per Hundred Females compared to Urban Average

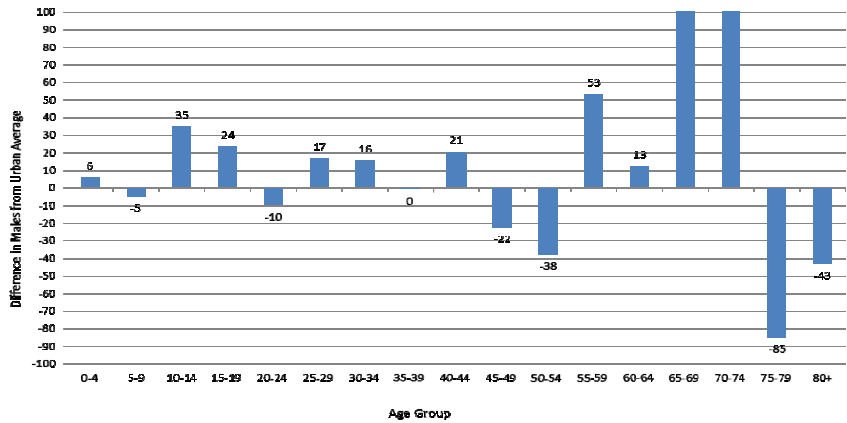


Figure 30. Porebada Population Pyramid compared to Urban Average

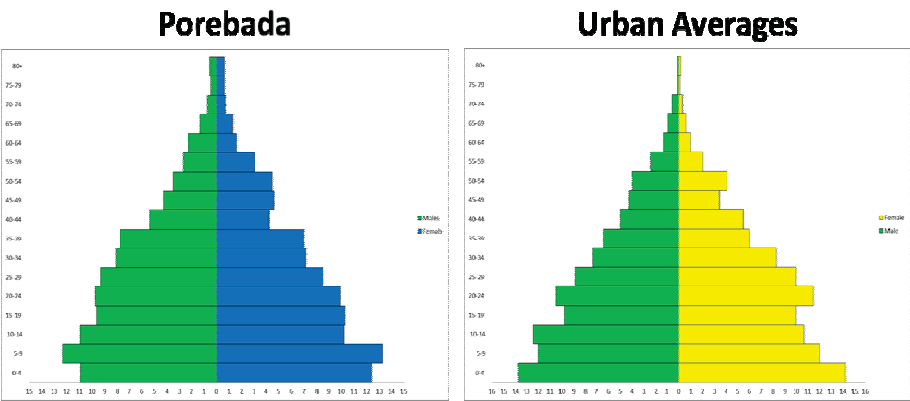
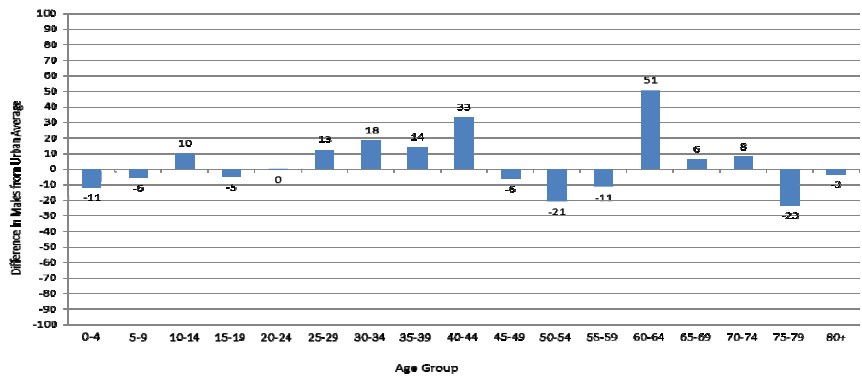


Figure 31. Porebada Difference in Count of Males per Hundred Females compared to Urban Average

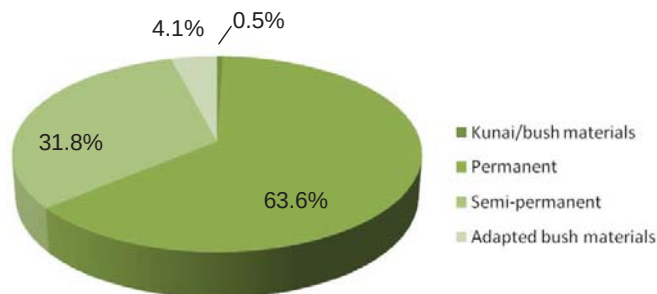


Figures 22-31 alternate between a village level population pyramid comparison to the urban average down and a comparison of village level sex ratios against the urban average. Many of the age brackets for the working age population, ages 15-45, are overwhelmingly male. Whether this is a result of in-migration due to the LNG project or not is unclear, as both Porebada and Boera exhibit the same trend despite seeing a population growth that is only at or below the national average. The highly skewed male: female ratio is discussed in early sections of this report.

Socioeconomic Indicators

Preliminary findings from the socioeconomic survey pilot study in Hiri are presented here.

Figure 32. Types of housing in West Hiri iHDSS 2011(N=195)



The majority of houses in West Hiri are modern and constructed from permanent materials like corrugated metal sheets. Semi-permanent housing represents 31.8% of the houses covered in the survey (Figure 32). While typically, both these types of houses have large windows and are well ventilated, almost half households reported cooking indoors (Figure 33). Indoor air pollution due to cooking inside the house is a known risk for respiratory diseases.

Figure 33. Characteristics of living conditions in West Hiri iHDSS 2011(N=195)

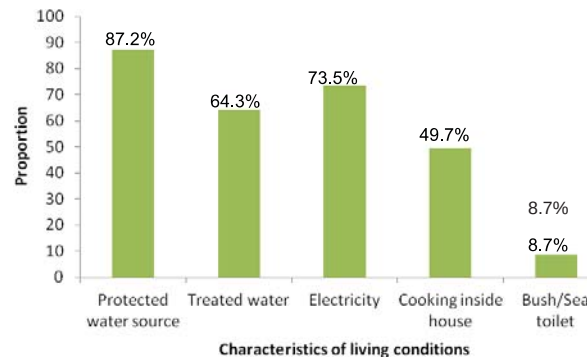
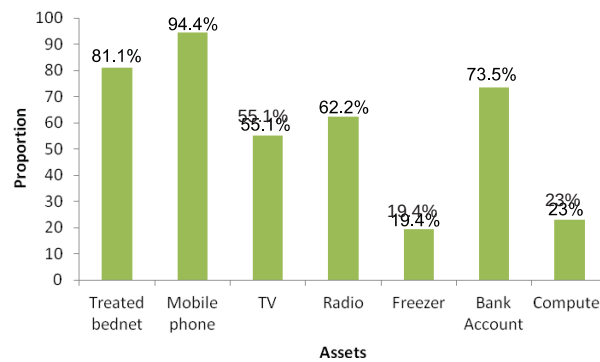
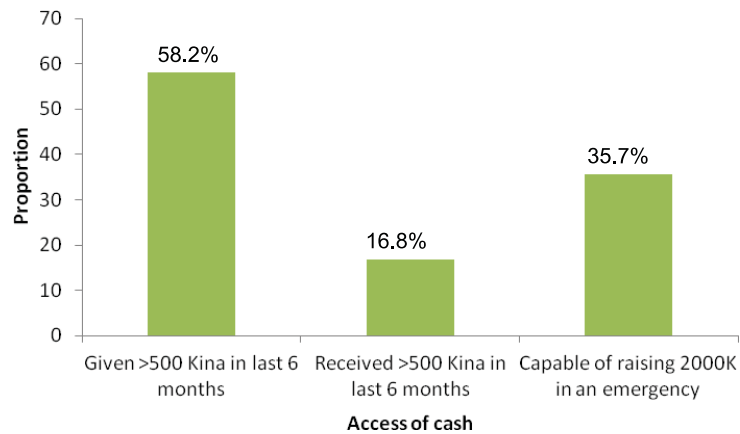


Figure 34. Proportion of households possessing selected assets in the total West Hiri iHDSS 2011 population (N=195)



Households in West Hiri possess a large number of assets (Figure 34). Mobile phone ownership is very high and almost all houses own at least one phone. Televisions and radios are owned by over half of the population and 23% of households reported owning at least one computer. A large number of households also report holding at least one bank account.

Figure 35. Proportion of households who have contributed or received more than 500Kina through social obligations in the past 6 months and those who report that they can raise 2000Kina in two weeks in the total HiriHDSS 2011 population(N=195)



The Socio-economic survey sought to account for economic activity and cash flow traditionally neglected in such questionnaires. PNGIMR asked, therefore, about the money spent and received for cultural events like marriages (bride price which paid to the bride's family) and funerals (*haus krai*). PNGIMR focused on those who contributed or received more than 500 Kina. More than half of the respondents reported contributing more than 500 Kina in the last 6 months to social obligations in the community yet only 16.8% reported receiving more than 500 Kina (Figure 35). This may suggest that many contributions are made regularly but in small amounts. Of course there may also be a strong reporting bias occurring here. People may be preferentially reporting or recalling their own generosity rather than their times of need. Another question posed was with respect to the household's capacity to raise 2,000 Kina in 2 weeks if an emergency were to arise. The amount of 2,000 Kina was identified during focus group discussions with IMR field staff. This amount was considered relatively challenging to raise but at the same time would be a realistic demand in many communities. In this Hiri community just over a third reported that they would be capable of doing so.

Wealth Analysis

During the large-scale construction phase of the PNG LNG, residents of the Hides and Hiri impact sites are expected to experience substantial employment and business opportunities. How this economic opportunity is managed at a household level is extremely important and directly relevant to the goals of the PiHP. Socio-economic status changes triggered by PNG LNG activity can have both immediate and long-term impacts (positive and/or negative) on household level health status. The project construction activity is occurring over a multi-year period; in addition, there will continue to be employment and economic activity during the 30+ years of operations.

The PNGIMR has established an integrated Demographic Health Surveillance System (iHDSS) for the Hides and Hiri sites with matched control locations. A variety of key performance indicators, e.g., morbidity and mortality outcomes, socio-economic status (income/consumption expenditure, assets, etc.) are monitored by the iHDSS for both impact and control locations. There is extensive published literature documenting the power of evaluating health through a household wealth metric, e.g., wealth quintiles (e.g., World Bank Report from Gwatkin *et al.* 2007; INDEPTH Network on asset indexing at <http://www.indepth-network.org>; World Bank at data.worldbank.org/data-catalog/HNPquintile; MeasuredDHS at <http://www.measuredhs.com/topics/Wealth-Index.cfm>).

How this “wealth” is accumulated, what it is spent on, and how changes in household-level socio-economic status triggered by the project impact local health and educational outcomes is of great interest to the PiHP. This wealth analysis study is based upon two surveys:

- (i) Baseline survey conducted as part of the Social Impact Assessment (SIA) in 2008 which shows the economic status of the impact sites before the large-scale construction phase began in 2009/10; and
- (ii) A pilot socio-economic study (SES), conducted in 2012 by PNGIMR.

Table 17 compares the SIA and the 2012 pilot surveys. Both surveys were convenience samples, i.e., they were not community censuses or stratified random samples drawn from a fully characterized listing frame. A target number of households were identified and survey enumerators selected households if a head of household was available for questioning. PNGIMR is following up this pilot effort with a census-style SES survey, i.e., all households will be queried. Therefore, this analysis should be considered as a preliminary exploratory data analysis effort. Nevertheless, PNGIMR does feel that the data provide some initial insight into PNGLNG's impact on household socio-economic status.

Table 17. Difference between SIA and IMR surveys

	SIA	IMR
Date of Survey	2007	2012
Total Households Surveyed	282	195
Porebada	127	92
Boera	54	33
Papa	61	21
Lealea	40	33
Other	0	16

The PNGIMR Socio-Economic Survey (SES) is being significantly expanded and is designed to cover virtually all of the households registered during the initial IMR census performed in 2011/12. A much more comprehensive data set will be available by the end of the second quarter of 2013. PNGIMR will analyze and report on this large data set as it becomes available.

Traditional methods of wealth analysis rely on an examination of expenditure data. However, consumption expenditure analysis suffers from several problems that make it impractical as an analytic tool in the context of PNG, i.e., obtaining these data would be expensive, time consuming and logistically formidable. The World Bank Living Standards Measurement Survey (LSMS) is specifically designed for this task at a national level. However, successfully

executing a LSMS is a daunting task that at best is performed every 5 years. In PNG, the last LSMS was performed in 1996. Aside from cost and logistical issues of accurately obtaining expenditure data, it is critical to understand that expenditure analysis assumes a consistent level of spending throughout the entire year. In both Hides and Hiri, constant expenditure may not be an accurate assumption, particularly for the Hides area, which has traditionally been a subsistence agricultural area. In a subsistence setting, spending may occur intermittently based upon agricultural seasons and harvest success generating sufficient excess crops that can be sold in local markets.

In order to avoid the complexities of expenditure data collection in many developing country settings, researchers have looked for potentially simpler surrogate metrics. As well demonstrated in the published literature, (Filmer & Pritchett 2001, Scott & Filmer 2008), asset analysis provides the researcher with a relatively simple and reliable proxy for wealth. Rather than rely on a households spending over a given month, as is done in expenditure analysis, asset analysis looks at the accumulation of durable goods that exist at the household level. A list of goods that were examined for the 2007 and 2012 studies can be found in Table 18. Because these studies were done by two different organizations, there is not 100% match in the type of asset analyzed; however, there is significant asset overlap.

Table 18: Assets used in MCA Analysis

SIA 2007	IMR 2012
Housing Material	Housing Material
Roof Material	Roof Material
Toilet Facility	Toilet Facility
Drinking Water Source	Drinking Water Source
Drinking Water Availability	Drinking Water Availability
Has Electricity	Has Electricity
Fuel Type	Fuel Type
Owns Generator	Owns Generator
Owns Radio	Owns Radio
Owns TV/Video	Owns TV/Video
Owns Refrigerator	Owns Refrigerator
Owns Sewing Machine	Owns Sewing Machine
Owns Motor vehicle	Owns Motor vehicle
Owns computer	Owns computer

Owns Cell Phone	Owns Cell Phone
Owns mosquito nets	Owns mosquito nets
Owns motor boat	Owns motor boat
Owns paddle boat	Owns paddle boat
Owns Personal bank account	Owns Personal bank account
Owns share bank account	Owns share bank account
	<i>Outer wall material</i>
	<i>Farms cash Crop</i>
	<i>Treated and/or Protected Water Source</i>
	<i>Access to Land and/or Garden</i>
	<i>Access to Separate Cooking Area</i>
	<i>Owns Washing machine</i>
	<i>Owns Tables</i>
	<i>Owns Chairs</i>
	<i>Owns Mattresses</i>
	<i>Owns Framed Bed</i>
	<i>Owns Gas cooker</i>
	<i>Owns Electric cooker</i>
	<i>Owns Toaster</i>
	<i>Owns Clock/watch</i>
	<i>Owns Bicycle</i>

Methods: Principle Component Analysis (PCA) and Multiple Correspondence Analysis (MCA)

Principle component analysis (PCA) has frequently been used to determine the relative wealth of households by looking at their asset mixture. Households that are relatively wealthy will have a larger number of assets in both count and value. Certain assets will group together and will have a large impact on whether or not an individual household is considered poor or wealthy, while other assets will have minimal effect. Typically, assets (e.g., pots/pans, blankets) that nearly everyone has will have no impact on wealth, while assets that few people have (e.g., computers, TVs) may indicate a wealthy household. Conversely a household

lacking an asset that most others have will likely “place” a household at a lower wealth level in an overall forced ranking of all households in a defined geographical area.

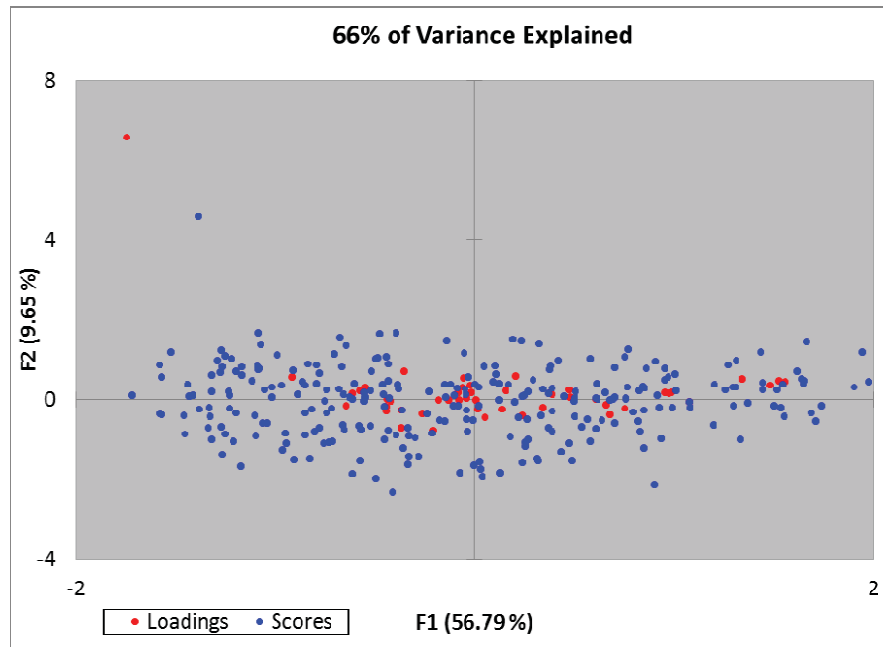
An important drawback to using PCA is that it requires all variables in the calculation to be on ordinal numerical scales. PCA allows us to say that a household with 2 televisions, 1 refrigerator, and 5 cell phones is wealthier than a household with only 1 television and 3 cell phones; however, it cannot make the distinction as to who is better off once categorical variables such as toilet facility (communal latrine, bush, indoor facility), water source (indoor, borehole, river/stream), and housing structure type (bush materials, brick, tine) are considered. These types of categorical variables are particularly important as they are highly correlated with positive health outcomes (Overby 2007).

In order to account for the potential predictive power of categorical variables, we use a discrete variable analogue of PCA; namely, Multiple Correspondence Analysis (MCA) is used (Greenacre&Hastie 1987). MCA is analogous to PCA in that it bases one's relative wealth on household level asset mixture. However, MCA is able to use categorical variables and thus, is more suitable for analysis with variables such as water quality, housing structure type and toilet facility. Therefore, the assets used in the overall analysis are grouped according to how they relate to one another in describing relative wealth. This grouping is known as a component. Each component explains some amount of the overall variance in the data.

In principal, there could be a large number of components (up to the number of observations in a data set) for a given analysis. However the payoff from this methodology arises from the empirical finding that most of the variation in the data is representable in terms of very few components. For the IMR and SIA studies, we use primarily the first two components and in most instances find that consideration of just the first component is adequate for representing the important variation in the data sets. The distribution of household component scores and asset component effects can be shown graphically on a bi-plot that integrates the information from the standard scores plot and loadings plot originally developed for PCA. For this analysis, a total component score of -3 represents a high level of household poverty, while a score of positive 3 represents a high level of household wealth; a score of zero represents an average level of household wealth.

Figure 35 shows the superposition of scores (household) and loadings (assets) for the four potentially impacted Hiri villages based on the 2007 SIA survey data. Scores refers to a household's relative wealth, while loadings refers to the effect each variable has on the household's numerical wealth (“score”).

Figure 36. Superposition of 2007 Scores and Loadings - All LNG (Hiri) Villages.



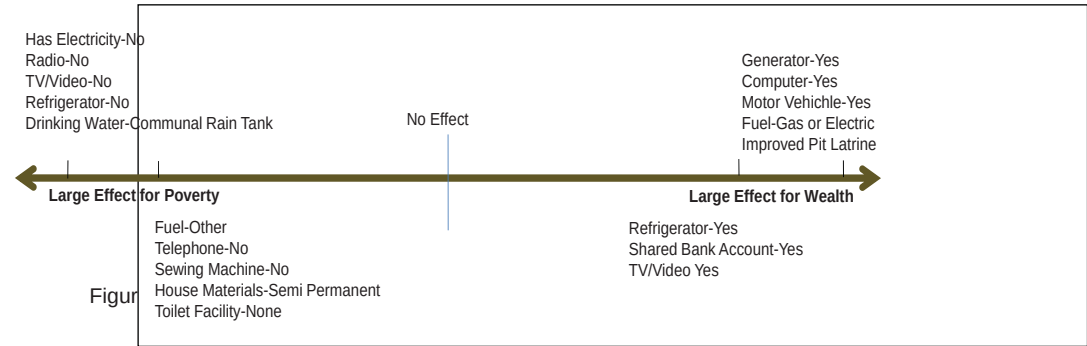
[Blue dots proximal to one another correspond to households with similar levels of assets. The distance of red dots from the origin correspond to influence of assets that reflect the level of wealth of households in their proximity. Red dots substantially to the left of the origin correspond to key assets of the poorest households. Those furthest to the right of the origin correspond to assets that distinguish the highest level of wealth.]

