Report of Partnership in Health Project (PiHP) January to June 2013

Papua New Guinea Institute of Medical Research

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ABBREVIATIONS

ANCs	Antenatal clinics
AFB	Acid Fast Bacillii
ALRI	Acute lower respiratory infections
BCG	Bacillus Calmette-Guérin
BMI	Body Mass Index
CFU	Colony forming units
CHIKV	Chikungunya virus
CI	Confidence Interval
COPD	Chronic Obstructive Pulmonary Disease
CP	Central Province
CRF	Study-specific case record forms
CVD	Cardiovascular Disease
DENV	Dengue virus
DOTS	Directly observed treatment, short-course
DNA	Deoxyribonucleic acid
DST	Drug Sensitivity Test
DTP	Diphtheria, tetanus, and pertussis
DSS	Demograpgic surveillance system
iHDSS	Integrated Health and Demographic Surveillance Survey
DSS	Demographic Surveillance Survey
EEDU	Environmental and Emerging Diseases Unit
EHL	Esso Highlands Limited
EHP	Eastern Highland Province
EPEC/ETEC	Enteropathogenic *E. coli*/Enterotoxigenic *E. coli*
EPI	the Expanded Program on Immunization
GCP	Good Clinical Practice
GDP	Gross Domestic Product

GIS	Geographic Information System
GPS	Global Positioning System
HAdV	Human Adenovirus
HepB	Hepatitis B
Hib	Haemophilus influenza type b
HIV/AIDS	Human Immunodeficiency Virus/Acquired Immunodeficiency Disease Syndrome
HNB	hydroxynaphthol blue
HP	Hela Province
HPS	HIV, HPV and other STIs
HPV	Human papillomavirus
HR-HPV	high-risk sub-types of human papillomavirus
HRSV	Human Respiratory Syncytial Virus
HRV	Human rhinovirus
HSV-2	*Herpes simplex* type-2
IEC	Information, education and communication
ILI	Influenzae like illness
IMR	Institute of Medical Research
IRB	PNG Institute of Medical Research Institutional Review Board
LAMP	Loop-mediated isothermal amplification
LLG	Local Level Government
LNG	Liquefied Natural Gas
MCH	Maternal and Child Health
MDG	Millennium Development Goals
MDR/TB	Multi-drug resistant tuberculosis
MGIT	Mycobacteria Growth Indicator Tube
MIRU-VNTR	Mycobacterial interspersed repetitive unit /variable-number tandem repeat
MP	Madang Province

MRAC	The PNG Medical Research Advisory Commitee
MTB	*Mycobaterium tuberculsosis*
NCD	Non-Communicable Diseases
NDoH	the National Department of Health
OPV	Oral Polio Vaccine
ORS	Oral rehydration salts
PCR	Polymerase chain reaction
PICT	Provider-initiated HIV counseling and testing
PiH	Partnership in Health Project
PNG	Papua New Guinea
PNGIMR	Papua New Guinea Institute of Medical Research
PNGLNG	Papua New Guinea Liquefied Natural Gas
PNG Med J	Papua New Guinea Medical Journal
POM	Port Moresby
PPAQ	Papua New Guinea Physical Activity Questionnaire
PSI	Population Services International
QMLR	Queensland Mycobacterial Reference Laboratory
RIF	Rifampicin
RNA	Ribonucleic acid
RRV	Ross River virus
RSV	Respiratory syncytial virus
STI	Sexually Transmitted Infections
SS	Sentinel Surveillance
SG	SYBR® Green I
SOP	Standard Operating Procedures
TB	Tuberculosis
UNICEF	United Nations Childre's Fund
UNSW	the University of New South Wales

UQ	the University of Queensland
UPS	Urinary pregnancy test
VA	Verbal Autopsy
VCT	Voluntary counselling and confidential HIV testing
VDS	Vaginal discharge syndrome
WASH	Water, Sanitation and Hygiene interventions
WHO	World Health Organization
WPR	Western Pacific Region
ZN	Ziehl-Neelsen stains

EXECUTIVE SUMMARY

As part of the Partnership in Health project (PiHP) the PNG Institute of Medical Research (PNGIMR) develops and submits semi-annual progress report. This report covers and updates new data and finding since the March 2013 submission. The work presented in this report includes new data and results covering the January –June 2013 time period, although there are some results that (i) include July and August information and (ii) late breaking September 2013 data. As a interim deliverable of the PiHP, the report does assume a basic understanding of the overall effort and does not fully recapitulate well-known background information of ether the PNG LNG or the PiHP. Whenever possible the focus is on new results developed since the March 2013 report; however, the PiHP is a longitudinal effort; therefore, the presentation of certain types of time sequence information is critical. Many health and social key performance indicators do not change rapidly; rather, they evolve over a period of several years. This is the power of the integrated health demographic surveillance system (iHDSS), i.e., revealing trends so that appropriate actions can be considered and taken by PNG LNG management and relevant PNG health officials.

Since the March 2013 report, a large number of surveys have been completed, including socio-economic surveys at all locations, continuous morbidity and mortality monitoring, core demography including in/out migration, household and community level wealth analyses, febrile/diarrheal disease studies (including opening of the new POM Diagnostic Infectious Disease Research Laboratory), sexually transmitted infection studies, water and sanitation, vaccination coverage, tuberculosis investigations in Kikori and non-communicable disease investigations. The results of these efforts are presented in a set of interlinked chapters. Whenever possible new findings are emphasized. The emphasis of this report is on the impact iHDSS locations, Hiri and Hides. Many surveys across all locations have been completed across all four sites (Hiri-Karkar, Hides-Asaro); however due to the volume of data, the impact site information is preferentially presented, pending full QA/QC of control site survey data. The March 2014 report will contain more comparative information across the different sites and studies.

Key Findings and Observations

DEMOGRAPHY, including Project Induced In-Migration (PIIM)

- Hiri villages have stabilized in terms of population and in/out migration
    - Consistent with Project construction wind down
    - Structure analysis (high resolution satellite imagery) in Hiri is consistent with population surveys
- Hides villages demonstrated differential growth patterns
    - Division 3 (HGCP) most impacted but within range predicated by International Finance Corporation (IFC) experience
    - Division 2 (Komo Airfield) significant wind down and directional return to steady-state conditions
- PIIM is monitored and evaluated by many core iHDSS activities
    - Differential village findings consistent with original predictions by the baseline PNG LNG Social Impact Assessment

WEALTH ANALYSIS

- Marked positive wealth changes in Hiri villages of Boera and Papa
- Surveys show household focus is on durables versus consumables
    - Modest positive changes Lealea
    - No significant change Porebada
- Hides- some positive changes relative to baseline
    - Surveys show household focus is on consumables versus durables
        - Not a sustainable pattern and likely will revert to baseline subsistence agriculture conditions for most households after construction wind down
    - Hides has marked poverty relative to Hiri; Asaro comparison data pending
- Differential village findings consistent with original predictions by the baseline PNG LNG Social Impact Assessment

MORBIDITY AND MORTALITY

- Morbidity and mortality patterns are aligned across iHDSS
    - Hiri clearly demonstrating an URBAN pattern of disease—movement from infectious diseases towards non-communicable disease pattern
        - Malaria is a non-issue but other febrile causes under investigation (dengue)

        - Cervical cancer is critical especially for women
        - TB is a huge issue and consistent with crowding and ties to Kikori area (TB is epidemic in Kikori)
            - Kikori TB studies demonstrate epidemic levels of TB including MDR-TB
        - HIV rates are not rising
        - HIV mortality represents past infection (>5-7 years ago and influence of POM proximity and possible return home when in acute illness stages)
            - Natural history of HIV -5-7+ yrs from time of infection to full blown disease without treatment
    - Hides clearly demonstrating a RURAL pattern of diseases dominated by infectious diseases—respiratory and diarrhea
        - Hides pattern documented since late 1970s and showing remarkable stability
        - Road traffic and violence account for a significant mortality burden
        - Pattern similar to ASARO but more dominance of violence in Hides
            - Hides HIV/AIDS extremely low, ASARO rates are much higher
    - Patient census at Hiri and Hides has stabilized and been reinforced to accommodate predicted rise in patient demand
    - Diarrhea rates have been stable across locations
        - Water source has changed and evolved across locations
        - WASH intervention across locations
            - Preliminary positive impacts in Hiri; Hides pending
        - Diarrheal studies are crucial and ongoing
- Morbidity and Mortality system is working and systematically tracking trends
    - Clear evidence malaria is a modest issue at Hiri/Hides
    - Respiratory disease burden dominates at all locations
        - TB is a huge issue at Hiri
        - Violence is a persistent problem in Hides
    - TB issues will likely persist in LNG workforce
    - Hides pattern of disease will be persistent
- Febrile and diarrheal illness studies ongoing and critical
    - Completion and full-scale activity of POM Lab has been accomplished

SEXUALLY TRANSMITTED INFECTIONS (STIs)

- Well monitored and tracked across iHDSS
    - Antenatal recruitment across all sites is progressing

- STI study providing critical high quality data
- Significant underlying burden of STIs at all locations
    - High levels of HPV at all locations particularly in Hiri
- Project has not adversely impacted HIV rates at key locations
    - Hides and Hiri HIV antenatal testing shows no new positive cases to date
- Human Papilloma Virus (HPV) levels are huge and a major cause of cervical cancer rates in women
- Preliminary STI data demonstrate that Project has not altered the underlying STI burden of disease at impact sites relative to background and control locations

VACCINATION COVERAGE

- Rates at all locations well below international standards
    - Hides rates 2-3 fold below international norms and are worse than ASARO control levels by 50%
    - Hiri below international targets but substantially better than other locations
    - Significant public health system failure
- Poor vaccination rates are a major contributor to underlying mortality and morbidity patterns
- Epidemic risk is significant, especially for measles

WATER AND SANITATION

- Morbidity and mortality data demonstrate a longitudinally stable pattern of findings for clinical reports of diarrheal diseases
    - Samples are now progressing through POM infectious disease laboratory so objective diagnostic data is been aggressively developed
- In Hiri there has been improvement in access to improved water sources
    - WASH project activities appear to have potentially had positive benefits
- In Hides water source access is highly variable across the three survey divisions
    - Underlying clinical burden of diarrheal disease morbidity and mortality appears stable; however better laboratory definition is ongoing

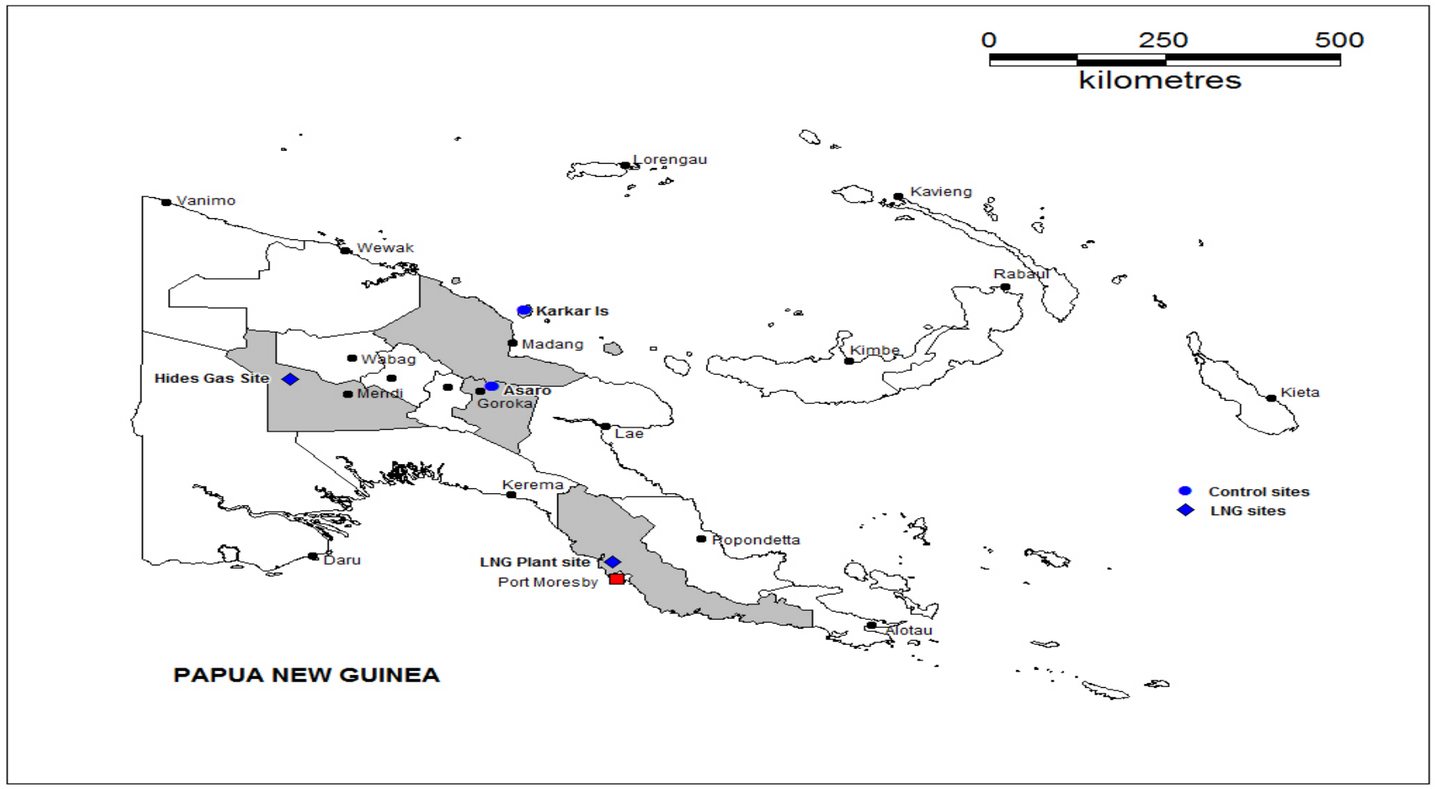
Overall, significant progress has been made and large volumes of high-quality data are now available. Demography studies provide an objective insight into potential PIIM issues and the extensive socio-economic surveys that have been completed and analyzed in 2013 provide important insight into household behaviors. Important findings regarding morbidity and mortality have been made based on the iHDSS data. A much clearer picture of the potential impacts of the PNG LNG project is beginning to emerge.

CHAPTER 1. HEALTH AND DEMOGRAPHY SURVEILLANCE SYSTEM

INTRODUCTION

The PNG LNG Project has recognised the potential positive and negative potential health impacts associated with the project. For this reason, PNG LNG has entered into a public-private partnership with the PNG Institute of Medical Research (PNGIMR) to actively monitorpotential project health impacts on populations in specific geographic areas where there has been both large construction activity and future long-term operations.

The PNG-IMR is monitoring the populations proximal to the two major impact sites in Hides and Hiri (impact sites). PNG-IMR also monitors two comparison populations in sites distant from the potential impacts of the PNG-LNG developments: (i) a highlands population in the Asaro Valley, Eastern Highlands Province and (ii) a coastal population in KarKar Island, Madang Province (Figure 1.1). Changes over time in these populations will be compared to those observed in the impact sites (coastal to coastal and highlands to highlands).



mographic Surveillance System (iHDSS).

Aims of the Partnership in Health Project (PiHP)

In addition to providing a stable longitudinal platform for monitoring potential impacts, the PiHP is also designed 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 (iv) operations health care delivery and performance in rural settings, and (v) project management and financial stewardship.

Objectives of PiHPProject

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 Arboviruses) 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. ‘Inside the fence” (workforce) monitoring performed by the PNG LNG also indicates that diseases like dengue may be very important and under diagnosed. 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. EHL and the PNGIMR have worked together to develop and build a fully functioning and sophisticated emerging infectious diseases laboratory in Port Moresby at the PNG School of Medicine. This laboratory is now open and full functional.

(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 and supported by the PNG LNG. A large multi-site STI Project is going and already providing critical information for the PNG LNG Project and PNG health authorities. Along with an assessment of common STIs including HIV/AIDS, the IMR study is performing the first comprehensive assessment of human papilloma virus (HPV) in PNG. HPV is a important cause of cervical cancer in women.

(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. With PNG LNG support, IMR has placed teams of physicians and nurses in key project area health clinics.

(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. The PNG LNG Project has strongly supported PNGIMR efforts to develop appropriate financial and management systems in order to continue to grow and attract long-term external funding for complex research projects that benefit the entire country. As the PNG LNG moves into operations in 2014, a diversified funding stream will be necessary in order to continue the full suite of PiHP activities.