F1 (x-axis) is the 1st component while F2 is the 2nd component. Figure 36 shows that there is an even distribution of households across the wealth spectrum. Only one principle component (F1) is needed to explain the variance of the explanatory variables. F1 accounts for almost 57% of the variance of the observed data distribution while F2 only contributes an additional 9%. Outlier values (e.g., shown in the upper-left quadrant) are insignificant as they are generated by the second principle component, which has much less explanatory power.

Figure 37 shows which assets have the greatest effect on wealth and poverty. Owning assets such as computers and generators, and having access to gas or electric fuel, as well as an improved pit latrine greatly increase a household's relative wealth. Conversely, not having

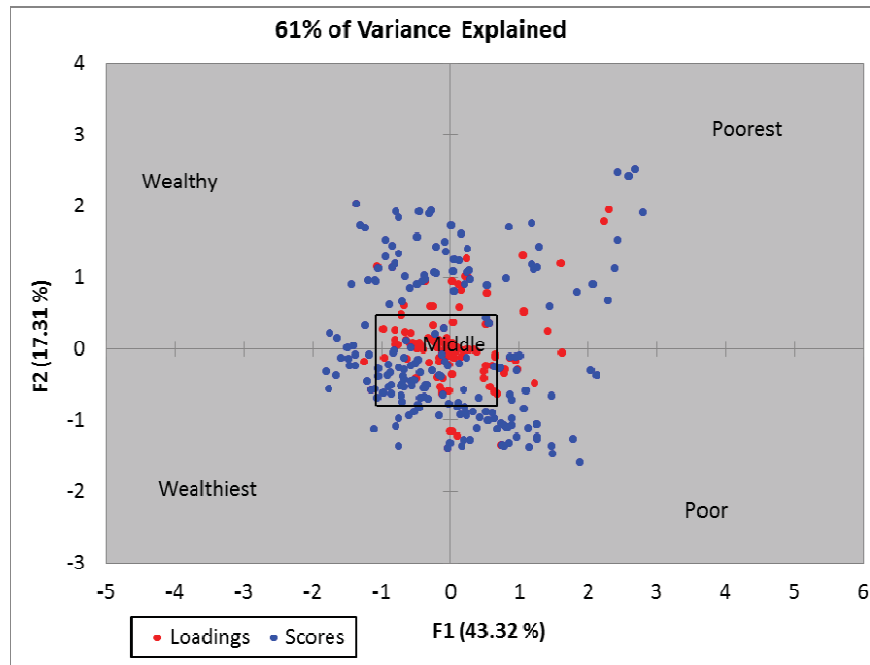
these assets, as well as having a house made of semi-permanent material strongly pulls a household towards poverty. For instance, the 2007 survey showed that about 50% of households owned a cell phone. The effect of cell phone ownership on wealth was -0.4 points toward poverty without a phone and 0.4 points towards wealth with a phone. In 2012, 96% of the households owned at least one cell phone; thus, not having a phone had a much larger effect on poverty than owning a phone had on wealth. Ownership of a phone contributed 0.4 points towards the wealth score, whereas not owning a phone contributes -1.4 points towards a poverty score.

Figure 37. Asset Combinations Associated with relative Levels of Wealth (scores)- 2007



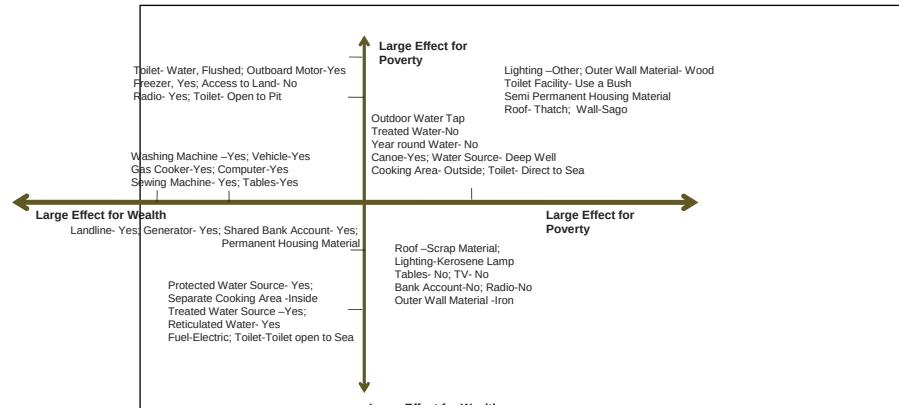
Unlike the 2007 MCA results, 2012 data variance is best explained using two principle components, due to the higher level of explanatory power in the second component and the lower level of explanatory power in the first component. The wealthiest individuals are in the southwest quadrant, the poorest in the northeast quadrant. There are also a substantial number of household located near the origin of the graph. These households are neither wealthy nor poor on either component and can thus be considered of average wealth. On Figure 37, they are shown as ‘middle.’

Figure 38. Superposition of 2012 Loadings and Scores- All Villages



The effect that a household's assets have on their wealth status can be seen in Figure 39. The results are similar to those in the 2007 analysis shown in Figure 36. Permanent housing, protected water, and a large number of assets lead to higher level of wealth. Whereas the lack of some items that are now commonplace, such as cell phones, led to higher levels of poverty.

Figure 39. Asset Combinations Associated with relative Levels of Wealth (scores)- 2012



Based on the pilot SES data, the PNG LNG project has likely succeeded in increasing the amount of wealth in the Hiri impact villages. As seen in Table 19, there has been an increase in the amount of durable goods owned, as well as substantial improvements in housing and access to improved water sources.

Despite many positive changes there are some potential negative changes that may be occurring. A comparison of household wealth scores from 2007 and 2012 shows a complex picture demonstrating shifts in both increased wealth for some households and status decline for other households. Figure 40 presents wealth scores for the first principle component on a -3 to 3 range. These scores are based on the MCA component calculations and derive from each household's individual asset mixture. While there has been a decrease in households scoring between 0 and -1.0, scores that would indicate a decrease in poverty, there has been an absolute increase in households with scores between -1 and -2.5, a score that would be indicative of extreme poverty. These households have not been further investigated and characterized. Thus, it is unknown whether this represents in-migration of benefit and/or employment seekers. Additionally, the number of household scores between 0.5 and 2.0 (indicating increasing wealth) has increased from 2007 to 2012.

Table 19. Asset Ownership Comparison 2007-2012

Asset Type Owned	Percent of Households that Own Asset	
	2007	2012
Mobile Phones*	49%	95%
Bank accounts	42%	75%
Computer	8%	23%
Electric Lighting	73%	75%
Electric Cooking Fuel	10%	34%
Mosquito Netting	72%	83%
Piped Water Access	53%	69%
Year Round Water Availability	56%	81%

* Mobile phones household acquisition went from one (1) per household with 49% of households reporting phone ownership to five (5) per household with 95% of all households reporting phone ownership

At issue is how to explain the observed increase in 'extreme poverty' households. The available data are based on a convenience sample pilot study so the analysis must be seen as preliminary pending the upcoming census-style SES that is being initiated by the Hiri iHDSS team. Numerically, the pilot study had proportionated to population sampling so that the absolute number of sampled households in Papa and Lealea is "low" relative to Porebada.

In addition the convenience nature of the sampling may have also introduced potential geographical bias as the household sample was not randomly spread across the entire listing frame. Finally, the effect of random error has not been analyzed. When the census-style (all

households are surveyed) SES data becomes available many of these methodological concerns should be resolved.

Nevertheless, in-migration, particularly in the Papa and Lealea villages, is a potential explanation. Analysis of Hiri village data indicates that population and physical structure growth in Papa and Lealea are strongly consistent with in-migration⁶. For 2007, Figure 41 shows that Papa and Lealea had a fairly even distribution of people in the poor and moderately wealthy categories, with most people scoring between -1.5 and 0.5. In 2012, there is a much different distribution of household wealth scores. There is a clear increase in extreme poverty, yet there is also an increase in wealthier households that score between 0.5 and 1.5.

Further evidence of the potential impact of in-migration can be seen by looking at the histograms of first MCA component scores for Porebada and Boera in 2007 and 2012. Unlike Lealea and Papa, which had a substantial increase in their population and physical structures, Boera and Porebada growth rates remained at or below the national average. The growth in physical structures was almost much less on either a quarterly or yearly compounded average.

As Figures 42 and 43 show, both Boera and Porebada became wealthier without demonstrating the apparent increase in extreme poverty that is evident in both Papa and Lealea villages. High population growth rates are likely associated with in-migrants in search of economic opportunities including future benefit streams. High structure rates represent both new housing and possible increased small-scale business activity. Analysis of households versus physical structures demonstrated that 85-93% of the new structures were identified as households on the IMR survey based on matching remote sensing locations versus IMR surveys (IMR determined location by GPS for each surveyed household).

The pilot SES data demonstrate both positive and negative wealth status shifts across Hiri villages. The observations are preliminary and will be more firmly established by ongoing sampling efforts. Additional work will be performed to analyze a series of health outcomes (morbidity and mortality) that are strongly related to household wealth status.

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⁶ Because of the small samples sizes for Papa and Lealea individually, and their generally similar characteristics, PNGIMR pooled their data to increase statistical robustness.

Figure 40. Histogram of first MCA Component Scores- All Villages

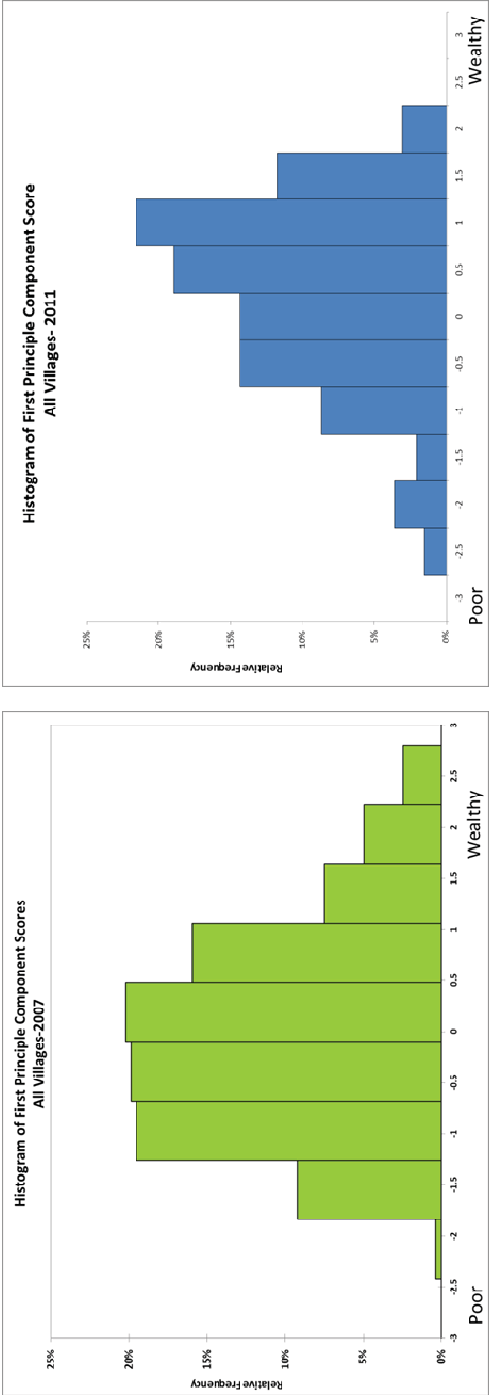


Figure 41. Histogram of first MCA Component Scores- All Villages -Papa and Lealea

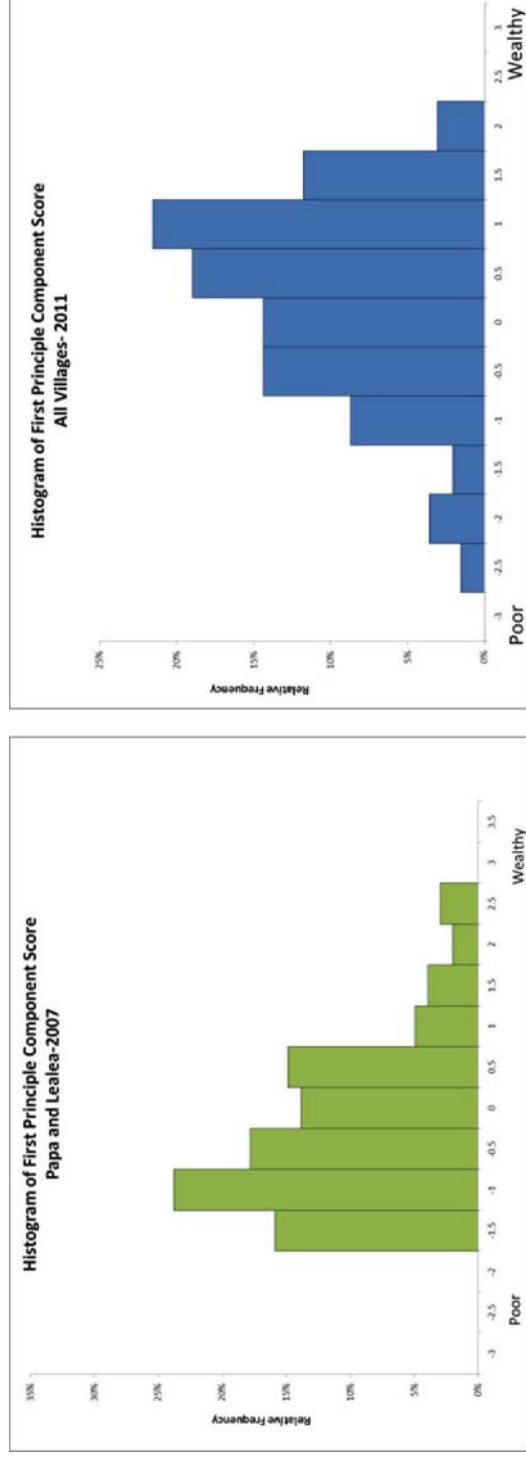


Figure 42. Histogram of first MCA Component Scores- All Villages-Porebada

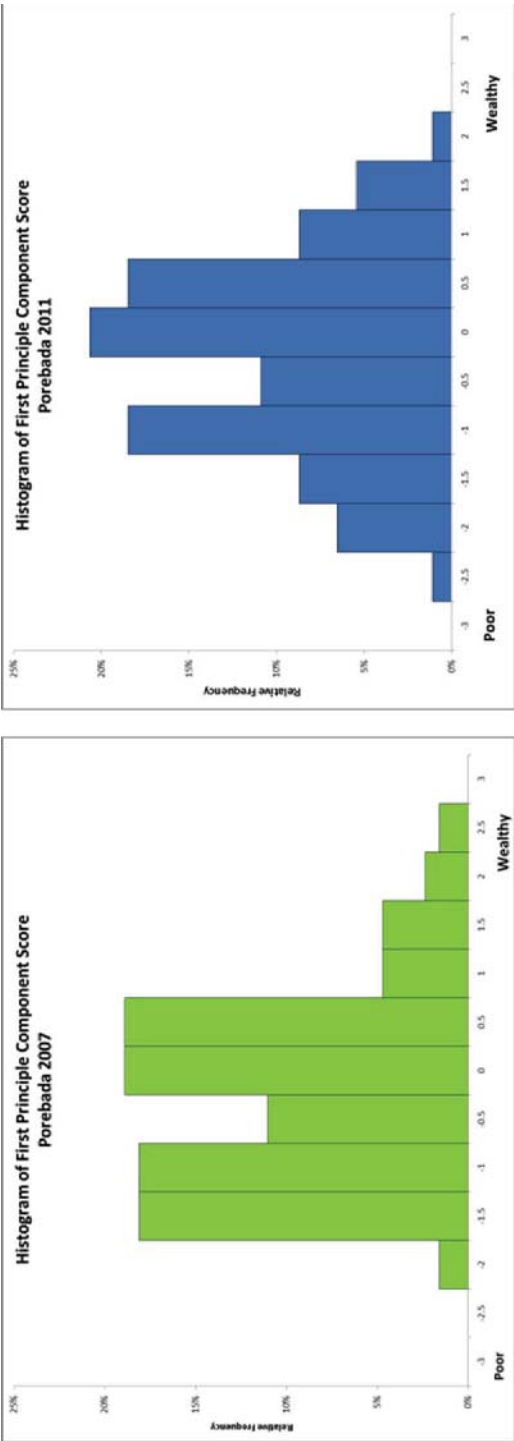


Figure 43. Histogram of first MCA Component Scores- All Villages Analysis- Boera



Women selling wild flowers arranged on sticks on the roadside, on the Highland highway to Tari, Hela Province

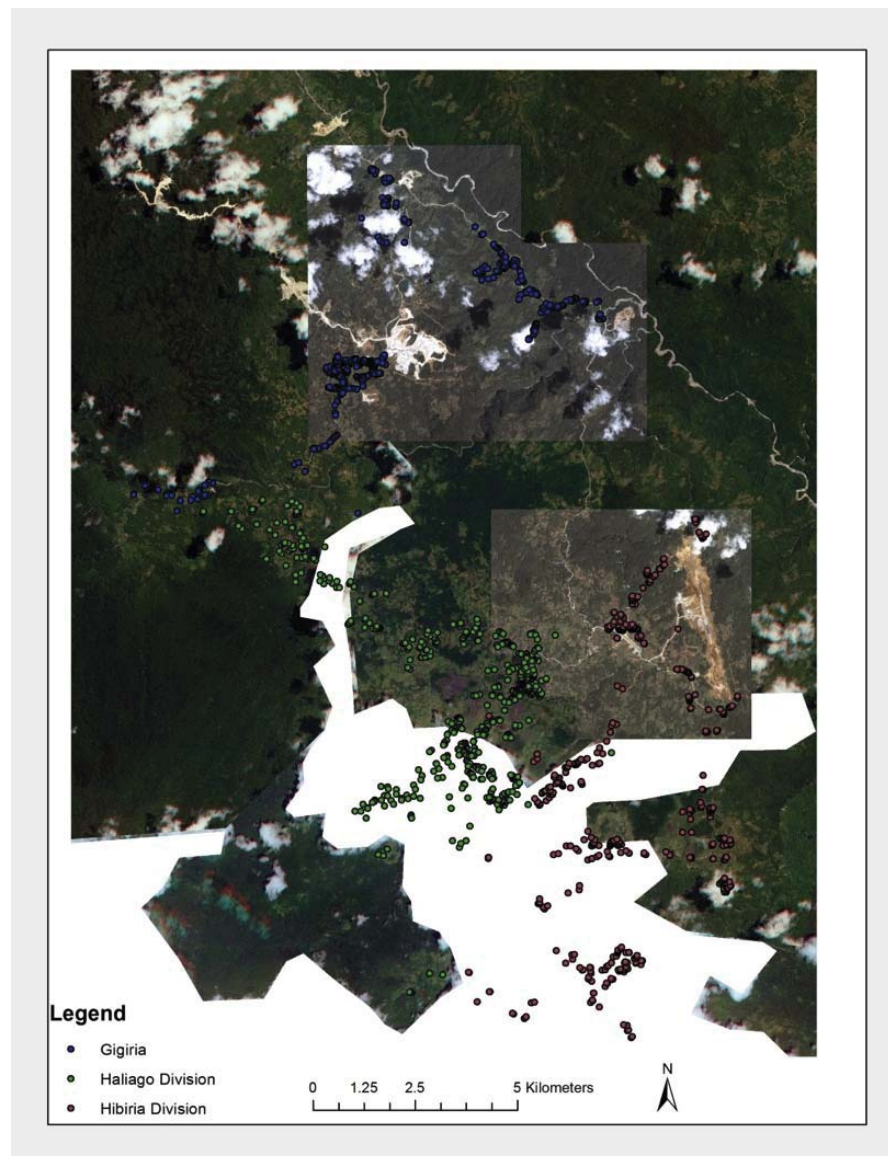
Brief Background

Komo-Hides is the site of the PNG-LNG plant, located in Komo district, Hela Province. People in this area are known as Huli and speak primarily Huli and Tok Pisin. The Huli are grouped in clans and subclans that operate autonomously. This area is rural and very remote. The Hides location, is home to the future PNG LNG gas conditioning plant and associated gas wells and critical transportation/logistics hubs. There is a new 5 kilometer-airport currently under construction in Komo area, near Malanda, to serve the PNG-LNG project and aid in the transport of big machinery and equipment. The main health facilities in this area included Malanda Health centre and Para clinic, and are run by Evangelical Church of Papua New Guinea (EC-PNG). There are nine elementary schools and two primary schools but no secondary/high school in this area(Goldman 2008).