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 integrated Health and Demographic Surveillance Survey (iHDSS). Ongoing PiHP efforts have focused on key infectious (TB, HIV/AIDS, HPV, pneumonia, diarrhoea) and vector-bourne diseases (dengue, malaria, etc.) in addition to studies on non-communicable diseases such as obesity, diabetes and heart disease.

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 status.

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.

MATERIAL AND METHODS

Census survey

Trained community-based reporters carry out the census survey. Reporters are IIMR supervised individuals hired from the villages that have attained at least a grade ten level of education and who are recommended by leaders in their community. Hence, the reporters are people who know the community well.

Socio economy survey (SES)

The socioeconomic survey was adapted for PNG from an INDEPTH[1] 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. Scientific officers piloted drafted questionnaires in each field site. In addition, a detailed content comparison between the IMR survey instrument and the baseline PNG LNG Project Social Impact Assessment was performed. These results are shown in subsequent sections of the report.

Demography update survey

Deaths, births, in/out migration and pregnancy are recorded by reporters at each update (two times a year). 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. Current longitudinal mortality data are shown in subsequent sections of the report.

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 percent of all households are randomly selected and are interviewed a second time to crosscheck the quality of the data collected.

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 (STATA Corp LP, College Station, TX).

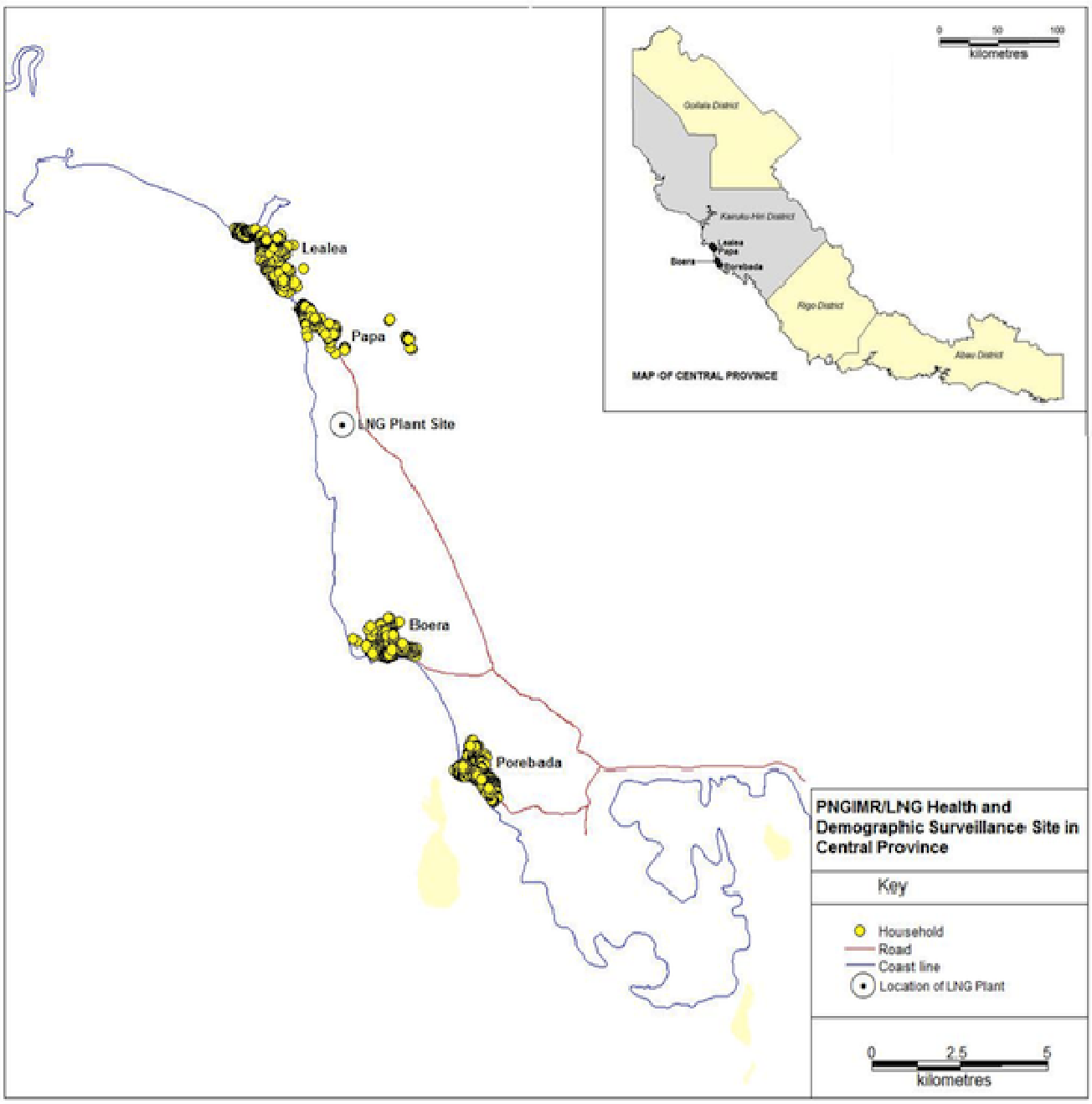
[1]The International Network for the Demographic Evaluation of Populations and Their Health

1.1. THE HIRI IHDSS

A DSS reporter conducted a survey with the local man.

Global Positioning System Mapping Results

Figure 1.1.1 Map of Households covered in the Hiri West iHDSS 2013



The Population

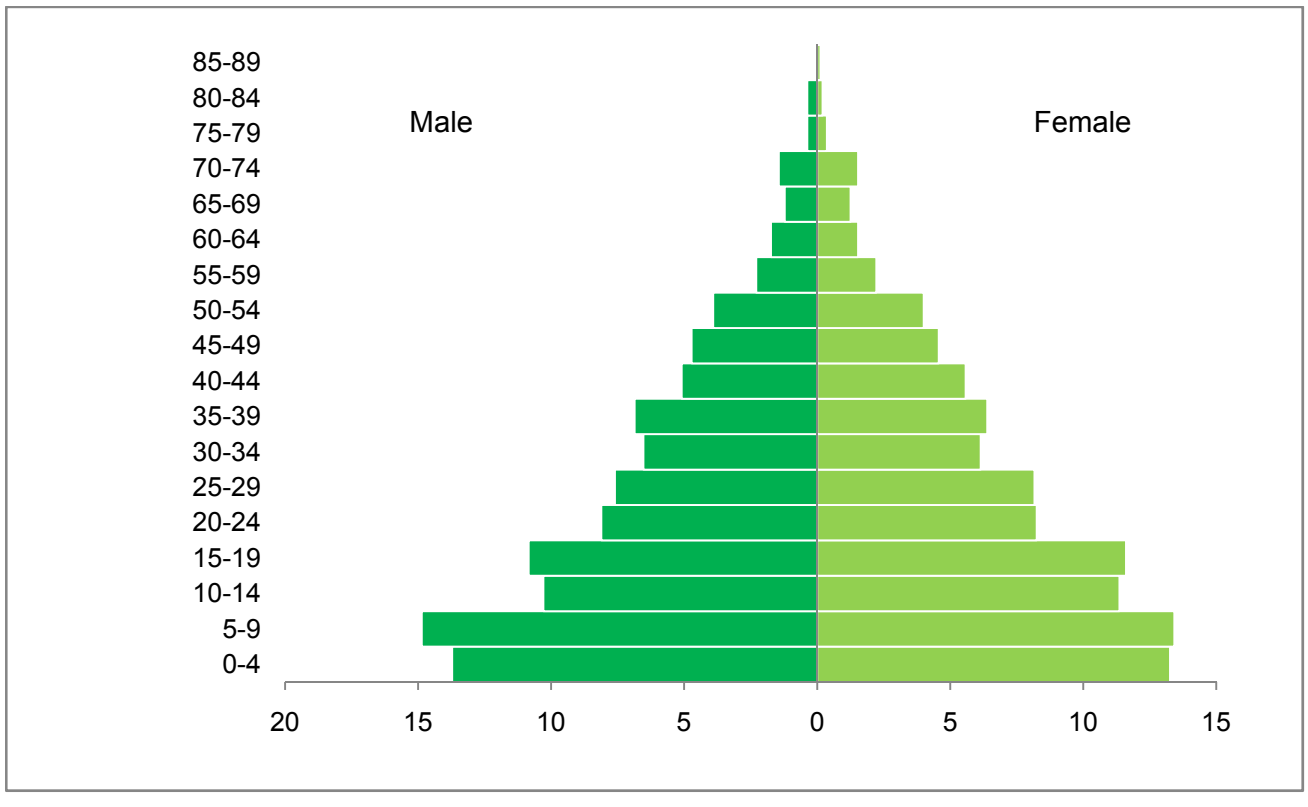
A total population of 12,246was initially recorded by the Hiri iHDSS.

Table 1.1.1 Total Hiri West (iHDSS 2012) population distribution by age and sex (%)

Age	All	Males	Females
All Ages	**12246**	**6129**	**5402**
0-4	1655 (13.5)	889 (13.7)	766 (13.3)
5-9	1738 (14.2)	967 (14.9)	771 (13.4)
10-14	1325 (10.8)	668 (10.3)	656 (11.4)
15-19	1369 (11.2)	701 (10.8)	668 (11.6)
20-24	1005 (8.2)	527 (8.12)	478 (8.3)
25-29	965 (7.9)	493 (7.6)	472 (8.2)
30-34	781 (6.4)	424 (6.5)	357 (6.2)
35-39	810 (6.6)	441 (6.8)	368 (6.4)
40-44	648 (5.3)	331 (5.1)	317 (5.5)
45-49	570 (4.7)	305 (4.7)	265 (4.6)
50-54	484 (4.0)	254 (3.9)	230 (4.0)
55-59	276 (2.3)	149 (2.3)	127 (2.2)
60-64	197 (1.6)	110 (1.7)	86 (1.5)
65-69	159 (1.3)	84 (1.3)	75 (1.3)
70-74	177 (1.4)	91 (1.4)	86 (1.5)
75-79	43 (0.4)	26 (0.4)	17 (0.3)
80-84	37 (0.3)	26 (0.4)	12 (0.2)
85+	8 (0.1)	3 (0.04)	6 (0.1)
0-14	4718	2525	2193
15-64	7103	3736	3367
>65	425	230	196

After further data QA/QC checks, e.g., elimination of duplicates, incomplete information, etc., the final population estimate is 12,148. This value is extremely close to the initial field estimate.

Figure 1.1.2. Population pyramid of the total Hiri West (iHDSS 2012) population



The population pyramid for Hiri West presents a picture of a society undergoing rapid population growth (Figure 1.1.2) 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 1.1.2. Description of age structure in Hiri West villages in iHDSS 2013

	All	Males	Females	Male:Female
Proportion of population between 0 and 14 (%)	38.5	38.9	38.1	115:100
Proportion of population between 15 and 64 (%)	58.0	57.6	58.5	110:100
Proportion of population over 65 (%)	3.5	3.54	3.4	117:100
Median age (years)	24	22	25	-
Dependency Ratio	65.2	-	-	-

A particularly striking result is the male to female ratios present in Table 1.1.2. For all four villages the ratio is about 114:100 males to females. Birth and death data for the 2012 full year are shown in Table 1.1.3.

Table 1.1.3 Birth and Death Data Hiri Villages 2012 Full Year Data

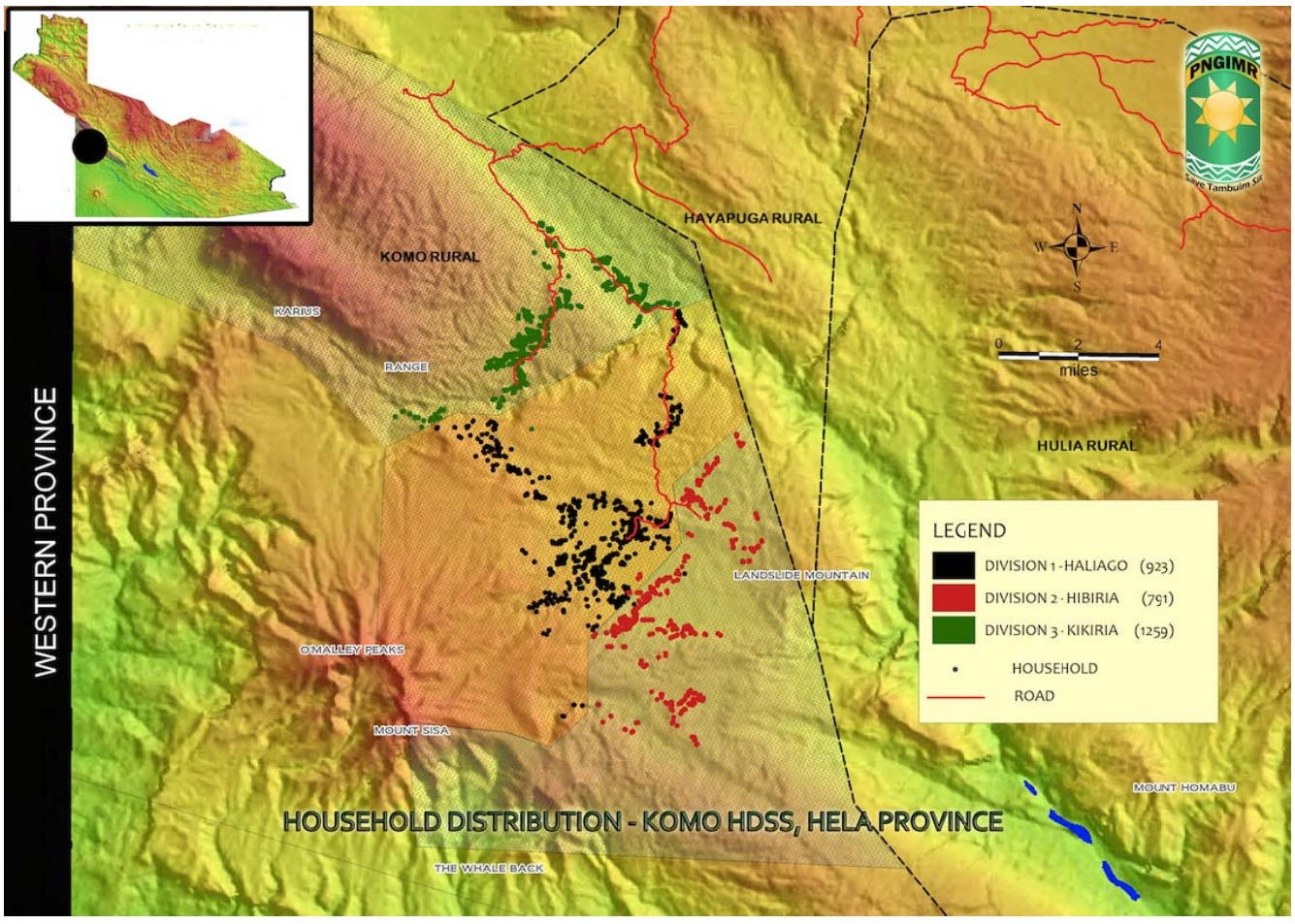
	All	Boera	Porebada	Papa	Lea Lea
Births/1000 population	12.3	42.7	2.0	4.6	17.7
Deaths/1000 population	9.6	10.1	10.7	5.8	12.5
Rate of natural increase from 2012 (per 1000 people)	2.7	32.6	-8.7	-1.2	5.1

	All	Boera	Porebada	Papa	Lea Lea
Births	150	76	11	8	55
Deaths	117	18	59	10	39
Total pop	12148	1781	5530	1728	3109

Overall the summed data are consistent with the typical PNG natural population rate increase of 2.7%; however, as illustrated by the Table 1.1.3 data, there are marked differences across the Hiri villages. The summed average masks significant differences and illustrates why village level analysis is preferred. More detailed analysis of these data is presented in the “Project Induced In-Migration section.