Hides iHDSS is focused on three divisions: 1-Haliago; 2- Hibiria; 3- Gigiria. The Malanda Clinic is in Division 1. Due to terrain, logistics, security and time/cost considerations, the iHDSS "capture area" is limited but based on extensive field reconnaissance is felt to encompass the likely geographic area of potential impacts. The Hides/KomoiHDSS has been designed to monitor approximately 13-15,000 individuals. This population is comparable to the HiriHDSS. The Para Health Clinic and the Hides Gas Conditioning Plant (HGCP) are located in Division 3. The Komo Airfield is located in Division 2. High-resolution satellite imagery for the southernmost area of Hides captured by the iHDSS is not available.

Global Positioning System Mapping

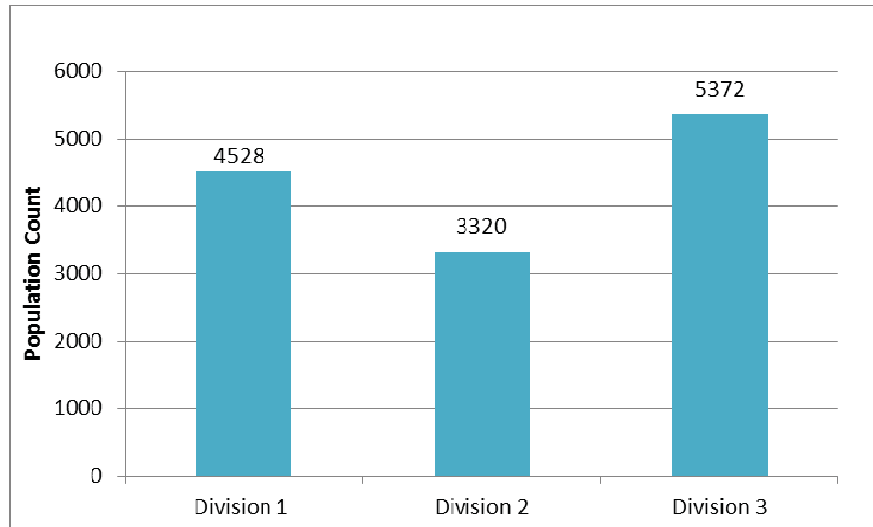
Figure 44.Hides/Komo iHDSS Imagery



The Population

The three divisions of Hides each have different makeups regarding population size and structure. Figure 45 shows the population distribution of Hides/Komo based on division.

Figure 45. Hides /Komo Population Count by Division



Figures 46-48 show the population pyramids for each of the divisions. Despite their close proximity to one another, the age distribution is quite different. Division 1 has a roughly equal distribution of people between the ages of 0-39, hovering around 10% for each 5-year increment in age. Division 2 has a large percentage of people age 25-29. Division 3 shows but a large number of adults age 25-29, as well as children in ages 0-9; however, there is also a noticeable lack of males age 20-24. These observed demographic “anomalies”, will be further evaluated in subsequent monitoring rounds/surveys.

Figure 46. Hides Division 1 Population Pyramid

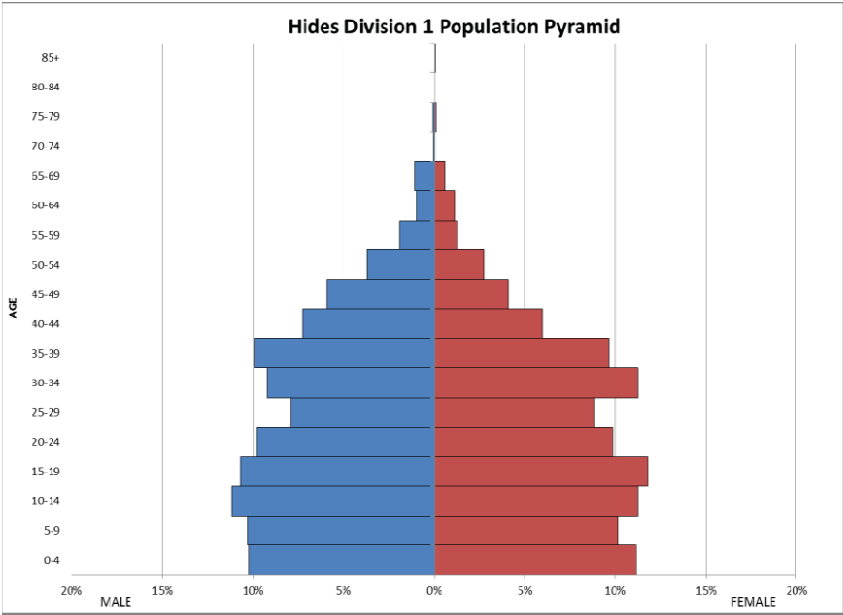


Figure 47. Hides Division 2 Population Pyramid.

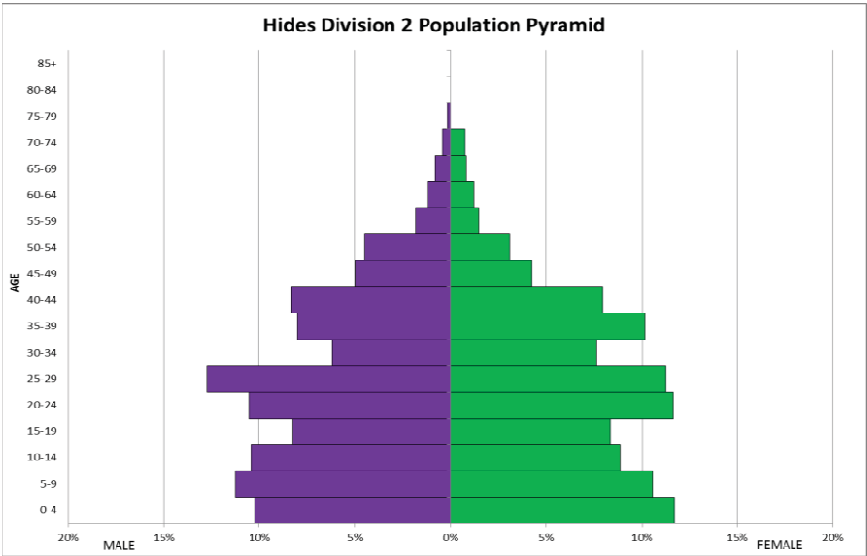
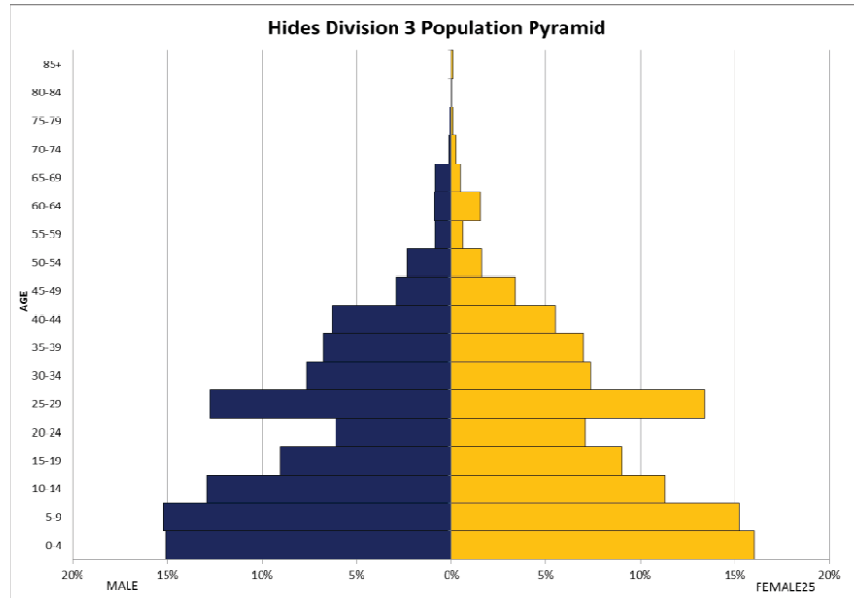


Figure 48. Hides Division 3 Population Pyramid.



Each of the Hides Divisions has more males than females, a pattern also observed by the HiriiHDSS. Table 20 shows the counts and sex ratios for all three divisions. Divisions 1 and 3 have a similar sex ratio, while Division 2 has proportionately highest number of females.

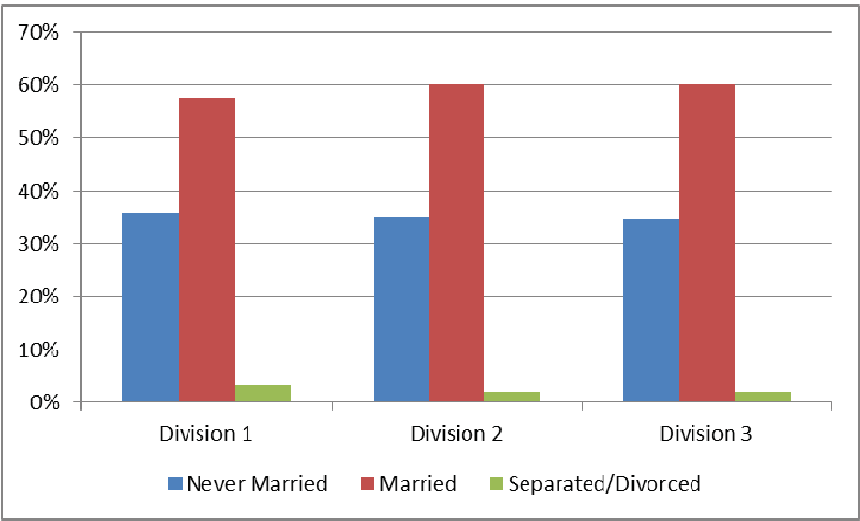
Table 20. Hides/Komo Population and Sex Ratio by Division.

	Male	Female	Unknown	Sex Ratio (Males/Females)
Division 1	2358	2151	19	109.6
Division 2	1710	1595	15	107.2
Division 3	2797	2548	28	109.7

The large percentage of males age 25-29 in Divisions 2 and 3 may be an indicator of employment-induced in-migration, as the Komo airfield and HGCP are the two largest sources of employment in the area. The location of the Para clinic may explain the comparatively large percentage of children in Division 3 as the clinic is the largest and most consistently open in the area. However, more ground level assessment is required in order to provide more definitive answers on the population patterns across all three divisions.

The distribution of marital status by division is shown in Figure 49. All three divisions show similar rates of marriage. Many Huli practice polygamy, with men taking on more wives as their wealth increases; further survey work is need to better evaluate this issue.

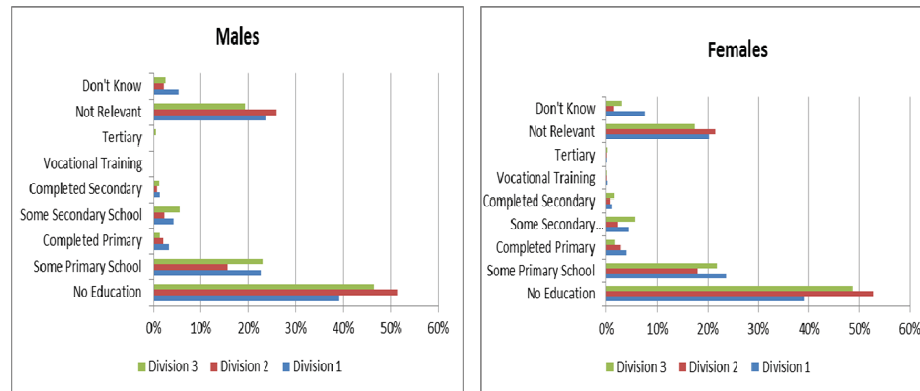
Figure 49. Hides/Komo Marital Status by Division



Education

The education status of Hides villagers, is shown by both sex and division in Figure 50. Household educational attainment in the Southern Highlands Province is historically poor and the initial census data confirms this finding.

Figure 50. Hides Educational Attainment Status by Sex and Division



Employment

Employment status by both division and sex is examined in Figure 51. For Divisions 1 & 2 the majority of residents are subsistence farmers. The number of people reporting employment within the *elementary occupations* category, which includes sales and service, waged agriculture, cash cropping, and laborer in mining and construction, are substantially higher for Division 3. As Table 21 illustrates, nearly all of this difference can be attributed to the labourer and construction category, which is likely a result of (i) proximity to major PNG LNG project activity and population density/proximity.

Figure 51. Employment Status for Adults by Sex and Division

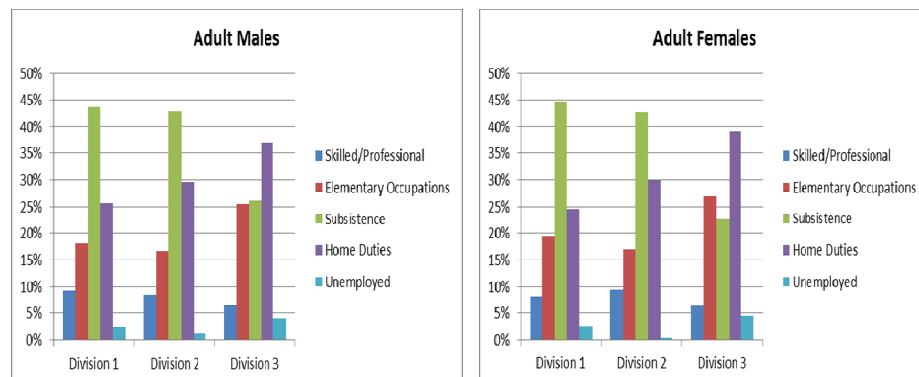
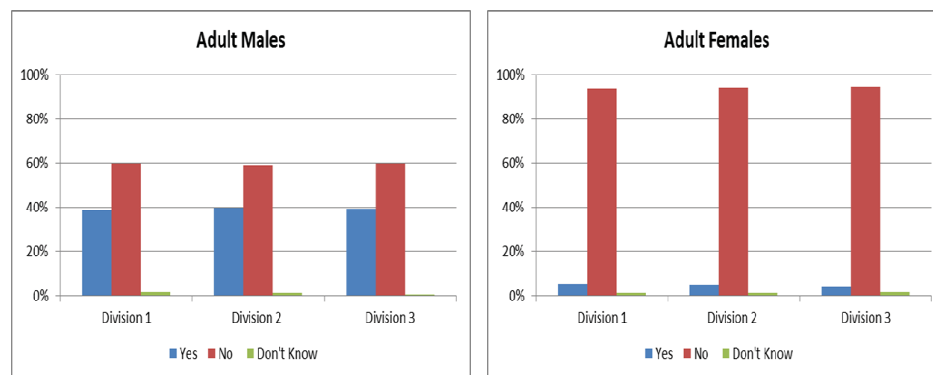


Table 21. Elementary Occupations by Division (male and female combined)

Occupation	Division 1	Division 2	Division 3
Sales and Service	35	52	9
Waged Agricultural	10	14	5
Cash Cropping	121	30	22
Misc.	9	0	2
Labourer in Mining or Construction	292	221	846

However, there is conflicting data. Figure 52 shows that for all divisions and sexes, the percentage of those employed within the LNG the project is similar. Further investigation and evaluation is ongoing by PNGIMR.

Figure 52. Percentage of Residents Employed by LNG Project by Sex and Division



Socioeconomic Indicators

This is the result of the “pilot study” in the Haliago Division, the survey covered 300 households, this is from convenient sample.

Almost all houses in the Haliago Divison are made up of traditional materials. 8.3% of the remaining houses are either constructed from permanent or semi-permanent materials (Figure 53).

Figure 53. Types of housing in Haliago (Hides/Komo iHDSS 2012) (N=300)

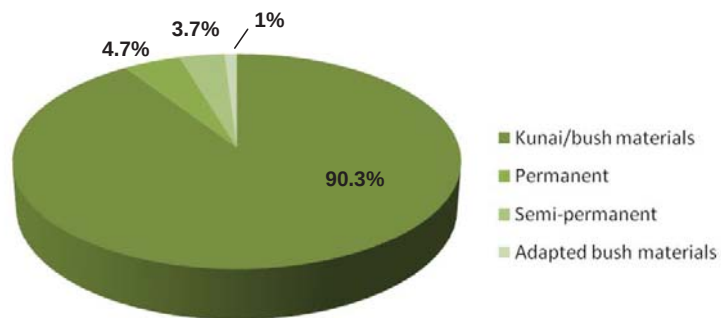
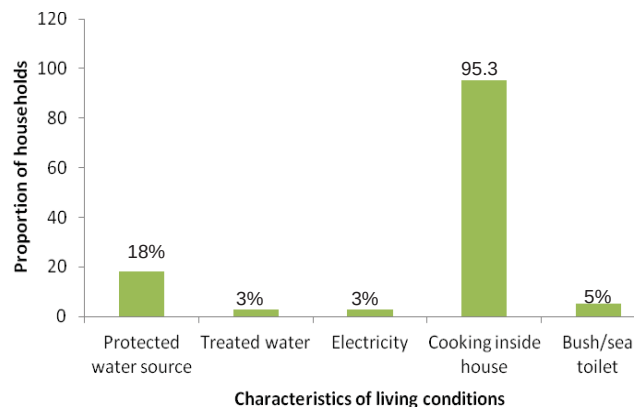
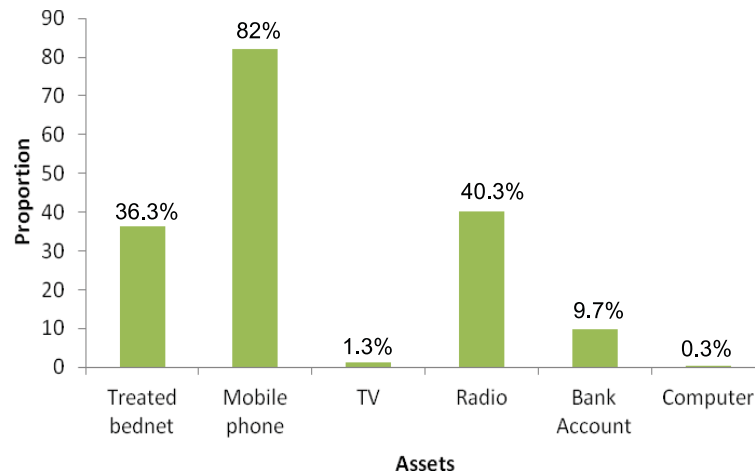


Figure 54. Characteristics of living conditions in Haliago (Hides/KomoiHDSS 2012) (N=300)



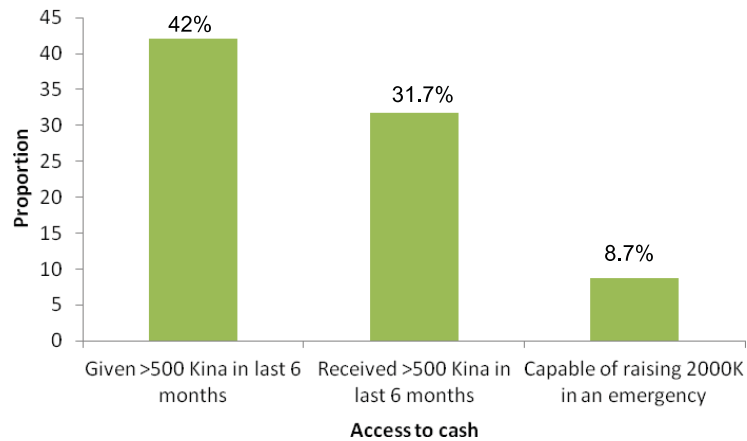
While up to 18% of households reported having access to protected water only about 3% had treated water. A similar number of households used electricity as their main source of lighting. 13% of households cooked indoors but about 70% also reported using a separate place for cooking (Figure 54). A common phenomenon in the highlands is the presence of a *hauscook*; a separate house intended specifically for cooking.