1.2 HIDES/KOMO IHDSS

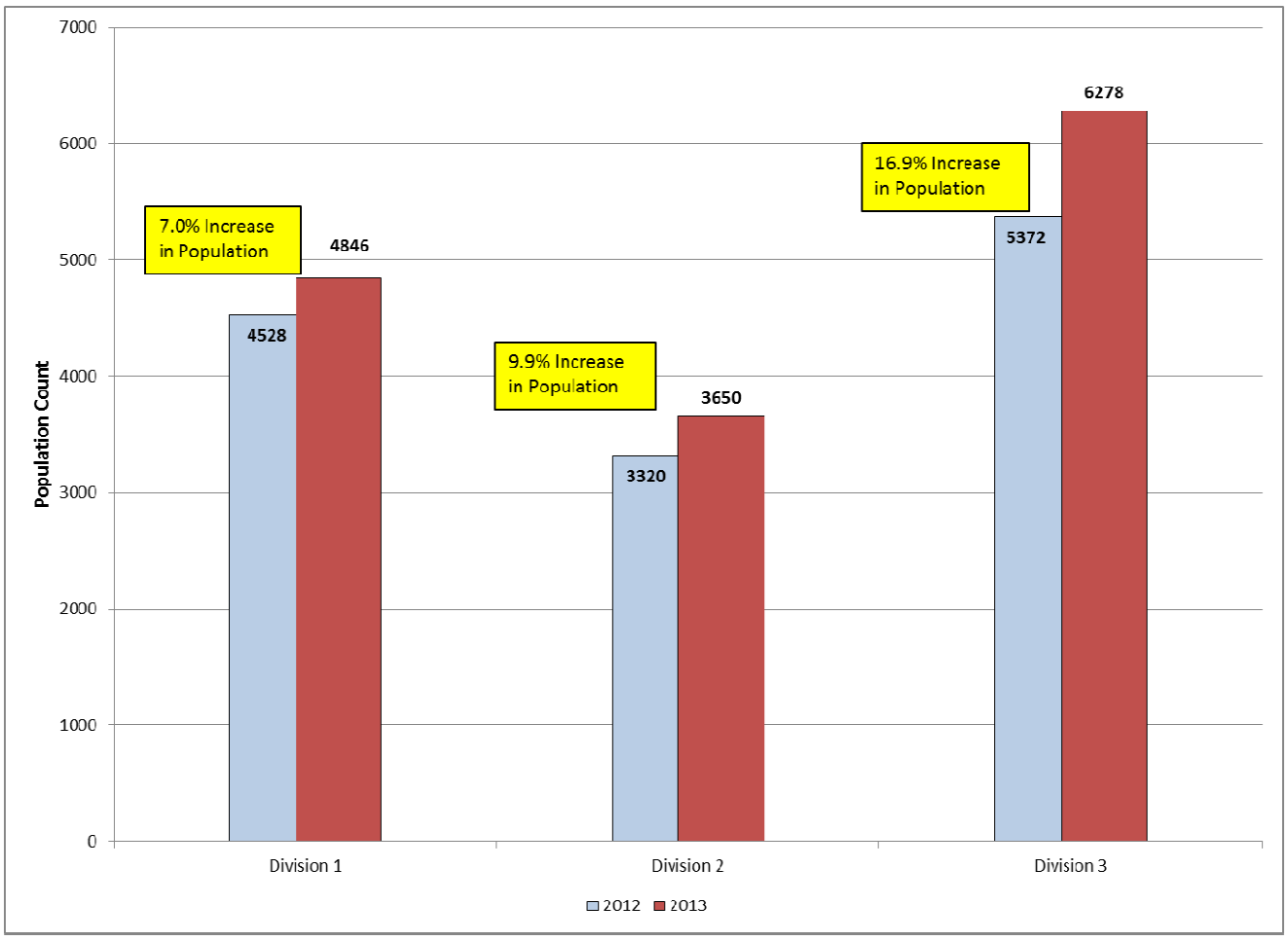
Figure 1.2.1. Hides/Komo iHDSS Imagery



The Population

The three divisions of Hides each have different makeups regarding population size and structure. Figure 1.2.2 shows the population distribution by division of Hides/Komo over two years: the 2012 initial data and the 2013 census update. There has been a substantial increase in the population count for each division, particularly for Division 3. This population increase is potentially related to the substantial economic activity associated with the PNG LNG and subsequent in-migration. More detailed analysis of these potential Hides-specific effects is presented in the “Project Induced In-Migration section.

Figure 1.2.2. Hides /Komo Population Count by Division over Time



Figures 1.2.3-1.2.5 show the population pyramids for each of the divisions the 2013 census. The large “bulge” in the age 25-29 in Divisions 2 & 3 may be an indicator of employment-induced in-migration, as work on the Komo airfield and HGCP are the two largest sources of employment in the area. Komo airfield work has been completed since the 2013 census.