Figure 55. Proportion of households possessing selected assets Haliago (Hides/KomoiHDSS 2012) (N=300)



82% of respondents reported that member of their household owned at least one mobile phone while only 4 households have a television. Only 42% and 31.7% of households contributed or received more than 500 Kina to community events respectively. While this could indicate that people in the area have access to cash, only 8.2% felt that they could raise 2,000Kina in an emergency (Figure 56).

Figure 56. Proportion of households who have contributed or received more than 500Kina through social obligations in the past 6 months and those who report that they can raise 2000Kina in two weeks in Haliago (Hides/KomoiHDSS 2012) (N=300)



Wealth analysis in comparison with SIA

Socio-economic survey (SES) data 2012 for all divisions were not available at present; however, additional survey work is ongoing. Initial “pilot” Division is available. These data are compared to the 2007 SES data collected by the pre-project SIA.

Figures 57-58 demonstrate that villagers have not systematically made major structural improvements to their homes. Bush materials are the most common housing materials. The presence of iron/tin roofs or electricity is not statistically different five years later.

Figure 57. Hides Division 1 Housing Material Comparison from 2007 to 2012

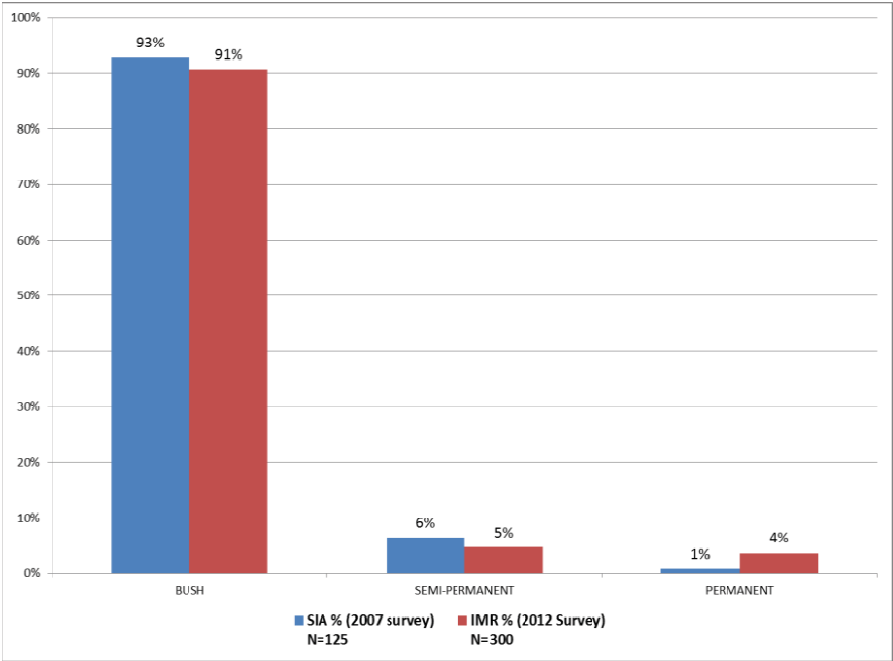
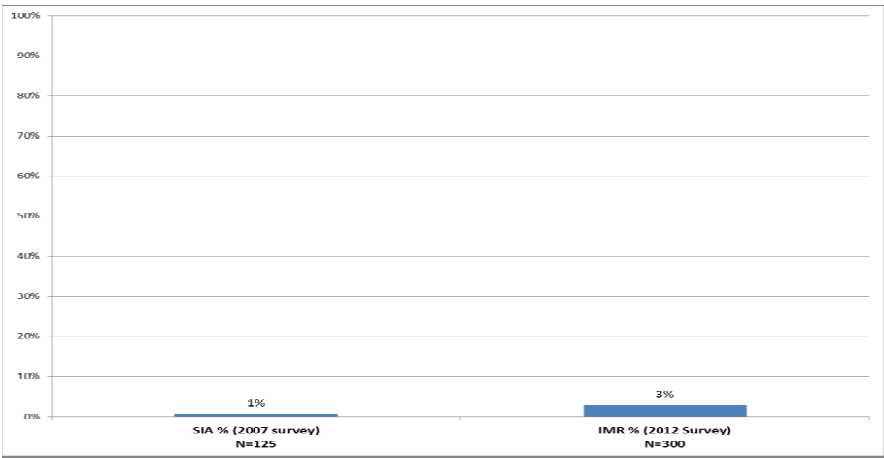
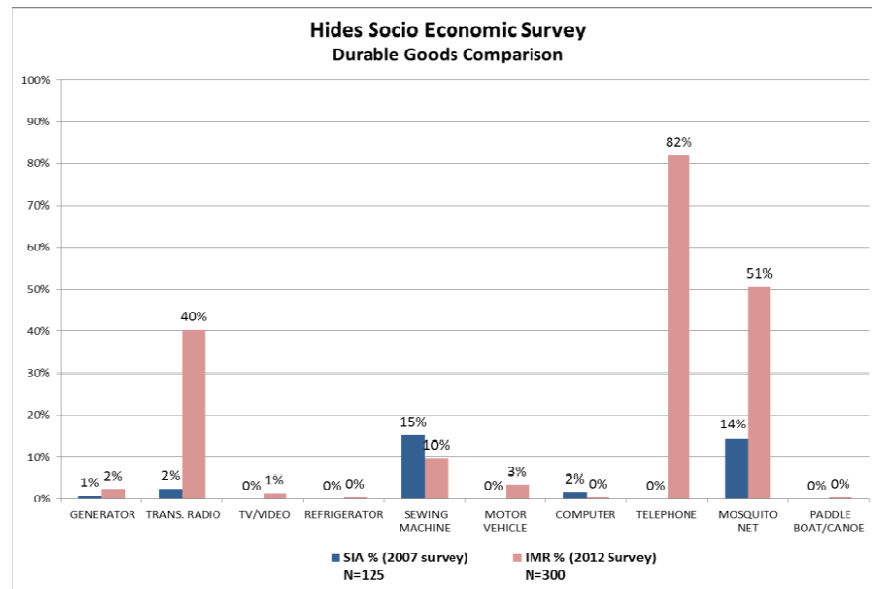


Figure 58. Hides Division 1 Percent of Homes with Electricity- Comparison from 2007 to 2012



Rather than spending money on structure upgrades, the pilot SES shows that much of the spending has come in the form of increased durable goods and livestock. Figure 59 shows that the main goods that Division 1 villagers are buying are radios, cell phones, and mosquito nets. Initial nutrition/food survey data also demonstrates a marked increase in “store/market” foods.

Figure 59. Hides Division 1 Percent of Household with Durable Goods – Comparison from 2007 to 2012



SES data on livestock shows an interesting connection. Figure 60 shows that the number of households with pigs or chickens has both seen a 15 percentage-point decrease. However, Figure 61 shows that the average number of chickens owned has nearly tripled, from 10 to 27, for each household that owns any livestock. Much of this increase in count, as well as the decrease in ownership percentage, is likely due to the creation of a project induced and sponsored commercial chicken market.

In 2007 there were no households that owned chickens for commercial purposes. By 2012, Figure 62 shows that 19% of all households had chickens for commercial purposes and another 8% had chickens for both domestic and commercial purposes.

Figure 60. Hides Division 1- Percent of Households with Livestock by Type

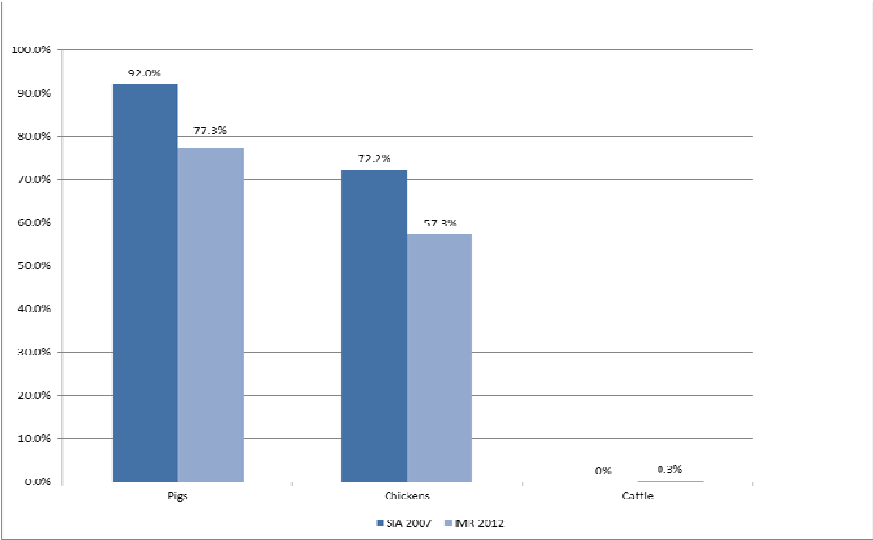


Figure 61. Hides Division 1- Average Number of Livestock Owned- 2007 to 2012 (Comparison of those who own at least one animal)

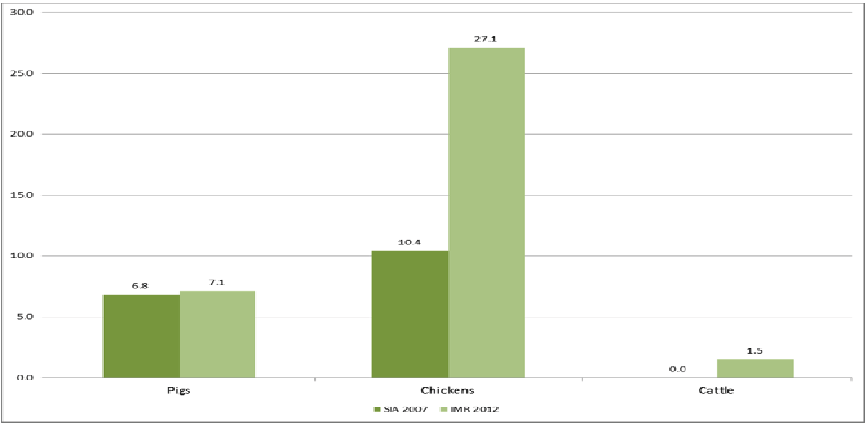
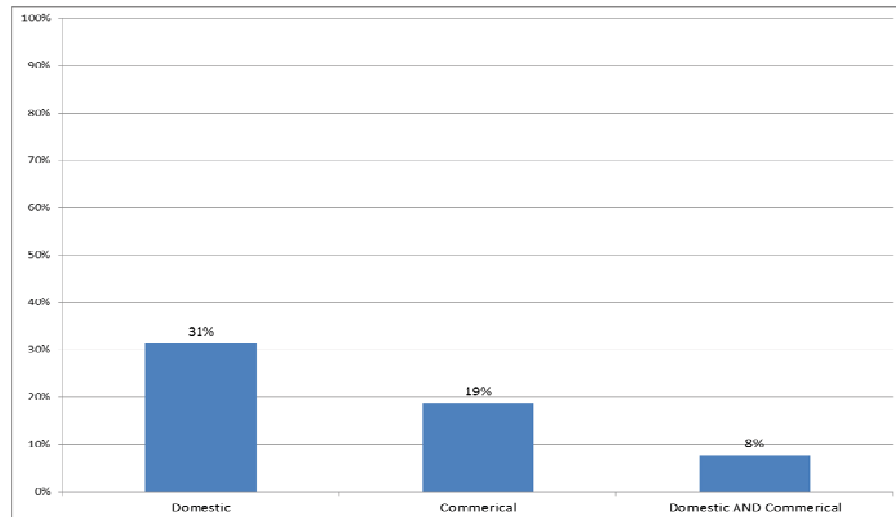


Figure 62. Hides Division 1- Chicken Ownership Type- 2012

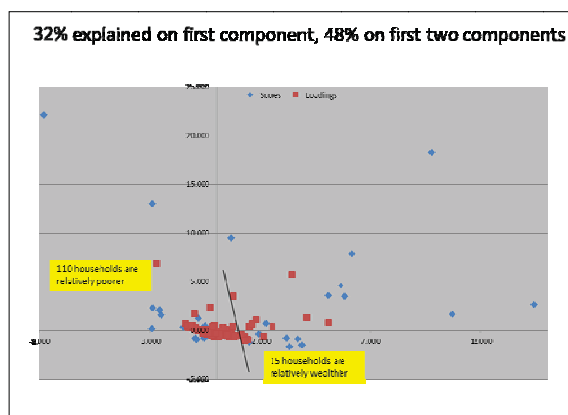


Multiple Correspondence Analysis (MCA) was performed to estimate the wealth of the potentially impacted Hiri villages. This same technique is used for Hides. Data are derived from the SES; hence, a wealth analysis can currently only be done on Division 1 residents.

Figure 60, shows the scores and loadings for the 2007 SIA survey of Division 1. As previously described in the Hiri analysis, “blue dots” proximal to one another correspond to households with similar levels of assets. The distance of red dots from the origin correspond to influence of assets that reflect the level of wealth of households in their proximity. Red dots substantially to the left of the origin correspond to key assets of the poorest households. Those furthest to the right of the origin correspond to assets that distinguish the highest level of wealth.

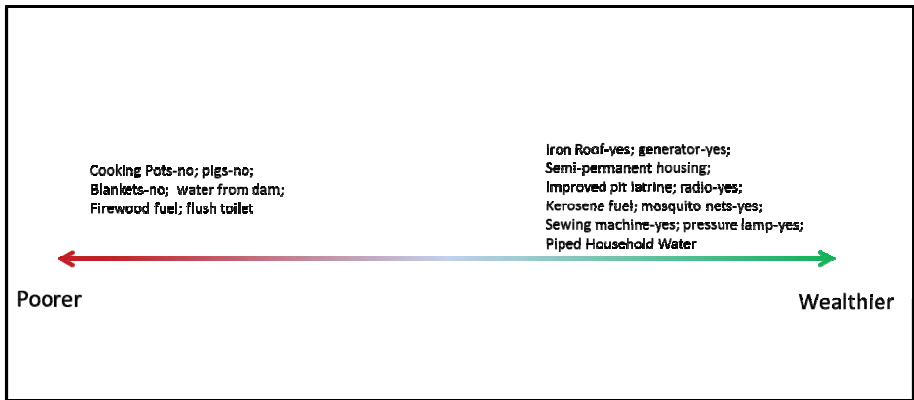
Only 32% of the overall variance can be explained by the first component. The addition of the second component increases the overall variance explained to nearly 50%. The vast majority of households are on the poor end of the spectrum, with only 15 of the 125 surveyed being classified as relatively wealthy.

Figure 63. Superposition of 2007 Scores and Loadings – Hides Division 1 Villages.



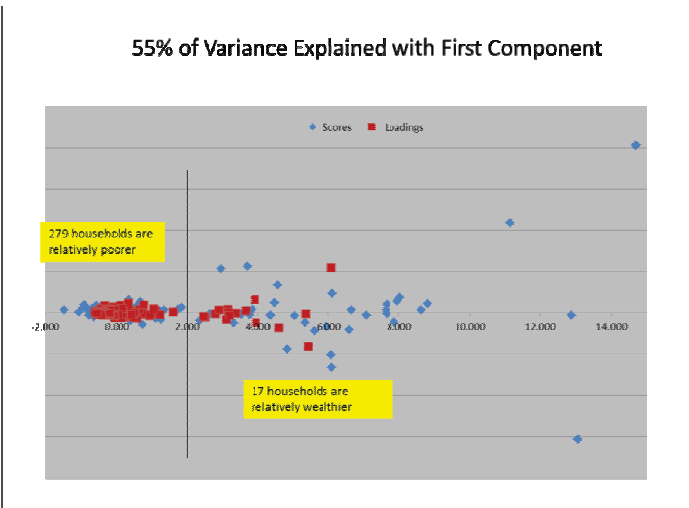
Those assets that have the greatest effect on wealth and poverty are shown in Figure 64. As previously discussed, the Division 1 villages had relatively few consumer durable goods; thus, those households who do have consumer durables are 'wealthier.' Those households that had metal roofs or semi-permanent homes were also those that were the wealthiest. A flush toilet as an indicator of being relatively poor is a statistical anomaly and should be discounted.

Figure 64. Hides Asset Combinations Associated with Relative Levels of Wealth (scores)- 2007



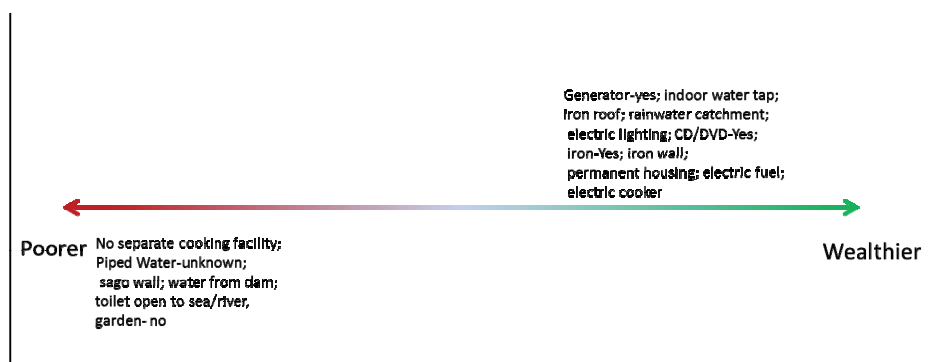
The results of the MCA for the 2012 SES data are shown in Figure 65. One component explains most of the variance in the data. A score above 2 indicates that the household is relatively wealthy, while a score below 2 indicates that the household is relatively poorer.

Figure 65. Superposition of 2012 Scores and Loadings – Hides Division 1 Villages



As was the case for the 2007 asset analysis, the presence of durable goods and housing improvements indicates a wealthier household. The 2012 asset combinations are shown in Figure 66. Poorer households appear to be relatively transient, while wealthier households have more permanent structures and consumer durables.

Figure 66. Hides Division 1 Asset Combinations Associated with Relative Levels of Wealth (scores)- 2012



An initial comparison of Figures 63 and 65 indicates that marginal changes in household wealth have occurred. This is due to the large clustering around the origin that makes wealth analysis based on these graphs difficult. Figure 67 provides greater clarification by showing a histogram of the first MCA component scores. In comparing 2007 to 2012, the histogram makes clear that the number of households at the extreme end of poverty have now disappeared. There has also been a marginal increase at the tail end of the wealth spectrum, indicating that some households are greatly increasing their wealth.

This preliminary data indicates that the PNG LNG project is positively impacting household level wealth.

As further data are available the analysis will be expanded, as it is quite likely that positive wealth effects will be observed in other divisions, particularly Division 3. However, there is the potential for negative impacts to those who did not have access to employment or other payment from the PNG LNG project as costs for food, goods and transportation have been observed to have increased.

Figure 67. Histogram of first MCA component scores-Hides Division 1

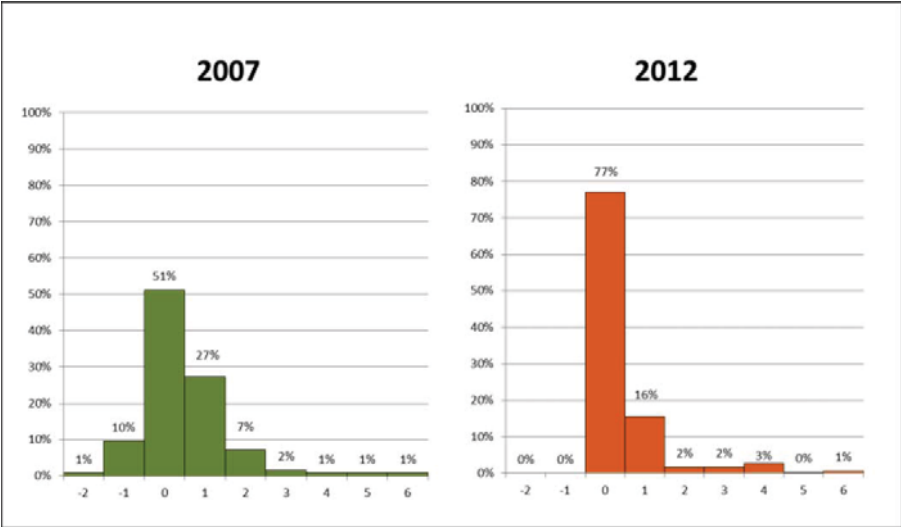




Figure 68. Village reporters conducted the census survey in Kar Kar iHDSS

Brief Background

It is a volcanic island located 30km off of the PNG coast in the Bismarck Sea and is part of Madang Province. Inhabitants of the island come from one of two language groups; Waskia in the North half of the island and Taskia in the South. Most inhabitants are either Lutheran or Catholic.