Figure 1.2.3. Hides Division 1 Population Pyramid

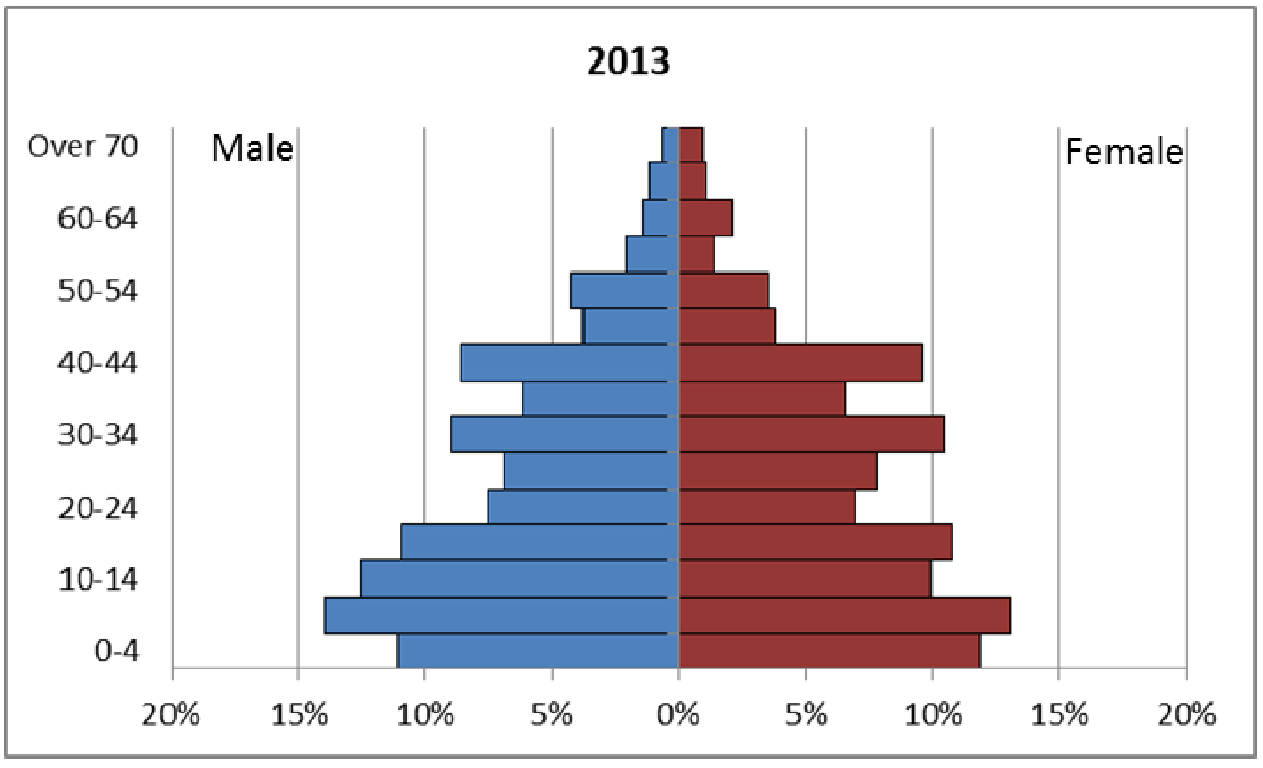


Figure 1.2.4. Hides Division 2 Population Pyramid

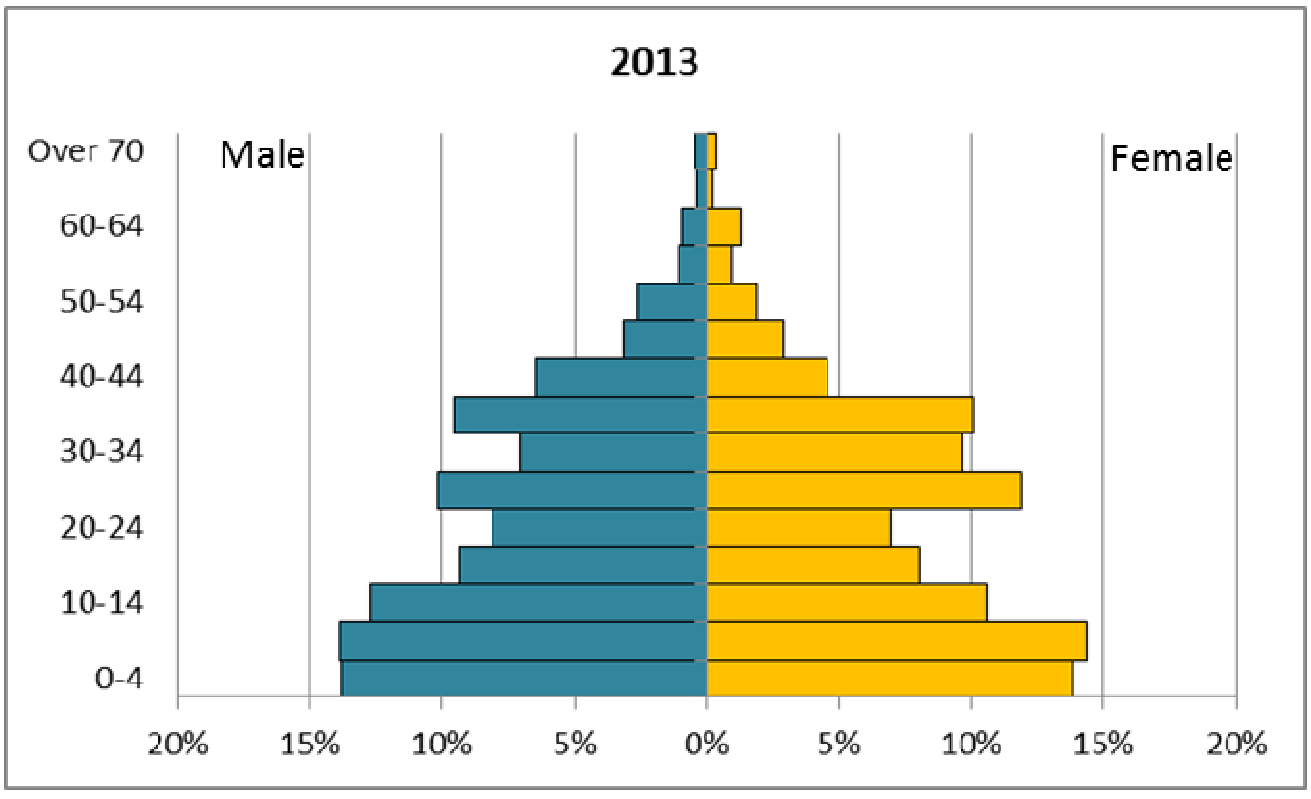
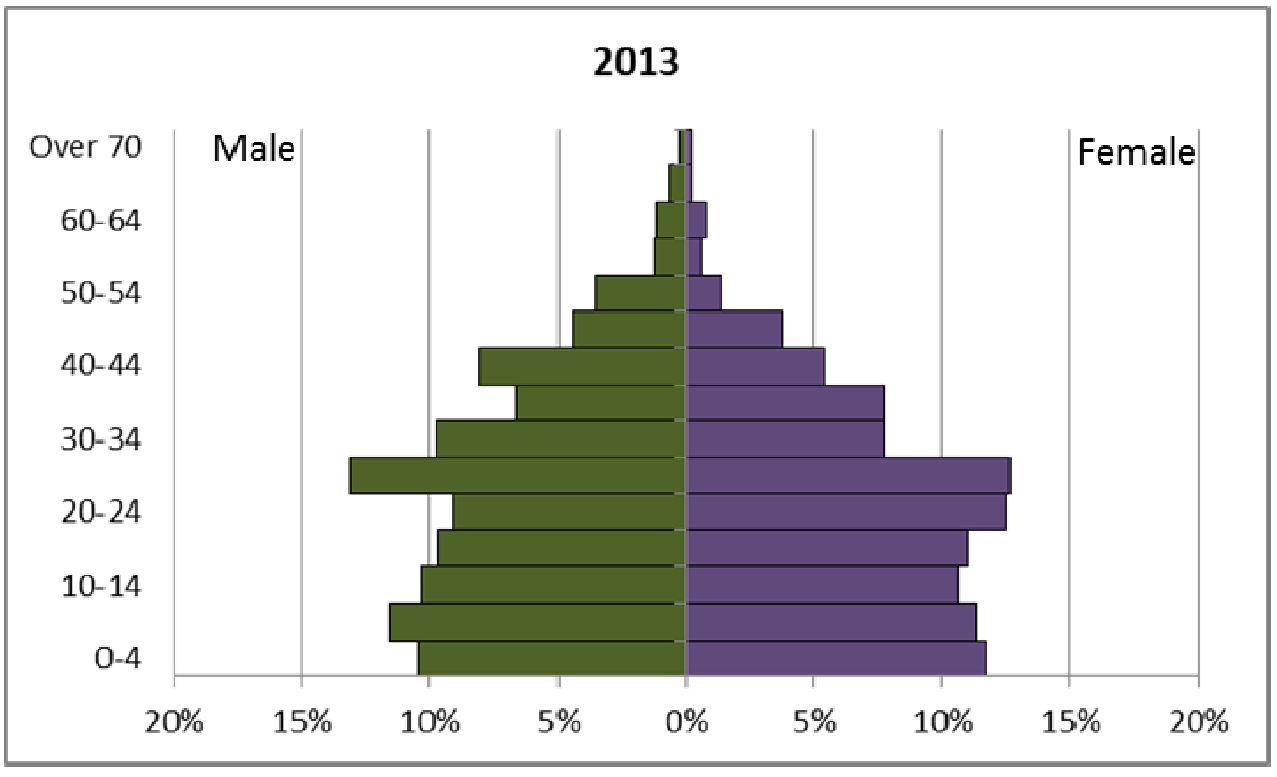


Figure 1.2.5. Hides Division 3 Population Pyramid



Each of the Hides Divisions has more males than females, a pattern also observed by the Hiri iHDSS. Table 1.2.1 shows the counts and sex ratios for all three divisions. Divisions 2 and 3 have high proportions of males, a finding consistent with employment/economic opportunity seeking behavior. Division 1, which is not as close to the Komo Airfield or HGCP, has a sex ratio that is much closer to being even.

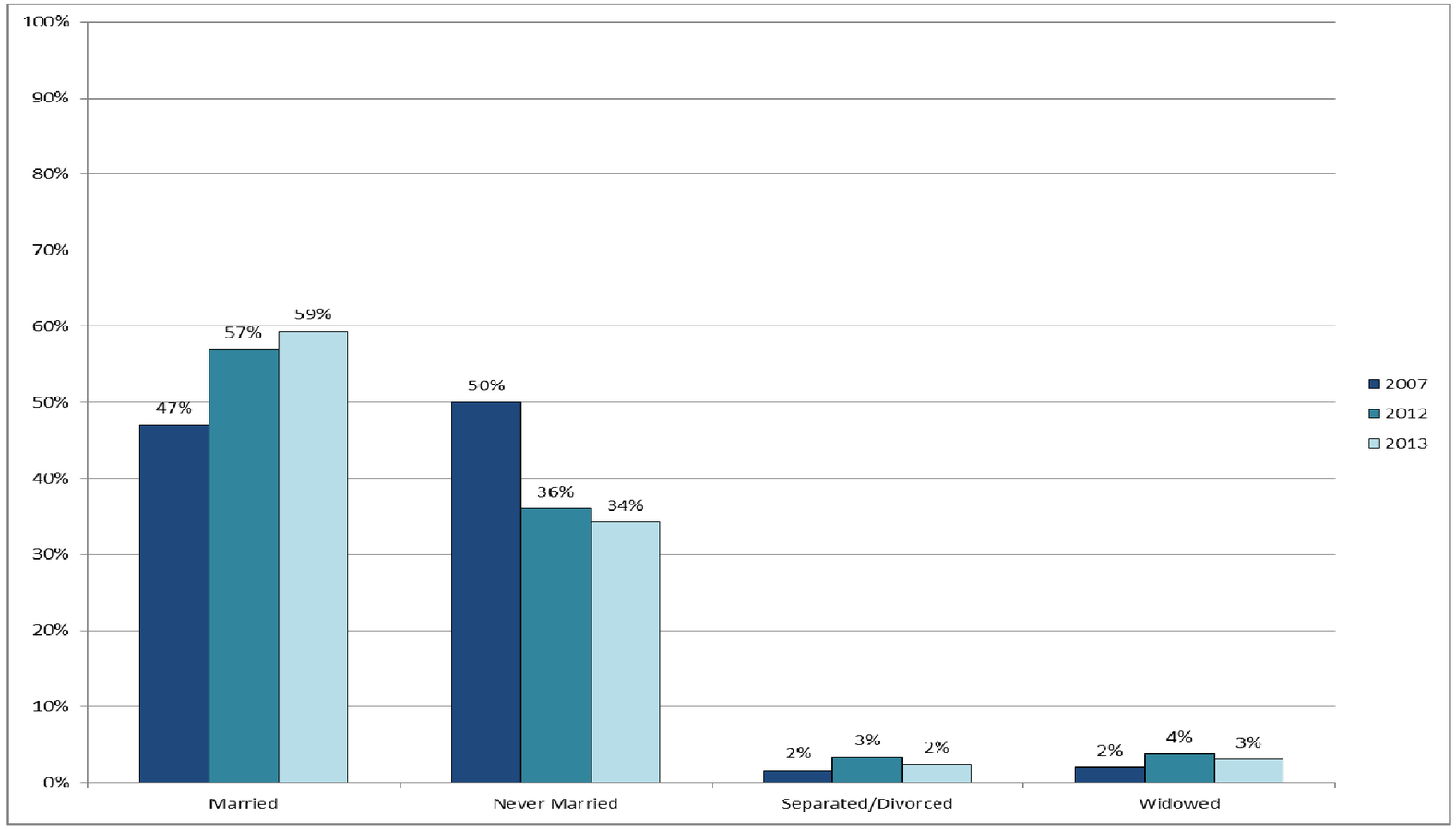
Table 1.2.1. 2013 Hides/Komo Population and Sex Ratio by Division.