One main road runs around the coast of the island and provides access to the three available health facilities (Figure 69). Gaubin Hospital is the largest of the facilities and is a Lutheran run institution.

The island's soil is known for its fertility and large plantations produce the island's main exports of cocoa and coconut and provide a large amount of the local employment opportunities. The total population of Karkar is about 60,000. From a PNGIMR perspective, a sample of about 20,000 was felt to be fully representative of the overall island population. Target recruitment goals were achieved using random cluster sampling to select villages weighted by size. Karkar has been unaffected by the extensive and intensive mining activity that has occurred in Madang; hence, Karkar was felt to be an appropriate "coastal control/comparison community" that could be compared to Hiri District communities.

The Population

At the time of writing this report the first Karkar census was complete and data entry ongoing. Presented here are the first 5,214 individuals to be recorded in the census and to have complete data entered and cleaned. The age and sex distribution has been calculated for this sample (Table 22).

Table 22. Total Karkar (iHDSS 2012) population distribution by age and sex (%)

Age (yrs)	All	Males	Females
All ages	5,188	2,713	2,475
0-4	699 (13.5)	371 (13.7)	328 (13.3)
5-9	736 (14.2)	404 (14.9)	332 (13.4)
10-14	558 (10.8)	278 (10.3)	280 (11.3)
15-19	582 (11.2)	294 (10.8)	288 (11.6)
20-24	423 (8.2)	220 (8.1)	203 (8.2)
25-29	410 (7.9)	207 (7.6)	203 (8.2)
30-34	328 (6.3)	177 (6.5)	151 (6.1)
35-39	344 (6.6)	185 (6.8)	159 (6.4)
40-44	276 (5.3)	138 (5.1)	138 (5.6)
45-49	242 (4.7)	129 (4.8)	113 (4.6)
50-54	205 (4.0)	106 (3.9)	99 (4.0)
55-59	117 (2.3)	62 (2.3)	55 (2.2)
60-64	85 (1.6)	47 (1.7)	38 (1.5)
65-69	64 (1.2)	33 (1.2)	31 (1.3)
70-74	77 (1.5)	39 (1.4)	38 (1.5)
75-79	19 (0.4)	10 (0.4)	9 (0.4)
80-84	15 (0.3)	10 (0.4)	5 (0.2)
85+	8 (0.2)	3 (0.1)	5 (0.2)
0-14	1,993	1,053	940
15-64	3,012	1,565	1,447
65+	183	95	88

Figure 70. Population pyramid of a portion of the Karkar (iHDSS 2012) population

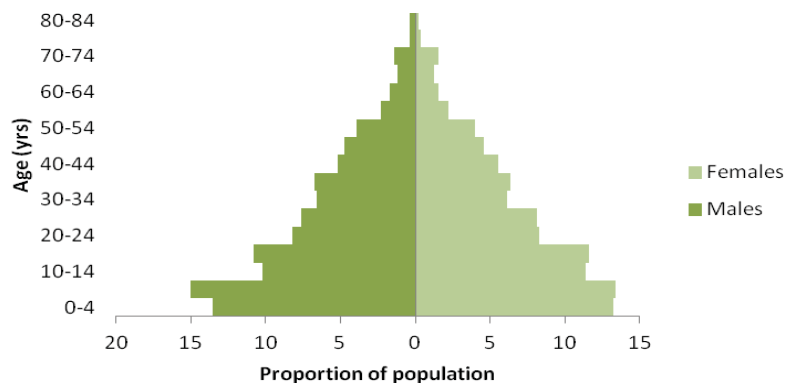


Table 23. Age and sex characteristic of a portion of the Karkar (iHDSS 2012) population

	All	Males	Females	Male:Female
Proportion of population between 0 and 14 (%)	38.4	38.8	38.0	110:100
Proportion of population between 15 and 64 (%)	58.1	57.7	58.5	108:100
Proportion of population over 65 (%)	3.5	3.5	3.6	108:100
Median age (years)	20	20	20	-
Dependency Ratio	72.1	-	-	-

With the largest proportion of their population between the ages of 0 and 14 (Figure 70), Karkar has the highest dependency ratio observed across the four iHDSS sites (Table 23). This is a young population that is growing rapidly. The male to female ratio is consistently high across the defined age groups

More people report having never attended formal education than observed in Hiri iHDSS; however, large numbers of males and females do attend some primary school. Very few people in the Karkar iHDSS presented here went on to complete secondary or continue to tertiary relative to Hiri (Tables 22 and 23).

Between 40% and 45% (females and males) of Karkar respondents report being primarily subsistence based.

Education

Table 24. Educational attainment amongst males by age in Karkar Island iHDSS 2012 (%)

Age (yrs)	No Education	Some Primary	Complete Primary	Some Secondary	Completed Secondary	National High School	Vocational	Tertiary	Don't know or NA	Total
5-14	81 (11.9)	358 (52.6)	1 (0.2)	-	-	-	-	-	239 (35.1)	679
15-24	11 (2.1)	330 (64.2)	102 (19.8)	44 (8.6)	8 (1.6)	1 (0.2)	14	3 (0.6)	1 (0.2)	514
25-34	24 (6.3)	187 (48.7)	75 (19.5)	65 (16.9)	8 (2.1)	1 (0.3)	15	8 (2.1)	1 (0.3)	384
35-44	12 (3.7)	215 (66.8)	20 (6.2)	46 (14.3)	7 (2.2)	2 (0.6)	7	9 (2.8)	4 (1.2)	322
45-54	15 (6.0)	174 (69.9)	13 (15.2)	28 (11.2)	2 (0.8)	1 (0.4)	3	10 (4.0)	3 (1.2)	249
55-64	11 (11.8)	60 (64.5)	-	9 (9.7)	2 (2.2)	1 (1.1)	-	8 (8.6)	2 (2.2)	93
65-74	7 (9.9)	41 (57.8)	5 (7.0)	6 (8.5)	-	-	-	3 (4.2)	9 (12.7)	71
75-84	0	13 (68.4)	2 (10.5)	1 (5.3)	-	-	1 (5.3)	1 (5.3)	1 (5.3)	19
85+	1 (33.3)	2 (66.7)	-	-	-	-	-	-	-	3
		1380								
All	162 (6.9)	59.1	218 (9.3)	199 (8.6)	27 (1.2)	7 (0.3)	40 (1.7)	42 (1.8)	260 (11.1)	2,336

Table 25. Educational attainment amongst females by age in Karkar Island IHDSS 2012 (%)

Age (yrs)	No Education	Some Primary	Completed Primary	Some Secondary	Completed Secondary	National High School	Vocational	Tertiary	Don't know or NA	Total
5-14	59 (9.6)	353 (57.7)	2 (0.3)	-	-	-	-	-	195 (31.9)	610
15-24	23 (4.7)	298 (60.8)	114 (23.3)	44 (9.0)	6 (1.2)	-	2 (0.4)	2 (0.4)	1 (0.2)	490
25-34	8 (2.3)	211 (59.6)	66 (18.6)	52 (14.7)	11 (3.1)	-	-	4 (1.1)	2 (0.6)	354
35-44	16 (5.4)	222 (74.8)	21 (7.1)	26 (8.8)	3 (1.0)	-	1 (0.3)	3 (1.0)	5 (1.7)	297
45-54	20 (8.9)	165 (73.0)	5 (2.2)	22 (9.7)	2 (0.9)	-	1 (0.4)	3 (1.3)	8 (3.5)	226
55-64	18 (22.8)	54 (68.4)	-	3 (3.8)	-	-	-	-	4 (5.1)	79
65-74	12 (18.2)	45 (68.2)	3 (4.6)	-	-	-	-	-	6 (9.1)	66
75-84	1 (7.1)	8 (57.1)	-	-	-	-	-	-	5 (35.7)	14
85+	-	3 (60.0)	-	-	-	-	-	-	2 (40.0)	5
All	157 (7.3)	1359 (63.4)	211 (9.9)	147 (7.0)	22 (1.0)	-	4 (0.2)	12 (0.6)	228 (10.6)	2,143

Employment

Table 26. Occupational type amongst males in Karkar Island iHDSS 2012 (%)

Age (yrs)	Professional	Skilled	Unskilled	Subsistence	Current Student	Unemployed	Military	Don't know or NA	Total
15-24	5 (1.0)	5 (1.0)	79 (15.4)	126 (24.5)	288 (56.0)	9 (1.8)	-	2 (0.4)	514
25-34	8 (2.1)	14 (3.7)	129 (33.7)	207 (54.1)	14 (3.7)	7 (1.8)	1 (0.3)	3 (0.8)	383
35-44	15 (4.7)	23 (7.2)	99 (30.8)	174 (54.2)	2 (0.6)	4 (1.3)	2 (0.6)	2 (0.6)	321
45-54	15 (6.4)	15 (6.4)	58 (24.8)	141 (60.3)	-	1 (0.4)	2 (0.9)	2 (0.9)	234
55-65	5 (4.6)	8 (7.3)	30 (27.5)	63 (57.8)	-	-	2 (1.8)	1 (0.9)	109
All	48 (3.1)	65 (4.2)	395 (25.3)	711 (45.6)	304 (19.5)	21 (1.4)	7 (0.5)	10 (0.6)	1,561

Table 27. Occupational type amongst females in Karkar Island iHDSS 2012 (%)

Age (yrs)	Professional	Skilled	Unskilled	Subsistence	Current Student	Unemployed	Military	Don't know or NA	Total
15-24	-	3 (0.6)	150 (30.7)	117 (23.9)	210 (42.9)	3 (0.6)	3 (0.6)	3 (0.6)	489
25-34	9 (2.5)	1 (0.3)	162 (45.8)	175 (49.4)	2 (0.6)	1 (0.3)	1 (0.3)	3 (0.9)	354
35-44	10 (3.4)	2 (0.7)	133 (44.9)	149 (50.3)	-	1 (0.3)	-	1 (0.3)	296
45-54	3 (1.4)	2 (1.0)	109 (51.7)	96 (45.5)	-	1 (0.5)	-	-	211
55-65	-	-	38 (41.3)	52 (56.5)	-	-	-	2 (2.2)	92
All	22 (1.5)	8 (0.6)	592 (41.1)	589 (40.9)	212 (14.7)	6 (0.4)	4 (0.3)	9 (0.6)	1,442

Socioeconomic Indicators

A slight majority of surveyed Karkar houses are constructed from traditional materials (40.1%); however, 38%, use a mixture of modern materials in order to build semi-permanent structures (Figure 71).

Figure 71. Types of housing in portion of Karkar iHDSS 2012 population (n=192)

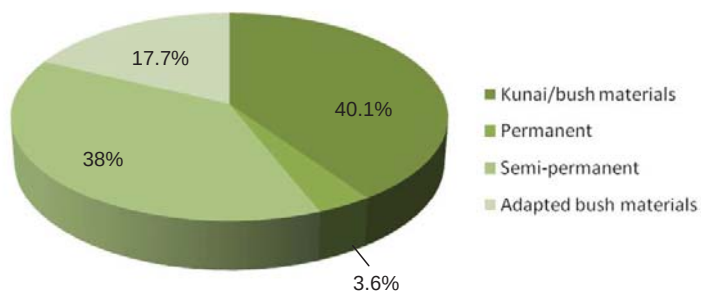


Figure 72. Proportion of households possessing selected assets in portion of Karkar iHDSS 2012 population (n=192)

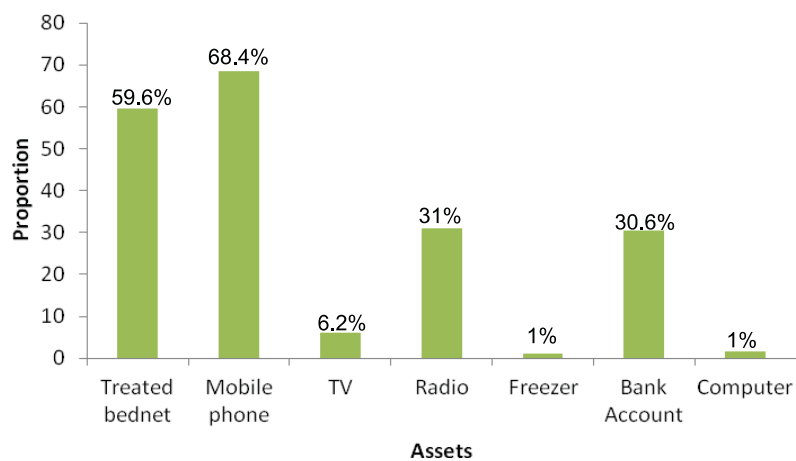
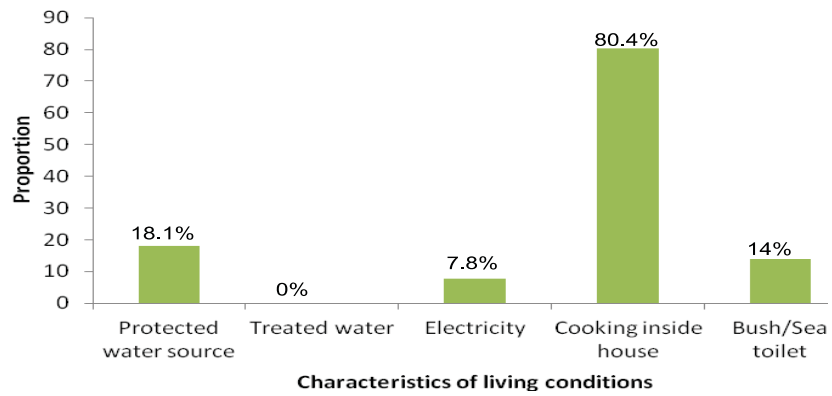
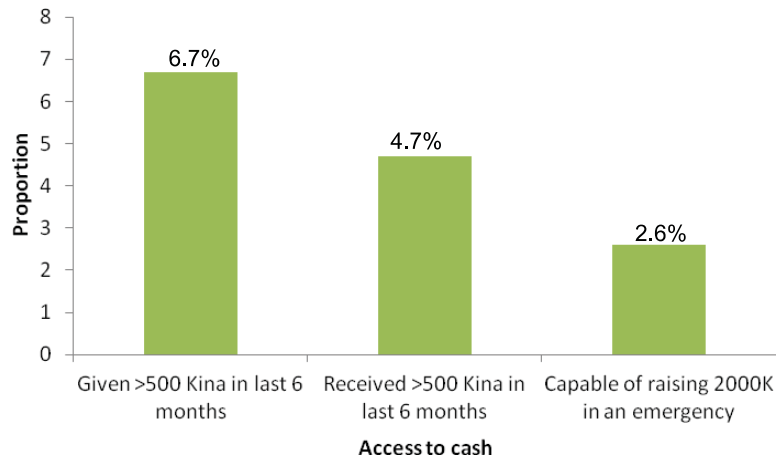


Figure 73. Characteristics of living conditions in portion of Karkar iHDSS 2012 population (n=192)



While mobile phone ownership is high, electrical goods like televisions and freezers are owned by few people (Figure 72). Access to electricity is limited with only 7.8% of households using electricity as their main source of lighting. Only 18.1% reported access to protected water. Almost everyone reported cooking inside their homes (Figure 73).

Figure 74. Proportion of households who have contributed or received more than 500Kina through social obligations in the past 6 months and those who report that they can raise 2000Kina in two weeks in a portion of the Karkar iHDSS 2012 population (n=192)



Very few people reported contributing or receiving more than 500 Kina in social obligations and only 2.6% of respondents felt that they could raise 2,000 Kina in an emergency (Figure 75). Residents of Karkar Island are likely to be the least 'monetised' of the communities surveyed in the PiH project. With limited employment opportunities on the island people are more dependent on subsistence gardening and small local trade of foods.



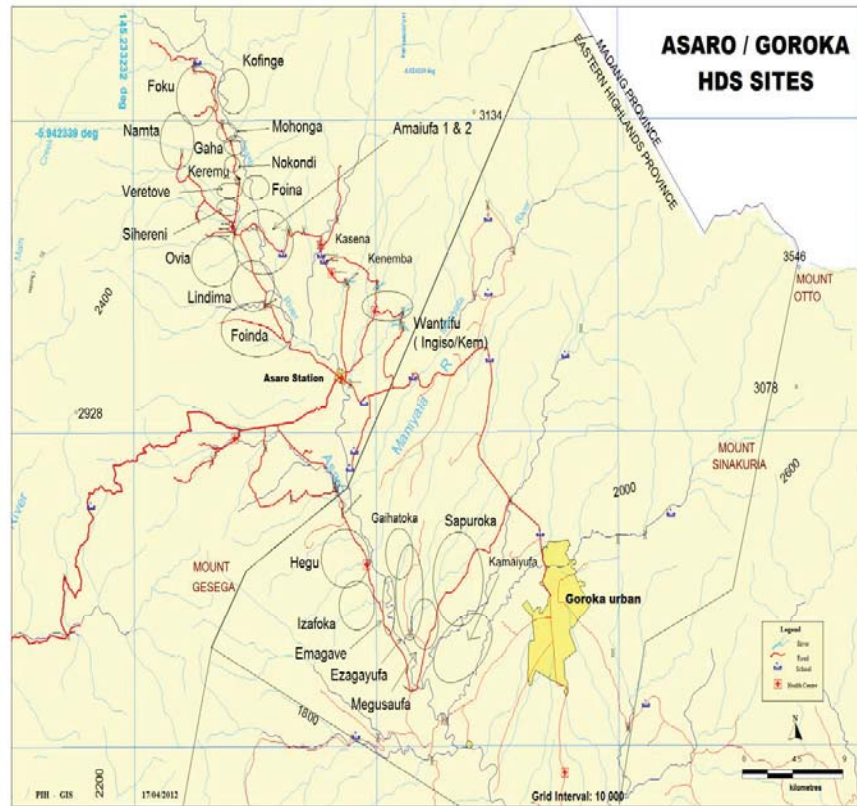
Figure 75. A common housing style with bush materials in Asaro iHDSS

Background and History

The Papua New Guinea Institute of Medical Research (PNGIMR) in Goroka has an established Demographic Surveillance System (DSS) in the Asaro Valley for a decade in 1980s by Deborah Lehmann and the team. The demography has been re-established under PiH project in 2011. The Asaro Valley lies 6° south of the equator and people live between 1500 and 1900 metres above sea level. The DSS site is within 40 kilometres and 45 minutes drive of Goroka Town. Rural people in the Asaro Valley live in hamlets, grouped together into villages and most houses are made out of bush material. People are primarily subsistence farmers, but earn cash through smallholder production of coffee, employment on plantations and marketing of garden produce (Benediktsson 2002). There are three main local languages 'tokples', Asaro, Gahuku and Siane are spoken in the DSS area. Melanesia pidgin *tok pisin* is widely spoken throughout the valley and was the main avenue of communication of non-'tokples' speakers and local inhabitants. However, most of our field reporters belong to one of the 'tokples' groups, which greatly facilitates our communication with local people. This defined population was used to derive the study population sample GPS Mapping and Sample Selection

Global Positioning System Mapping Results

Figure 76. Map of Villages covered in the AsaroiHDSS 2011



The Population

The population age and sex distribution is overall similar to other sites with large numbers of 0-14 year olds and, on average, more males than females (Table 28 and Figure 77). One exception is the more even sex ratios in older age groups.