	Male	Female	Sex Ratio (Male/Female)
Division 1	2440	2368	**103.0**
Division 2	1890	1735	**108.9**
Division 3	3290	2964	**111.0**

*Those records where gender has been omitted have been excluded from table

The distribution of marital status by time period is shown in Figure 1.2.6. All three divisions show similar rates of marriage. Marriage rates have increased substantially from 2007 to 2013. Many Huli practice polygamy, with men taking on more wives as their wealth increases; thus, it may be that the increase in marriage rate is resulting from men adding additional wives to their families. Further survey work is needed to better evaluate this issue.

Figure 1.2.6. Hides/Komo Marital Status Over Time



Education

The education status of Hides villagers is shown by sex in Figure 1.2.7 and by sex and Division in Figure 1.2.8. Household educational attainment in the Southern Highlands Province is historically poor and the initial census data confirms this finding, as 60% of females and nearly 50% of males have received no education. An analysis of education by division shows that Division 2 has substantially more residents, (over 20 percentage points more), that have received no education. Both Divisions 1 and 3 have 5-6 times as many respondents responding “Don’t Know” to the education attainment question. If “Don’t’ Know” actually means “none”, then the difference in those responding “none” shrinks to a 13 percentage point difference between Divisions 1 and 2 and a 9.4 percentage point difference between Divisions 2 and 3.

Figure 1.2.7. 2012 Hides Educational Attainment Status by Sex

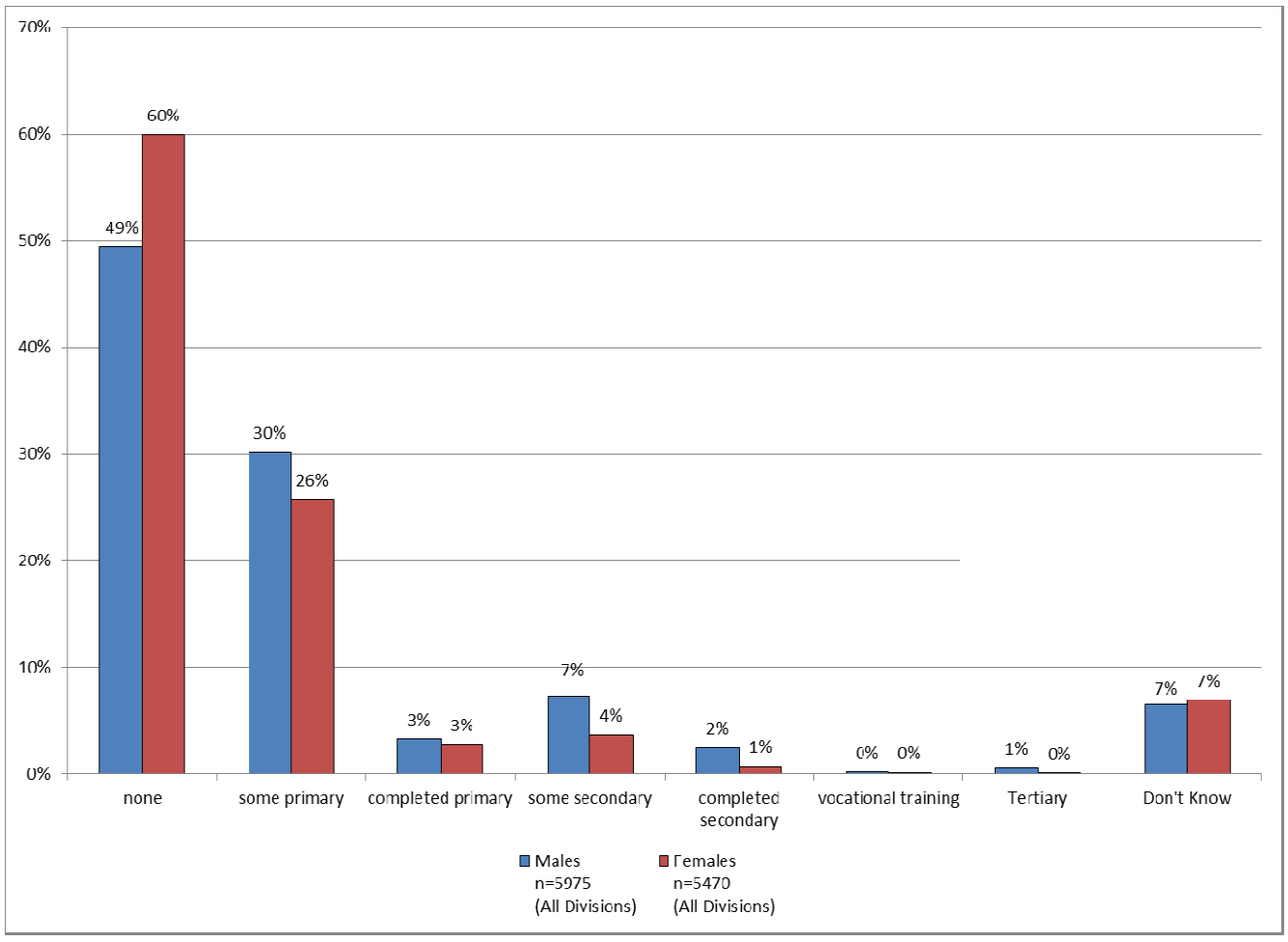
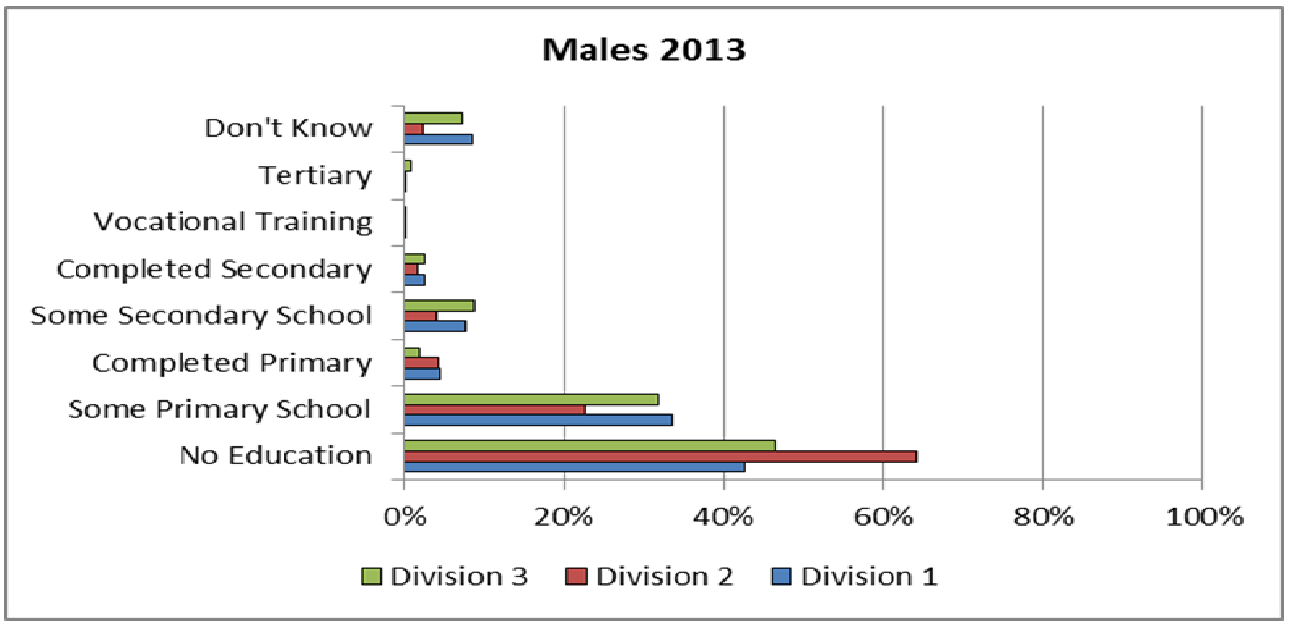
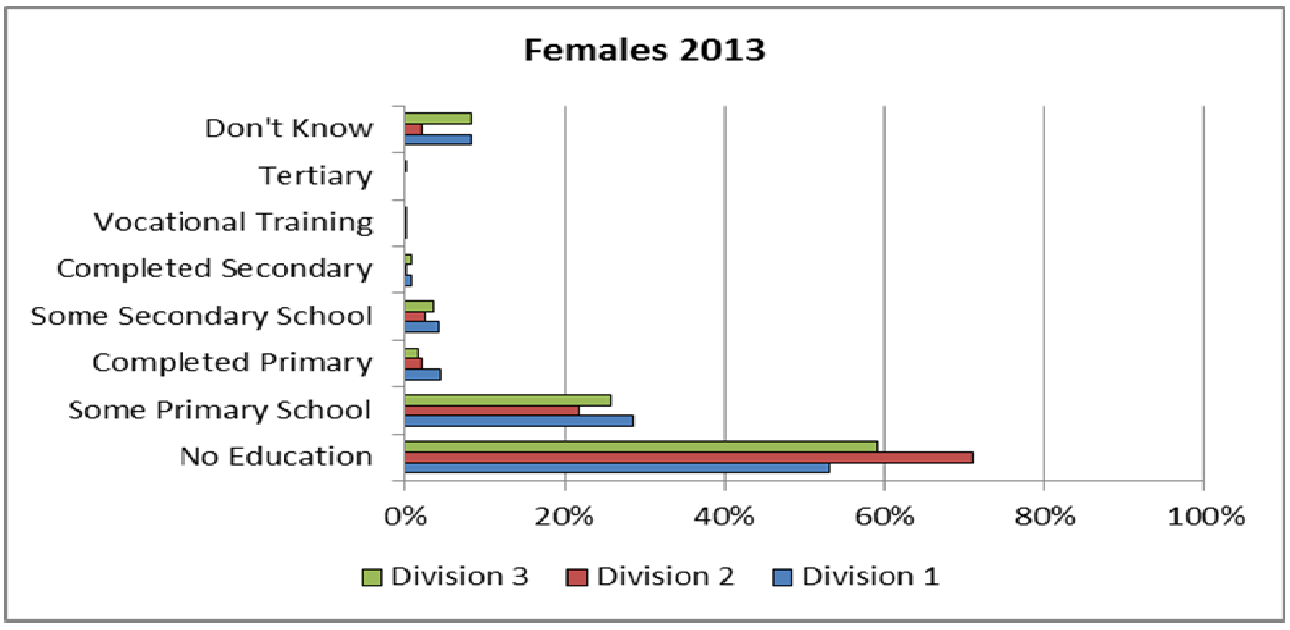