Table 28. Total Asaro iHDSS (2011) population distribution by age and sex

Age (yrs)	All	Males	Females
All ages	10,034	5,098	4,936
0-4	1118 (11.1)	579 (11.4)	539 (10.9)
5-9	1284 (12.8)	648 (12.7)	636 (12.9)
10-14	1037 (10.3)	543 (10.7)	494 (10)
15-19	925 (9.2)	506 (9.9)	419 (8.5)
20-24	778 (7.8)	393 (7.7)	385 (7.8)
25-29	841 (8.4)	391 (7.7)	450 (9.1)
30-34	682 (6.8)	305 (6)	377 (7.6)
35-39	759 (7.6)	387 (7.6)	372 (7.5)
40-44	621 (6.2)	293 (5.8)	328 (6.7)
45-49	437 (4.4)	234 (4.6)	203 (4.1)
50-54	376 (3.7)	193 (3.8)	183 (3.7)
55-59	331 (3.3)	181 (3.6)	150 (3)
60-64	292 (2.9)	169 (3.3)	123 (2.5)
65-69	234 (2.3)	111 (2.2)	123 (2.5)
70-74	131 (1.3)	73 (1.4)	58 (1.2)
75-79	76 (0.8)	33 (0.7)	43 (0.9)
80-84	51 (0.5)	25 (0.5)	26 (0.5)
85+	61 (0.3)	34 (0.7)	27 (0.5)
0-14	3439	1770	1669
15-64	6042	3052	2990
65+	553	276	277

Figure 77. Population pyramid of the total Asaro (iHDSS 2011) population

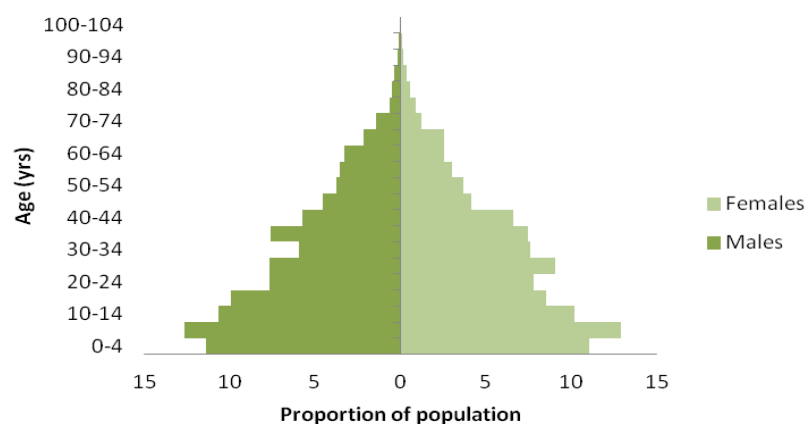


Table 29. Age and sex characteristic of the total Asaro (iHDSS 2011) population

	All	Males	Females	Male:Female
Proportion of population between 0 and 14 (%)	34.3	34.7	33.8	106:100
Proportion of population between 15 and 64 (%)	60.2	59.9	60.6	102:100
Proportion of population over 65 (%)	5.5	5.4	5.6	100:100
Median age (years)	22	21	23	-
Dependency Ratio	66.1	-	-	-

Table 30. Number of deaths and mortality rates (/1000)by age in Asaro iHDSS (2011)

Age (yrs)	Population in 2011	Number of deaths in 2011	Mortality rate /1000
0-4	1118	18	16.10
5-14	2321	4	1.72
15-44	4606	28	6.08
45-59	1144	14	12.24
60-69	526	20	38.02
70+	292	26	89.04
All Ages	10034	110	10.96

Education

Table 31. Educational attainment amongst males by age in Asaro iHDSS 2011 (%)

Age (yrs)	No Education	Some Primary	Completed Primary	Some Secondary	Completed Secondary	National High School	Vocational	Tertiary	Don't know or NA	Total
5-14	62 (5.2)	667 (56.0)	5 (0.4)	-	-	-	-	2 (0.2)	443 (37.2)	1,191
15-24	104 (11.6)	514 (57.2)	54 (6.0)	165 (18.4)	33 (3.7)	6 (0.7)	10 (1.1)	12 (1.3)	1 (0.1)	899
25-34	115 (16.5)	340 (48.9)	43 (6.2)	134 (19.3)	28 (4.0)	1 (0.1)	6 (0.9)	25 (3.6)	4 (0.6)	696
35-44	186 (27.4)	311 (45.7)	47 (6.9)	77 (11.3)	18 (2.7)	-	5 (0.7)	28 (4.1)	8 (1.2)	680
45-54	202 (42.3)	187 (39.1)	20 (4.2)	35 (7.3)	6 (1.3)	1 (0.2)	2 (0.4)	18 (3.8)	7 (1.5)	478
55-64	181 (60.5)	86 (28.8)	7 (2.3)	8 (2.7)	2 (0.7)	-	1 (0.3)	7 (2.3)	7 (2.3)	299
65-74	119 (64.7)	35 (19.0)	-	3 (1.6)	-	-	1 (0.5)	4 (2.2)	22 (12.0)	184
75-84	41 (70.7)	7 (12.1)	-	1 (1.7)	-	-	1 (1.7)	-	8 (13.8)	58
85+	21 (61.8)	3 (8.8)	1 (2.9)	-	-	-	-	-	9 (26.5)	34
	1031								509	
All	(22.8)	2150 (47.6)	177 (3.9)	433 (9.6)	89 (2.0)	8 (0.2)	26 (0.6)	96 (2.1)	(11.3)	4,519

Table 32. Educational attainments amongst females by age in Asaro iHDSS 2011 (%)

Age (yrs)	No Education n	Some Primary	Complete Primary	Some Secondary	Completed Secondary	National High School	Vocational	Tertiary	Don't know or NA	Total
5-14	54 (4.8)	645 (57.1)	5 (0.4)	-	-	-	-	3 (0.3)	413 (36.6)	1,130
15-24	126 (15.7)	477 (59.3)	57 (7.1)	109 (13.6)	11 (1.4)	4 (0.5)	4 (0.5)	9 (1.1)	7 (0.9)	804
25-34	246 (29.8)	396 (47.9)	46 (5.6)	91 (11.0)	12 (1.5)	1 (0.1)	3 (0.4)	14 (1.7)	18 (2.2)	827
35-44	354 (50.6)	257 (36.7)	21 (3.0)	35 (5.0)	1 (0.1)	-	4 (0.6)	13 (1.9)	15 (2.1)	700
45-54	318 (75.9)	73 (17.4)	5 (1.2)	9 (2.2)	3 (0.7)	-	1 (0.2)	4 (1.0)	6 (1.4)	419
55-64	200 (83.3)	26 (10.8)	1 (0.4)	1 (0.4)	-	-	-	2 (0.8)	10 (4.2)	240
65-74	157 (86.7)	4 (2.2)	-	2 (1.1)	-	-	-	-	18 (9.9)	181
75-84	51 (73.9)	1 (1.5)	-	-	-	-	-	-	17 (24.6)	69
85+	18 (66.7)	-	-	-	-	-	-	-	9 (33.3)	27
All	1524 (34.7)	1879 (42.7)	135 (3.1)	256 (5.8)	28 (0.6)	5 (0.1)	12 (0.3)	45 (1.0)	513 (11.7)	4,397

Employment

Table 33. Occupational types amongst males in Asaro iHDSS 2011 (%)

Age (yrs)	Professional	Skilled	Unskilled	Subsistence	Current Student	Unemployed	Military	Don't know or NA	Total
15-24	7 (0.8)	3 (0.3)	115 (12.8)	275 (30.6)	456 (50.7)	23 (2.6)	7 (0.8)	13 (1.5)	899
25-34	48 (6.9)	6 (0.9)	208 (29.9)	388 (55.8)	28 (4.0)	10 (1.4)	4 (0.6)	4 (0.6)	696
35-44	49 (7.2)	12 (1.8)	210 (30.9)	387 (56.9)	3 (0.4)	2 (0.3)	(1.6)	6 (0.9)	680
45-54	31 (7.3)	10 (2.3)	118 (27.6)	251 (58.8)	1 (0.2)	4 (0.9)	7 (1.6)	5 (1.2)	427
55-65	11 (3.1)	5 (1.4)	86 (24.6)	238 (68.0)	1 (0.3)	3 (0.9)	1 (0.3)	5 (1.4)	350
All	146 (4.8)	36 (1.2)	737 (24.2)	1539 (50.4)	489 (16.0)	42 (1.4)	30 (1.0)	33 (1.1)	3,052

Table 34. Occupational types amongst females in Asaro iHDSS 2011 (%)

Age (yrs)	Professional	Skilled	Unskilled	Subsistence	Current Student	Unemployed	Military	Don't know or NA	Total
15-24	11 (1.4)	5 (0.6)	139 (17.3)	363 (45.2)	256 (31.8)	16 (2.0)	1 (0.1)	13 (1.6)	804
25-34	22 (2.7)	4 (0.5)	210 (25.4)	558 (67.5)	11 (1.3)	10 (1.2)	-	12 (1.5)	827
35-44	25 (3.6)	5 (0.7)	175 (25.0)	487 (69.6)	-	-	2 (0.3)	6 (0.9)	700
45-54	7 (1.8)	1 (0.3)	102 (26.4)	267 (69.2)	-	2 (0.5)	2 (0.5)	5 (1.3)	386
55-65	2 (0.7)	-	38 (13.9)	224 (82.1)	-	-	1 (0.4)	8 (2.9)	273
All	67 (2.2)	15 (0.5)	664 (22.2)	1899 (63.5)	267 (8.9)	28 (0.9)	6 (0.2)	44 (1.5)	2,990

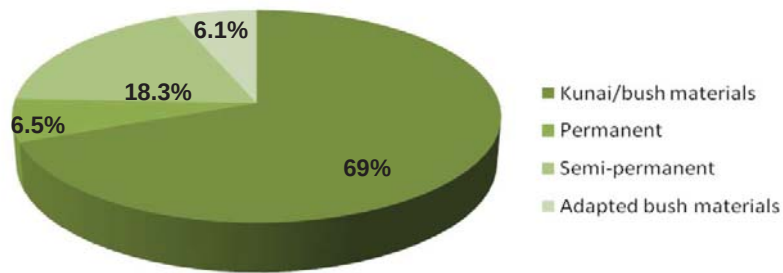
The Asaro population have a substantial population of individuals who have never received any formal education (Table 32), a similar phenomenon to the Hides/Komo. Furthermore, an inequality between males and females in access to education is evident, with females less likely to have any higher education.

The majority of males and females report subsistence gardening as their main occupation, more than in any of the other sites (Tables 33 and 34).

Socioeconomic Indicators

Like Haliago district, the households making up the Asaro iHDSS are mostly traditional buildings made from bush materials. The finding is similar to the Hides/Komo. Semi-permanent structures are the primary house type for 18.3% of the households interviewed (Figure 78).

Figure 78. Types of housing in Asaro iHDSS 2011 (N=230)



With only 46.5% of households reporting ownership of at least one mobile phone, the Asaro sample has the lowest phone coverage of the four sites (Figure 79). Almost 80% of the household reported cooking inside the house (Figure 80).

Figure 79. Proportion of households possessing selected assets in total AsaroiHDSS 2011 population (N=230)

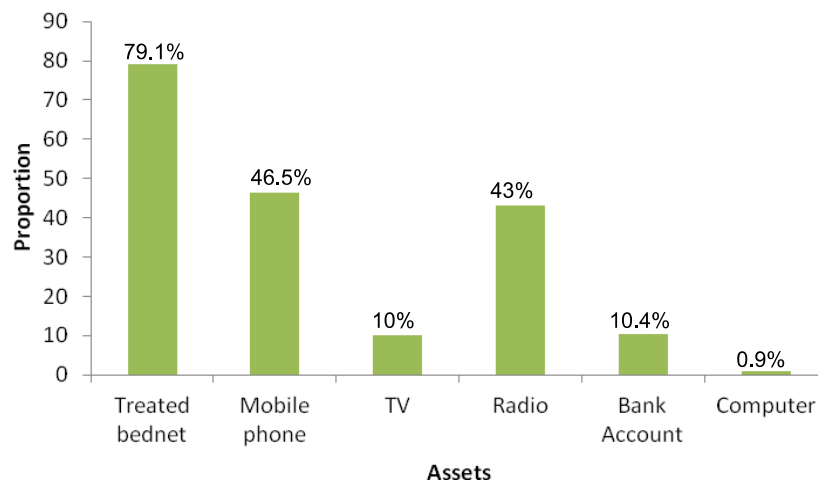


Figure 80. Characteristics of living conditions in total AsaroiHDSS 2011(N=230)

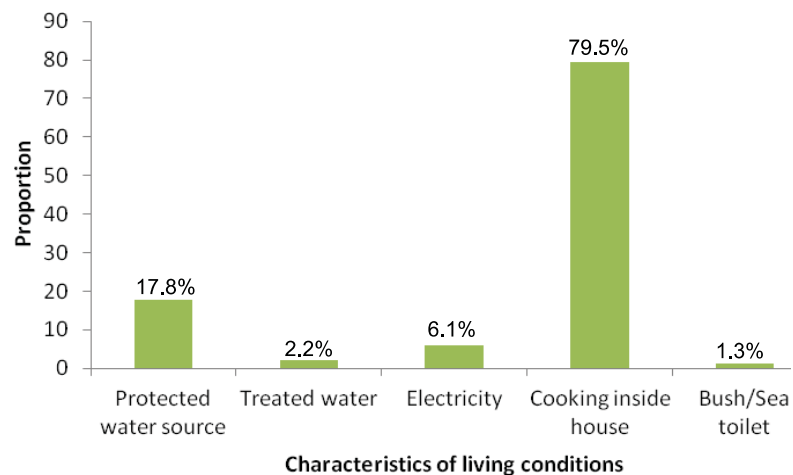


Figure 81. Proportion of households who have contributed or received more than 500Kina through social obligations in the past 6 months and those who report that they can raise 2000Kina in two weeks in total AsaroiHDSS 2011 population. (N=30)

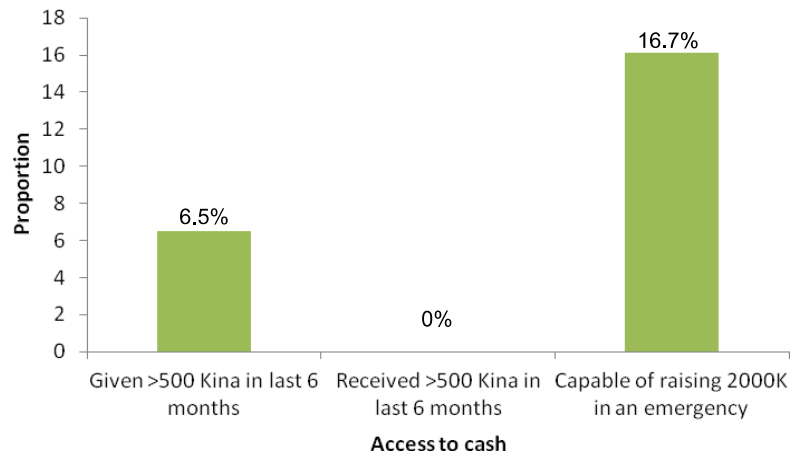
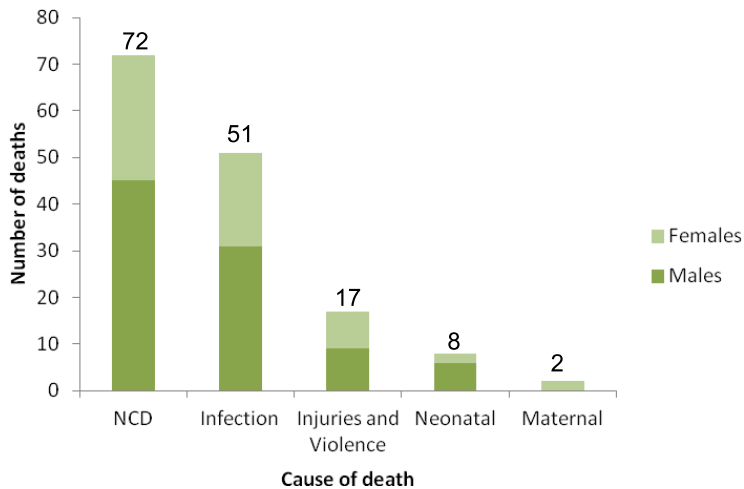


Figure 81 presents the results of the social obligation portion of the socio-economic questionnaire. The questionnaire went through many changes during the trial period and these questions were only added after the first trial in the Asaro HDSS area. The team then returned to the field to try the new questions on a small sample of thirty households. Due to these small numbers, interpretation of these results is limited. As with the rest of the socio-economic survey the full instrument will be applied to the whole community in the near future.

Causes of death

The leading causes of deaths that occurred between 2010 and 2012 in the AsaroiHDSS sample are non-communicable in nature (Figure 82).

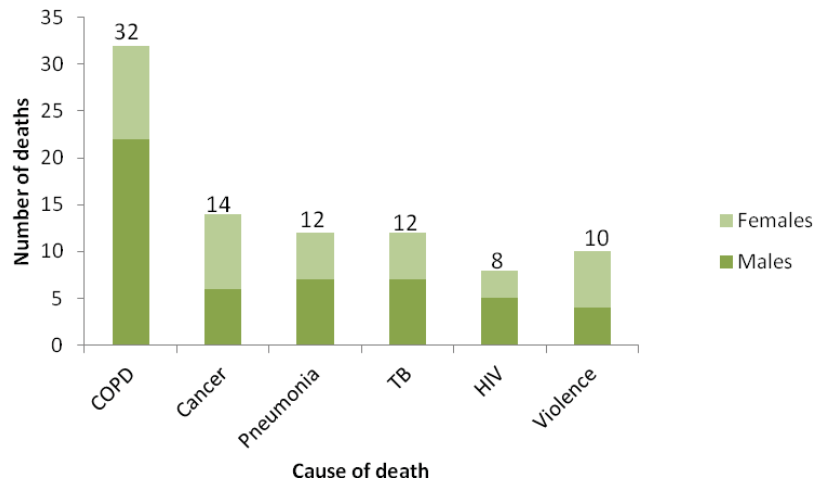
Figure 82. Cause of death amongst AsaroiHDSS 2010-2012 population by disease categories, by sex



NCD = Non-Communicable Diseases

The majority of the deaths caused by a non-communicable disease were attributed to chronic obstructive pulmonary disease making up 44.4% of the total. Tuberculosis is the leading cause of death amongst the infectious diseases but this is very closely followed by HIV/AIDS (Figure 83). Violent events were the cause of over 9% of all deaths reported in the Asaro/Goroka HDSS. These results should be considered preliminary however as many of these deaths were initially identified because they took place at Goroka General Hospital which may have biased the kinds of deaths we collected at the start. Further more, the cause of death ascertained from the interviews by physicians still required confirmation.

Figure 83. Six most frequent causes of death in AsaroiHDSS 2010-2012, by sex



COPD = Chronic Onstructive Pulmonary Disease
TB = Tuberculosis

DISCUSSION AND CONCLUSIONS

This report presents the preliminary results from the four sites included in the Partnership in Health Project- integrated Health and Demographic Surveillance System (iHDSS). Data from Karkar Island are still incomplete and data entry is currently on-going.

The male to female ratios are high in all communities monitored but particularly so in the coastal populations Hiri West and Karkar Island. Table 33 presents the total male to female ratios in each site against the Demographic and Health Survey (DHS) of 2006. While its proximity to the capital city Port Moresby may help explain the similarities between Hiri West and urban populations surveyed by the DHS, Karkar also exhibits an exceptionally high ratio. These results raise a number of questions about these populations and requires thorough analysis and careful interpretation.

Table 35. Male to Female Ratios in all four sites and compared to the Demographic and Health Survey 2006

	Males to Female Ratio
Hiri-West (iHDSS 2011)	113:100
Komo-Hides (iHDSS 2012)	109:100
Karkar (iHDSS 2012)	110:100
Asaro (iHDSS 2011)	103:100
Urban Population(DHS 2006)	113:100
Rural Population (DHS 2006)	103:100

Hiri West stands out as particularly unique amongst these four sites. Its historical contact with church based institutions and proximity to the capital city means these villages exhibit more signs of modernization than the other three sites. The inhabitants of these communities attain relatively high levels of education, own a large range and a large number of assets and a comparatively larger number of respondents are employed in professional and skilled positions. While people in this area may continue to garden it is not typically what they consider their main occupation. Karkar Island, the HDSS selected as a comparison population for Hiri West is very different for these variables. Subsistence gardening is still the mainstay of the island's inhabitants and few people are formally employed. The male to female ratio in these two locations is more similar. Like Hiri, educational attainment is also relatively high in Karkar. Most people have some primary education and there is little difference in educational attainment between men and women.

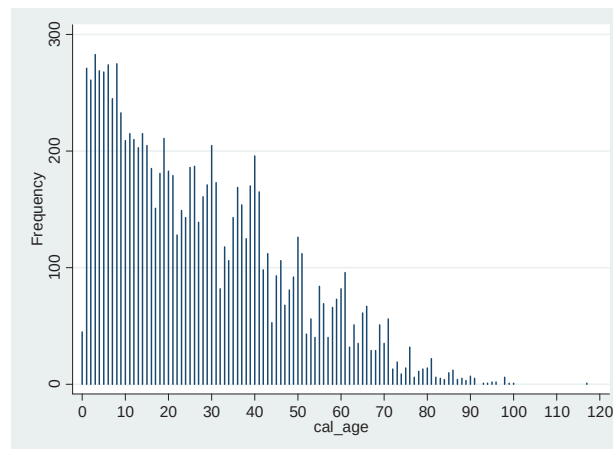
The two highlands populations, Hides/Komo and Asaro also exhibit a number of similarities. Both of these populations are still largely subsistence based but males in Hides/Komo report higher levels of employment. A large amount of this employment is reported be provided by the PNG LNG project.

Mortality surveillance has been on-going in the Hiri West and AsaroiHDSS sites since 2011. The Karkar Island iHDSS mortality surveillance began in June 2012 and Hides/Komo will begin by the second quarter of 2013. Results from Hiri West and Asaro thus far reveal a double burden of infectious as well as non-communicable diseases. Like many rapidly modernizing populations globally, diabetes is emerging as an important cause of death in the Hiri population.

Challenges and Limitations

As in many developing countries, and particularly in rural communities in developing countries, people often do not recall their precise date of birth or age. During the census when a person could not provide a date of birth to the interviewer, the interviewer ask for the person's age or estimated age. When estimating one's age people tend to choose numbers that end in 0 or 5 (Figure 81). This phenomenon will may have the effect of skewing the results and requires careful statistical adjustments. Such processes will be explored and applied to future iterations of iHDSS reports.

Figure 84. Peak plot of age distribution showing the preference for ages with terminal digits of 0 and 5.



A lag between data collection and data analysis is to be expected. Between the point of interview and the point of analysis several steps are necessary including quality checks, transport of forms to Goroka or Madang, data entry and data cleaning. In the past, both the transport of forms and data entry have created bottlenecks in the process. These issues have now been addressed but required constant supervision.

Further delays have been experienced due to conditions in the field. The election period (between June and August 2012) caused various degrees of tension in different communities and it became necessary to pause fieldwork in all sites for some time. Due to water shortages, clinical work at Papa clinic is concentrated into morning sessions. Due to vehicle restrictions this means all fieldwork must fall into a constrained schedule. Lastly, road conditions in the Asaro and Hides/Komo iHDSS site, especially during the rainy season, can frequently slowdown access to villages. All these factors mean that fieldwork progress can be delayed.

The experience of undertaking the first census in each site has provided invaluable lessons to improve planning and implementation of the surveys and future censuses. Additionally the systems for data cleaning and analyses have been improved to increase the quality and timeliness of results in future rounds.

The baseline census in each of the four sites and the structure of having intervention (impact) and control (comparison) sites allows a unique opportunity to monitor changes in PNG health, socioeconomic and demographic characteristics over time, and also assist in understanding any unique contributions of the PNG LNG activities to these changes.



Figure 85. Banana is a staple food in all iHDSS sites

EXECUTIVE SUMMARY

With economic development and urbanisation come epidemiological transitions. Changes in diets and nutritional status are central to the evolving patterns of disease in a population. Papua New Guinea (PNG) is in the midst of such changes and the Papua New Guinea Institute of Medical Research (PNG-IMR) is working in with Esso Highlands Limited in a collaboration entitled the Partnership in Health Project (PiHP) to monitor the changes in the demography, socio-economy and health of populations affected by the development of the PNG- Liquefied Natural Gas Project.

The PiHP has set up a Health and Demographic Surveillance System (HDSS) in four sites. The two impact sites where the PNG-LNG project is based, Hiri in Central Province and Hides/Komo in Hela Province. Two other regions were selected to act as comparison sites; Karkar Island in Madang Province and Asaro in Eastern Highlands Province.

This report presents the results of a preliminary study, which aimed to gather baseline data on food consumption in the four sites, which will aid in the development of research instruments suitable for the study populations of interest.

The results of this exercise reveal a substantial amount of commonality in diets and dietary practices between the four sites. Having said this, study participants from different sites reported different levels of accessibility to animal protein and store-bought foods. Hiri, in particular, with its close proximity to Port Moresby, stands out for its considerable variety of foods consumed. While study participants in Hides/Komo and its comparison site Asaro report a similar dependency on garden foods, respondents in Hides/Komo do report consuming far greater amounts of soft drinks and animal protein in the form of chicken.

Further analysis of this data requires appropriate software support. Researchers are currently being trained and ongoing analysis is aimed at investigating the serving sizes consumed. This will greatly deepen and enrich potential interpretations. This study has provided the basis for the development of appropriate survey methods which are now ready for implementation.

Figure 86. Soft drink and scones are consumed in greater amount in Hides/Komo.



INTRODUCTION

The Esso Highlands Limited (EHL) led Papua New Guinea Liquid Natural Gas (PNG LNG) project is the largest ever resource project in the history of Papua New Guinea (PNG). Once fully operational, it will contribute more than a third of the PNG gross national product as well as provide royalties to landowners and taxes to the PNG Government. It is therefore expected that the project will contribute very significantly to the economic and social development of PNG.

Rapid economic development of this kind can bring with its improved living standards and therefore better health and greater life-expectancy (Satia 2010). At the same time it can also be accompanied by increased burden from particular causes of death, injury or disease (Norgan 1995). Road traffic accidents and non-communicable diseases for example have been known to increase at times of economic growth. Furthermore, in most countries the benefits of economic development are rarely equally distributed and greater inequalities in health status can be expected (Yamauchi 2001). The Partnership in Health Project (PiHP) aims to monitor the impact of economic development due to the PNG LNG Project on population health.

Nutrition plays an import role in amongst these socio-economic and epidemiological transitions. As some parts of the country gain greater access to cash, they are likely to consume more store bought foods. Bought food like tinned fish and fried meats will provide more protein, but these and other refined foods will also increase the consumption of fats, salt and sugars. Consumed in excess these dietary components can act as a risk factor for non-communicable diseases and will lead to a growing burden of such diseases as obesity, diabetes and cardiovascular disease (Kende 2001).

At the same time, these transitions are expected to be occurring in different ways across communities in PNG, leading to varying levels of vulnerability to food insecurity due to food shortages and changes in economic and other circumstances. Preschool children provide a sensitive indicator of these changes occurring in the population as they are the group most vulnerable to food insecurity, with food shortages and disruptions in access of adequate nutrition during this stage of growth resulting in stunting and associated with the development of non-communicable diseases in adulthood.

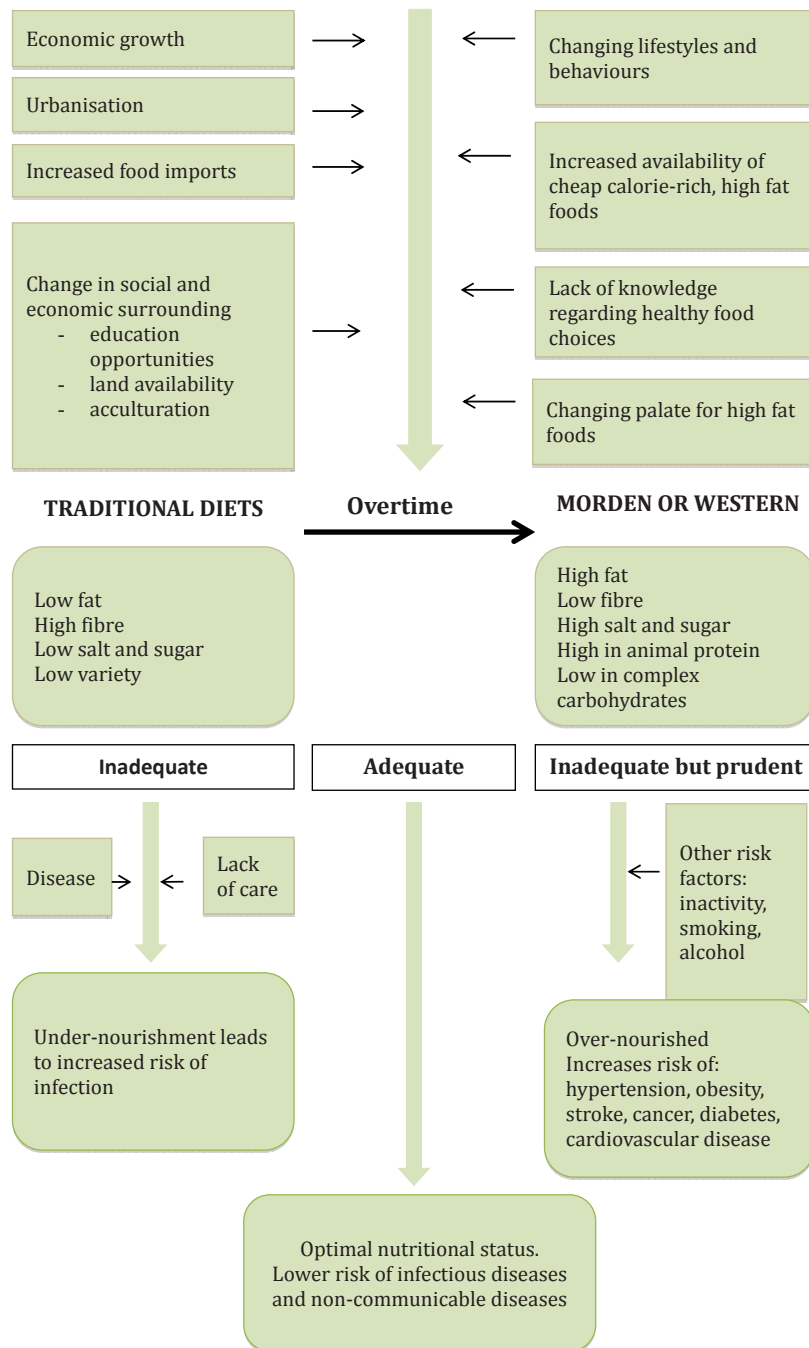
BACKGROUND

Nutrition is at the heart of the public health challenges faced by most developing countries today. As societies modernize and populations become increasingly urbanized changes in diets and lifestyle lead to increasing prevalence of non-communicable diseases. Meanwhile infectious diseases and malnutrition remain undefeated major public health problems, leaving such countries with a so-called 'double burden' (Vorster 1999).

As depicted in Figure 82, traditional diets are often deficient in protein and can lead to malnutrition. Under-nutrition can increase the vulnerability of a population to infectious diseases and can cause stunting or growth faltering in children (Ulijasek 1993).

At the same time, as populations modernize, fresh garden foods become more difficult to obtain and calorie-dense, high-fat food become cheaper and easier to access. This transition, to what is commonly referred to as a 'western' diet, can be considered a problem of 'over-nutrition' and is associated with non-communicable diseases.

Figure 87. The nutritional transition model(adapted from Vorster *et al* 1999)



NUTRITION TRANSITION IN PNG

As in many developing countries, many people and communities in PNG still face the threat of under-nutrition (Duke 1999, Gibson *et al.* 1991, Temu *et al.* 2009). According to the household survey in 1991, women in rural settings were twice as likely as men to have a Body Mass Index (BMI) below 18.5kg/m² (Hodge *et al.* 1996a). Keeble & Keeble (2006) stated that malnutrition in 1 to 4 year olds is a significant and worsening problem.

In recent decades over-nutrition has slowly become a major health issue in PNG, leading to increasing rates of obesity and diabetes. Studies of PNG in the sixties revealed low BMI in both coastal and highland populations (Zerba *et al.* 1991). Since that time we have observed a clear trend of increasing BMI, particularly in urban populations (Kende 2001, Lourie & Taufa 1986, Hodge *et al.* 1996b).

Traditional diets in PNG have been characterised by carbohydrate-rich foods such as tubers (*Colocasia* taro, yam, cassava and sweet potato), banana, and sago starch (Martin *et al.* 1980). In coastal or island regions, slash-and-burn cultivation was conducted for the production of tubers and bananas (Ulijaszek 2003). People in coastal or islands regions also fished or hunted wild pigs, several species of marsupials and birds, the contribution of protein intake to the total diet was marginal in most areas. In the Highlands people depended heavily on one variety of sweet potato and pigs are reared for protein consumption for their diet. More than 70% of food energy came from sweet potatoes (Feil 1987).

The dietary transition in Papua New Guinea has been characterized by the increased consumption of "imported foods" such as rice, tinned fish, tinned meat, lamb flaps, noodle, wheat flour, soft drinks, sugar, oil and beef tallow. These types of foods are energy-dense in comparison to the "traditional" foods such as tubers and bananas. In the initial period of dietary change, "imported foods" were eaten only on special occasions. Cooking methods have also changed over this time; traditionally, people steamed or roasted their food, over the last few decades frying has become a more popular method of cooking. Along with these changes has also come the introduction of beer.

Contribution of "imported foods" to energy intake has gradually increased. The percentage of energy from "imported foods" was particularly higher in the communities that were influenced

by mining operation, logging, and tea/coffee plantation (Saweri 2001). Yet, the rural people were still benefited from wide varieties of foods produced in their gardens, collected/hunted in forest, or fished.

During the colonial period obesity and cardiovascular diseases were rare. The people relied largely on diet of low energy density and engaged “heavy” physical activity for their subsistence, which resulted in well-balanced energy intake and energy expenditure of individuals. Vulnerable nutritional effects of “westernization” or “modernization” became remarkable first in coastal or island regions and then in Highlands regions (Hodge & Dowse 1998, Shaw 1999).

VARIATION OF NUTRITION TRANSITION IN PNG

Inter-community variation in the prevalence of obesity in rural Papua New Guinea was associated with the extent of urbanization or modernization. Ulijaszek *et al.* (2005) showed, in the Purari Delta of Gulf province, the negative association between the distance from the residential village to urban centre and body mass index of individuals. King *et al.* (1985) also showed that BMI values of the individuals increased as their residential community of were located close to the urban area in Eastern Highlands Province. Similar trend was found even in the most remote and isolated areas in Papua New Guinea (Hongo *et al.* 1994).

A corollary of such studies is that problems of obesity are not evenly distributed in rural and more modernized populations. It is expected that the problems might be more serious in the latter than in the former. In fact, Hodge & Dowse (1998) reported that BMI values were higher in modernized communities than in rural communities in both coastal or Highlands regions, while Yamauchi *et al.* (2001) reported slightly higher BMI values in Huli migrants to Port Moresby than in their rural counterparts. Prevalence of obesity or cardiovascular diseases varied even in urban areas whether the original places of migrants were coastal/islands regions or Highlands regions. In a review article by Saweri (2001), it was concluded that obesity or cardiovascular diseases were more prevalent in urban areas than in rural areas.

Periodic food insecurity has been a common occurrence for many PNG communities over a long period of time. Originally this was mainly a result of crop failure due to pests or weather, or seasonal changes in food from household gardens. This has changed with growing use of stores for food purchases. For many people this has become a buffer against changes in food available from their gardens or through local markets. However for others it has led to a dependence on cash to purchase their food requirements. Consequently the drift to urban areas, and changes to employment opportunities can have a range of effects on food security for communities.

It is possible to construct both positive and negative scenarios concerning the potential effects of the PNG LNG project on the nutritional transition and food insecurity in the project sites, with the effects varying across sub populations defined by the nature of their engagement with the project; for example, land owners, workers, landowners and workers, non-landowners.

THE STUDY SITE

The Partnership in Health Project (PiHP) is constitutes a partnership between Esso highlands and the PNG Institute of Medical Research. This research project has been developed to monitor the impact of the PNG-LNG project in its surrounding communities.

To this end an integrated Health and Demographic Surveillance System (iHDSS) has been set up in the two sites where the PNG-LNG major developments have taken place; Hides/Komo in Hela Province and Hiri West in Central Province. Two other locations have been selected to act as 'comparison sites'. The Asaro valley in the Eastern Highlands province is intended to act as a comparison to Hides, a highlands population and Karkar Island will act as a comparison site to Hiri West, a coastal population.

The two iHDSS sites under PNG LNG project's operation are the West Hiri in Central Province and Hides/Komo in Hela Province. The West Hiri study site comprises the villages Porebada, Boera, Papa, and Lealea in Hiri District, Central province. With an approximate population of 20 000, the West Hiri Motuan villages are distributed along a 20-30 kilometre stretch of coastline starting about 20 kilometres North West of Port Moresby, National Capital District. The dry grassland vegetation makes it difficult for gardening and, therefore, diet is mainly made up of rice, fresh fish and canned protein.

The Hides/Komo site is a 2 hour drive south of Tari, in Hela Province with a population of approximately 13,000 people. It covers 3 areas, namely Gigiria, Haliago and Hibiria divisions, these villages surround the Hides LNG conditioning plant site. The diet mainly consists of traditional or garden food such as sweet potato with greens and occasional protein from wild animals or canned protein.

Karkar Island is located about 20 kilometres off the Northern coastline of Madang Province with an approximate population of 30 000. The local diet is made up of garden food and occasional protein in the form of fresh fish or canned fish and meat.

Figure 88: Store bought goods are common in Hiri



One of the two comparison sites under the iHDSS is Asaro which is about 20-30 kilometres north of Goroka town with approximately 12 000 people. The Asaro iHDSS was established in 2004 prior to the pneumonia vaccine trial and shut down due to the completion of the trial in 2008. The site was reopened to facilitate this new iHDSS study in 2011. Similar to the Hides/Komo site, the diet primarily consists of garden food and occasional protein.

Figure 88: A woman feeds her chickens in Komo. Chicken are increasingly used as a source of protein in and around Hides/Komo



Aim and objectives of the preliminary nutrition study

This preliminary study aimed to examine the food habits in the four study sites to inform development of methods for the nutrition and food security components of the iHDSS. This preliminary study aimed to achieve as follows:

1. Compile a list of the full range of foods consumed in the four sites.
2. Document methods of cooking and food preparation; include similarities and differences across sites.
3. Estimate common food serve sizes and how these vary across sites
4. Identify any other factors that need to be considered for assessing dietary intakes in the iHDSS
5. Describe the pattern of food habits for the study sites, including consumption of imported foods in the sites.

For the purpose of the preliminary study, the study population in each site included all age groups, and distinct subgroups were not identified during the study. To provide context for this work, the following are the aims and objectives of the nutrition component of the iHDSS

Aim

To examine the changing dietary habits and trends in food security in four community-based study sites across PNG.

Objectives

- 1- To determine the status of food insecurity in four community-based study sites across PNG.
- 2- To compare the status of food insecurity in four community-based study sites across PNG.
- 3- To describe and compare the changing dietary patterns in the four study sites across PNG
- 4- To determine the prevalence of dietary habits which may act as risk factors for non-communicable diseases in the four study sites across PNG.
- 5- To compare the prevalence of dietary habits which may act as risk factors for non-communicable diseases in the four study sites across PNG.

The study will also look into the distinctive populations groups within each site. These distinctive populations groups are as follows:

1. Landowners, 2. Workers, 3. Landowners and workers, 4. Non-Landowners ("Traditional subsistence").

These subgroups are of great interest as they will be distinctively affected by the change brought upon by the LNG project. The study will be carefully designed to capture distinctive groups. These groups, however, will not be considered in this preliminary report.

METHOD

Each village included in the preliminary study was divided into sections, which were to be covered by each of the scientific officers and reporters working in teams. All participants were made up of a convenient sample of the community and interviews were conducted on face to face with the respondents. Age and sex of participants were recorded during the survey. Quality checks of all forms were conducted in a daily basis.

Figure 89. Training the village reporters



DATA COLLECTION

As there are no existing dietary and physical activity measurement instruments validated for adult surveys in the PNG setting we began by constructing and testing dietary assessment protocols. This was followed by training of staff on methods of data collection on background information of each study site and baseline dietary data. The baseline survey was carried out by scientific officers.

24-Hour Sheet Modification and Trial

One of the most common methods for assessing diets for adults in surveys is the 24-hour dietary recall. This involves interviewing survey participants about their food and beverage consumption during a 24-hour period of time, typically the previous day or the preceding 24 hours. The method generally has a high response rate and can provide detailed information about diets. It is particularly useful in contexts where the foods consumed vary across communities, or are likely to change over time.

A modified 24-hour recall survey appropriate for the PNG setting was developed. This was trialed in four study sites. Time segments of the 24-hour food recall sheet were modified according to the eating times for people in PNG. As part of dietary survey there is the task to quantify the servings of each food and standardize them across the four sites. To standardize the servings a direct food weighing (DFW) was carried out in all sites so to record and quantify all serving sizes. Aids for use in the dietary survey are currently under development to assist in the dietary data collection. Food photography atlas will be employed and will include photos of all possible foods eaten in the four sites.

Data collections – 24 hour dietary data

The 24-hour recall was conducted as a face-to-face interview carried out by scientific officers under the supervision of a scientific officer. Preliminary data was collected for the four sites (Hiri, Hides/Komo, Karkar and Asaro).

Training

Before fieldwork commenced, scientific officers were trained to carry out the 24-hour recall interview and were familiarized with field related tasks including community relations. They were closely supervised during a trial period when a number of questionnaires (forms/sheet) in the institution using colleagues as participants. Similarly to the field reporters for Hiri had to

undergo one day training and carry out numerous trials under supervision by the scientific officers. InHides/Komo, reporters had to go through 3 day training before engaging in the actual survey due to low standard of education of the reporters. Also to build up confidence since most would be working alone.

Fieldwork

The fieldwork for the 24-hour recall was carried out in all four sites from November 2011 to January 2012 and each of the field trips lasted less than a week each. Interviews in the Asaro villages were done in the month of October (2011), in Hiri and Karkar the interviews were conducted in November (2011), and in Hides/Komo the interviews were conducted in January (2012). Seasons and the seasonality of different foodswill be considered in analysis and will inform future fieldwork scheduling.

Interview Process

Before the 24-hour recall interview was conducted, a brief explanation on the importance of this survey was given by a scientific officer (SO) to the participant; after which verbal consent was given by the participant. The 24-hour recall was conducted by a scientific officer, the SO had a 24 hour recall sheet for each participant interviewed; on average one interview takes approximately 15-20 minutes. For those participants who could communicate with an SO in pidgin, a one on one interview was done however for those where language acted as a barrier, translation was done by the reporters or by other participants. In cases where the participant was unable to give further/additional information, the SO probed participants to encourage them to remember what they may have forgotten.

Data Analysis

The analyses reported here were conducted using Microsoft Excel. Further analyses are planned using FoodWorks software (to estimate nutrient intakes) and STATA11 (for statistical comparisons). Descriptive statistics will be used to test differences in prevalence among sites and among groups within sites.

RESULTS

The sample populations in each site, was made up of between 501 and 1251 individuals.

Tables 36 describe the sample populations by age and sex in each of the four sites.

Table 36. Demographic information of participants

Hiri N=1251			
	F	M	Total
Age group	% (n)	% (n)	% (n)
0-5	7.54(50)	8.16(48)	7.83(98)
6-15	18.25(121)	22.79(134)	20.38(255)
16-35	41.93(278)	40.82(240)	41.41(518)
36-55	25.49(169)	20.41(120)	23.10(289)
<56	6.79(45)	7.82(46)	7.27(91)
Hides/Komo N=959			
	F	M	Total
Age group	% (n)	% (n)	% (n)
0-5	9.55 (45)	8.81(43)	9.18(88)
6-15	22.51(106)	22.95(112)	22.73(218)
16-35	40.76(192)	39.14(191)	39.94(383)
36-55	22.29(105)	21.72(106)	22.00(211)
<56	4.88(23)	7.38(36)	6.15(59)
Asaro N=501			
	F	M	Total
Age group	% (n)	% (n)	% (n)
0-5	14.12(36)	11.79(29)	12.97(65)
6-15	28.24(72)	23.58(58)	25.95(130)
16-35	32.94(84)	28.86(71)	30.94(155)
36-55	17.65(45)	23.58(58)	20.56(103)
<56	7.06(18)	12.20(30)	9.58(48)
Karkar N=557			
	F	M	Total
Age group	% (n)	% (n)	% (n)
0-5	12.23(39)	11.76(28)	12.03(67)
6-15	21.32(68)	30.25(72)	25.13(140)
16-35	36.68(117)	27.73(66)	32.85(183)
36-55	21.63(69)	21.01(50)	21.36(119)
<56	8.15(26)	9.24(22)	8.62(48)

Table 37. List of foods mentioned by 15 or more individuals

Hiri	Hides/Komo	Asaro	Karkar
Fruits and vegetables	Fruit and vegetables	Fruit and vegetables	Fruit and vegetables
Apple	Bean	Bean	Bean
Banana	Corn	Corn	Bread fruit
Greens	Greens	Greens	Corn
Mango	Pineapple	Pumpkin	Greens
Onion	Pitpit	Ripe banana	Pawpaw
Orange	Pumpkin		Ripe Banana
	Ripe banana		
	Sugarcane	Starches and staples	Starches and staples
Root vegetable and other vegetable	Root vegetable and other vegetable	Cassava	Baked flour
Bread		Fried flour	Cassava
Cassava		Kaukau	Fried flour
Baked flour	Fried flour	Noodles	Kaukau
Flour Dumpling (Bakibaki)	Kaukau	Rice	Kulau
Fried flour	Noodles	Scones	Noodles
Fried rice	Rice	Taro	Rice
Kaukau	Sago	Banana	Taro
Noodles	Scone		Banana
Potato	Taro	Protein-rich foods	
Rice	Yam	Lamb	
Sago	Banana	Nut	Protein-rich foods
Scone		Pork	Chicken
Yam	Protein-rich foods	Tinned fish in oil	Fresh fish
	Chicken		Pork
	Egg	Junk food and cakes	Tinned Fish in oil
Protein-rich foods	Nut	Biscuit	Tinned Meat
Baked beans	Pork	Scallops	
Beef	Tinned fish in oil		Junk food and cakes
Chicken	Tinned meat		Biscuit
Chicken stew	Marita	Drinks	
Crab		Coffee	
Egg		Tea	Drinks
Fresh fish	Junk food and cakes		Coffee
Lamb	Biscuit	Other	Tea
Peanut butter	Ice block	Coconut cream	
Pork	Twisties	Cooking Oil	Other
Sausage		Maggie cube	Coconut cream

Hiri	Hides/Komo	Asaro	Karkar
Soup fish	Drinks	Sugar cane	Coconut - dry
Tinned fish in oil	Coffee		Cooking oil
Tinned meat	Soft drink		
Wallaby	Tea		
Junk food and Cakes	Other		
Biscuit	Cooking oil		
Cake	Maggie cube		
Chips			
Cream bun			
Dairy			
Butter			
Milk			
Ice Cream			
Drinks			
Coffee			
Cordial			
Juice			
Milo			
Soft drink			
Tea			
Other			
Coconut milk			
Vegemite			
Garlic			

Table 37 lists all foods that were cited by fifteen or more individuals in each site. Hiri residents reported the most variety in foods commonly consumed while Asaro, Karkar and Hides/Komo appeared to cite a relatively similar number of common foods. All lists included a large proportion of foods purchased from the stores. Many of the same types of food were consumed in each site but a clear difference is observed in the range of protein-rich foods consumed by those in Hiri as compared to the other sites. Hiri respondents also reported consuming more junk food and sweet drinks than any of the other sites.

Figures 90 and 91 portray the proportion of people who consumed different types of foods in the last 24 hours. Figure 90 looks at the consumption of traditional foods such as those found in the garden as well as the traditionally reared pig and fresh fish, which are caught by coastal communities. These foods are commonly consumed across all sites except Hiri, where fresh vegetable consumption is particularly low.

The results reflect differences in the main staple foods consumed, with kaukau (sweet potato) most common in Hides/Komo and Asaro, a mix of kaukau and banana in Karkar. Rice is the most commonly consumed store food across all communities, but has particular importance in Hiri where it is the most commonly reported staple food. Hiri also reported more bread and flour products than any of the other sites surveyed (Figure 91).

Amongst the protein-rich foods, fish is most commonly consumed in the coastal communities of Hiri and Karkar. The relatively low proportions consuming fresh and tinned meats/ fish, suggest a relatively low overall protein intake for the communities. This will be assessed in the nutrient analyses. Fruit consumption is consistently low across all communities. Respondents in Hides/Komo reported drinking more soft drinks than any of the other communities.

Figure 91. Proportion consuming common traditional foods in the last 24 hours, by site

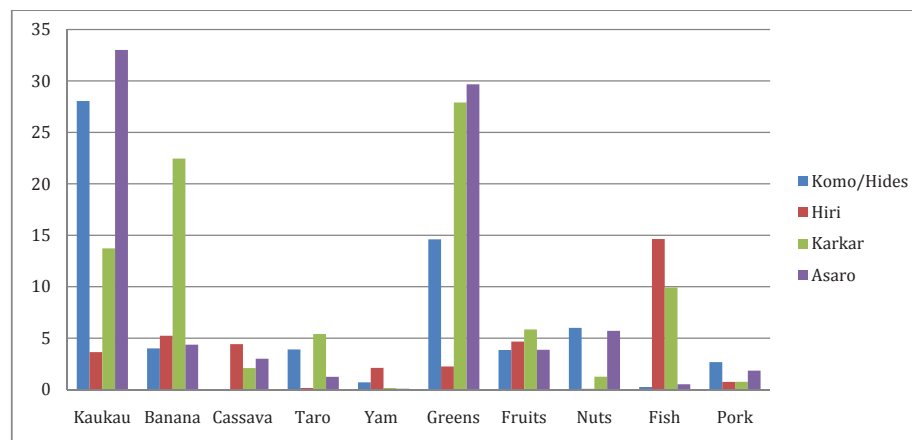


Figure 92. Proportion consuming common imported foods in the last 24 hours, by site

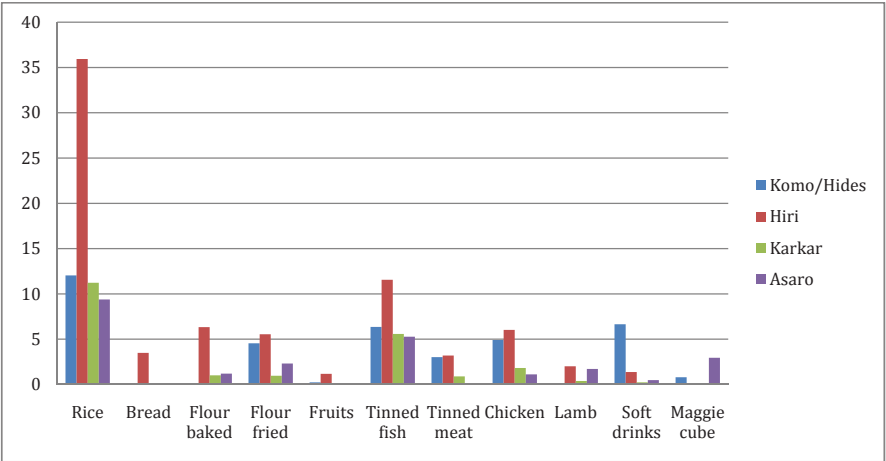


Table 38. Proportions eating any foods during specified time intervals by age group and sex in Hides/Komo

Age group	0-5		6-15		16-35		36-55		>56	
	M	F	M	F	M	F	M	F	M	F
TIME INTERVALS										
05:00 am -10:00 am	95.3	95.6	83.0	85.8	71.2	72.4	80.2	81.9	94.4	82.6
10:01 am -02:00 pm	60.5	75.6	61.6	64.2	63.9	63.0	67.9	57.1	44.4	56.5
02:01 pm -05:00 pm	69.8	53.3	50.9	61.3	45.0	52.1	48.1	51.4	61.1	52.2
05:01 pm -08:00 pm	69.8	88.9	50.9	79.2	89.5	83.3	90.6	91.4	83.3	87.0
08:01 pm -12:00 pm	4.7	6.7	10.7	7.5	6.8	10.9	12.3	8.6	11.1	13.0

Table 39. Proportions eating any foods during specified time intervals by age group and sex in Asaro

Age group	0-5		6-15		16-35		36-55		>56	
	M	F	M	F	M	F	M	F	M	F
TIME INTERVALS										
05:00 am -10:00 am	89.7	91.7	93.1	91.7	74.6	75.0	70.7	80.0	80.0	100.0
10:01 am -02:00 pm	69.0	72.2	81.0	76.4	69.0	71.4	62.1	62.2	60.0	66.7
02:01 pm -05:00 pm	51.7	38.9	31.0	27.8	38.0	35.7	31.0	26.7	10.0	11.1
05:01 pm -08:00 pm	72.4	77.8	86.2	87.5	76.1	84.5	86.2	77.8	83.3	77.8
08:01 pm -12:00 pm	10.3	5.6	12.1	11.1	12.7	11.9	10.3	15.6	6.7	11.1

Table 40. Proportions eating any foods during specified time intervals by age group and sex in Hiri

Age group	0-5		6-15		16-35		36-55		>56	
	M	F	M	F	M	F	M	F	M	F
TIME INTERVALS										
05:00 am -10:00 am	97.9	100.0	99.3	100.0	95.4	97.8	98.3	97.0	100.0	100.0
10:01 am -02:00 pm	79.2	82.0	80.6	74.4	82.5	78.4	85.0	70.4	78.3	80.0
02:01 pm -05:00 pm	52.1	48.0	53.0	55.4	42.9	50.4	45.0	45.6	37.0	53.3
05:01 pm -08:00 pm	87.5	84.0	88.8	85.1	84.6	87.1	87.5	87.0	93.5	95.6
08:01 pm -12:00 pm	12.5	6.0	9.7	10.7	14.2	12.2	14.2	17.2	15.2	13.3

Table 41. Proportions eating any foods during specified time intervals by age group and sex in Karkar

Age group	0-5		6-15		16-35		36-55		>56	
	M	F	M	F	M	F	M	F	M	F
TIME INTERVALS										
05:00 am -10:00 am	96.4	94.9	94.4	92.6	93.9	88.9	76.0	87.0	72.7	88.5
10:01 am -02:00 pm	39.3	35.9	27.8	36.8	33.3	40.2	32.0	42.0	40.9	88.5
02:01 pm -05:00 pm	32.1	20.5	30.6	26.5	40.9	37.6	46.0	26.1	40.9	19.2
05:01 pm -08:00 pm	85.7	94.9	88.9	92.6	90.9	94.0	96.0	92.8	100.0	96.2
08:01 pm -12:00 pm	3.6	5.1	5.6	4.4	9.1	6.0	10.0	4.3	4.5	0.0

Tables 38 to 41 present the proportion of people who ate some food during specific time intervals throughout the day. Future analysis will look to better understand the amounts of food eaten during different time intervals with a particular interest in observing differences between sexes and between children and adults.

Table 42 shows that the main cooking methods are similar across the four sites. However there is variation in emphasis across the sites. While boiling food is the most common method, the secondary methods vary. The analysis is limited by the focus considering the method in terms of all foods reported. It will be more informative to look at this in terms of the foods that comprise the main component of the diets. This will be feasible once the data have been analyzed with FoodWorks software program.

Table 42. Proportion of foods prepared using different cooking methods, by site

	Hides/komo (N=33,565)	Hiri (N=43,645)	Karkar (N =19,495)	Asaro (N=17,535)
Method	% (n)	% (n)	% (n)	% (n)
Baked	1.2 (412)	2.9 (1283)	0.4 (73)	0.9 (154)
Boiled	13.5 (4525)	16.1 (7048)	14.7 (2897)	11.8 (2066)
Fried	1.1 (370)	2.9 (996)	0.5 (105)	1.0 (167)
Roasted	3.7 (1241)	0.1 (46)	1.4 (275)	2.0 (344)
Steamed	0.0 (0)	0.0 (0)	0.0 (1)	0.0 (2)
Smoked	0.0 (0)	0.0 (37)	0.0 (0)	0.0 (0)

DISCUSSION

General observation

For decades nutritionists have focused on malnutrition and the “protein gap” affecting impoverished populations. But today the world is witnessing a new pandemic. Obesity and other NCDs are rapidly becoming some of the leading causes of disease burdens across the globe regardless of the level of wealth. Under-nutrition and infectious diseases continue, however, to dominate the diseases burden in developing countries and this has created a ‘double burden’ of diseases that threatens to overcome health systems of many resource poor countries, which include PNG. Public health policy in PNG, with its traditional emphasis on malnutrition, needs to adapt to the changing situations (Inaoka 1995, Kende 2001, Leeder *et al.* 2004).

There is still much debate on the health impact of economic development on population health. In some cases and populations changes bring about increased food availability and improved living standards reducing infectious diseases. On the other hand the development bring changes in diets and causes inactivity resulting in increased risk of NCDs. In Papua New Guinea where 80% of its population still lives a traditional lifestyle of subsistence farming it is important to observe how such processes affect our population. Therefore to monitor or observe the major determinants that contribute to the health outcome of the population is crucial.

The results of this study suggest that diets in the different study populations vary greatly. The sample surveyed in Hiri in particular report consuming far more variety in their foods both in terms of ingredients that are associated with healthier diets such as proteins, as well as foods that act as risk factors for NCDs such as calorie dense and high fat junk foods. On the other hand, Hiri inhabitants report eating far fewer vegetables than those respondents from the three other sites.

The Hiri villages are located close to Port Moresby, the nation's capital. The residents of these villages have had relatively extensive contact with missionaries over the years and have high level of education as compared to those in other sites. Being close to Port Moresby these villages are likely to be influenced by the forces of urbanization. Indeed the consumption

patterns revealed in this study indicates a greater dependency on store-bought foods and a more 'westernized' diet than Hides/Komo, Karkar or Asaro.

While the study population in Komo/Hides continues to rely on garden foods like kaukau there is more reported consumption of store bought foods like tinned fish and soft drink than reported in the study populations of Karkar or Asaro. This may be indicative of greater availability of cash in this community.

Implications for the iHDSS surveys

The preliminary study has confirmed the value of using the 24-hour recall methodology for the adult survey. It has been shown to be practical, and acceptable to the community. The results also show the benefit of using an 'open-ended' methodology to assess the range of foods consumed. In particular it enables the investigators to observe differences across sites in the ranges of foods consumed and cooking methods. We might expect this to become a particularly important feature of the method into the future as the range of foods and cooking methods change over time.

The dietary assessment involves several steps including recording types of foods consumed and how they have been prepared, estimating quantities consumed, and coding of foods for calculation of nutrients consumed. The food lists, reports on cooking methods and assessment of serving sizes have provided an important basis for refining the iHDSS dietary assessment methods. They will guide development of training materials, be used as the basis for conversion factors where these are needed (especially quantities consumed), and provide the starting point for matching the list of foods consumed against the foods included in dietary composition databases.

Dietary habits and NCD risk

From this preliminary report a number of potential risk factors for NCDs can be identified in the different study populations. Lamb flaps, a very fatty form of meat, in Asaro and Hiri are consumed readily. Maggie cubes, which are very high in salt - a risk factor for high blood pressure and therefore cardiovascular disease- are added regularly to other foods in Asaro.

Conclusion

This preliminary study has confirmed the value of the 24-hour recall methodology for the iHDSS and provided the basis for refining the method and protocols. The results confirm that the nutritional transition is well underway in PNG, including some dietary habits that are potential risk factors for NCDs. Importantly, the patterns for these results differ across the study sites. Future work will refine the measurement of servings of food and will allow for a more complete analysis of differences in dietary patterns and nutritional status across these populations.

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