Figure 1.2.8. Hides Educational Attainment over time by Sex and Division

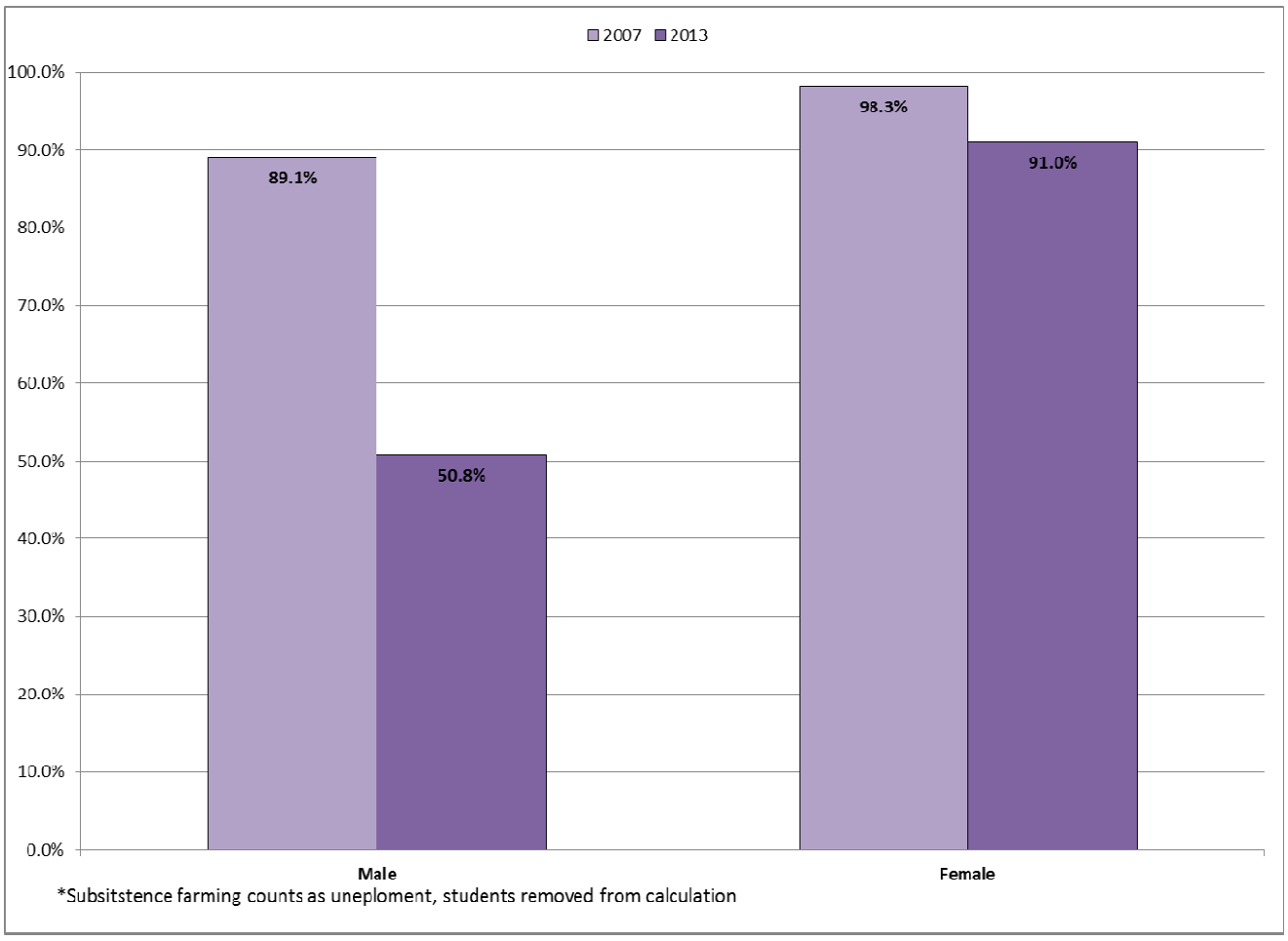




Employment

Employment status by sex is examined in Figure 1.2.9. Those people in the cohort with these responses were considered unemployed: (i) unemployed, (ii) subsistence farming, and (iii) home duties. There was a nearly 40-percentage point drop in the male unemployment rate from the SIA conducted in 2007 to Census update in 2013. Over the same time period, there was over a 7-percentage point decrease among females.

Figure 1.2.9. Employment Status for Adults by Sex



Given the substantial decrease in male unemployment, Figure 1.2.10 compares the percentage of males by employment type (as asked by the census) and Division. The high percentage of workers that fall into “Labourer in mining, construction, and transport” category in Division 3 is likely because of its proximity to the HGCP construction activity. Similarly, the higher count of plant and machine operators and assemblers is likely due to the proximity of the Komo Airfield.

Figure 1.2.10. Male Employment by Type: 2012-2013 Comparisons

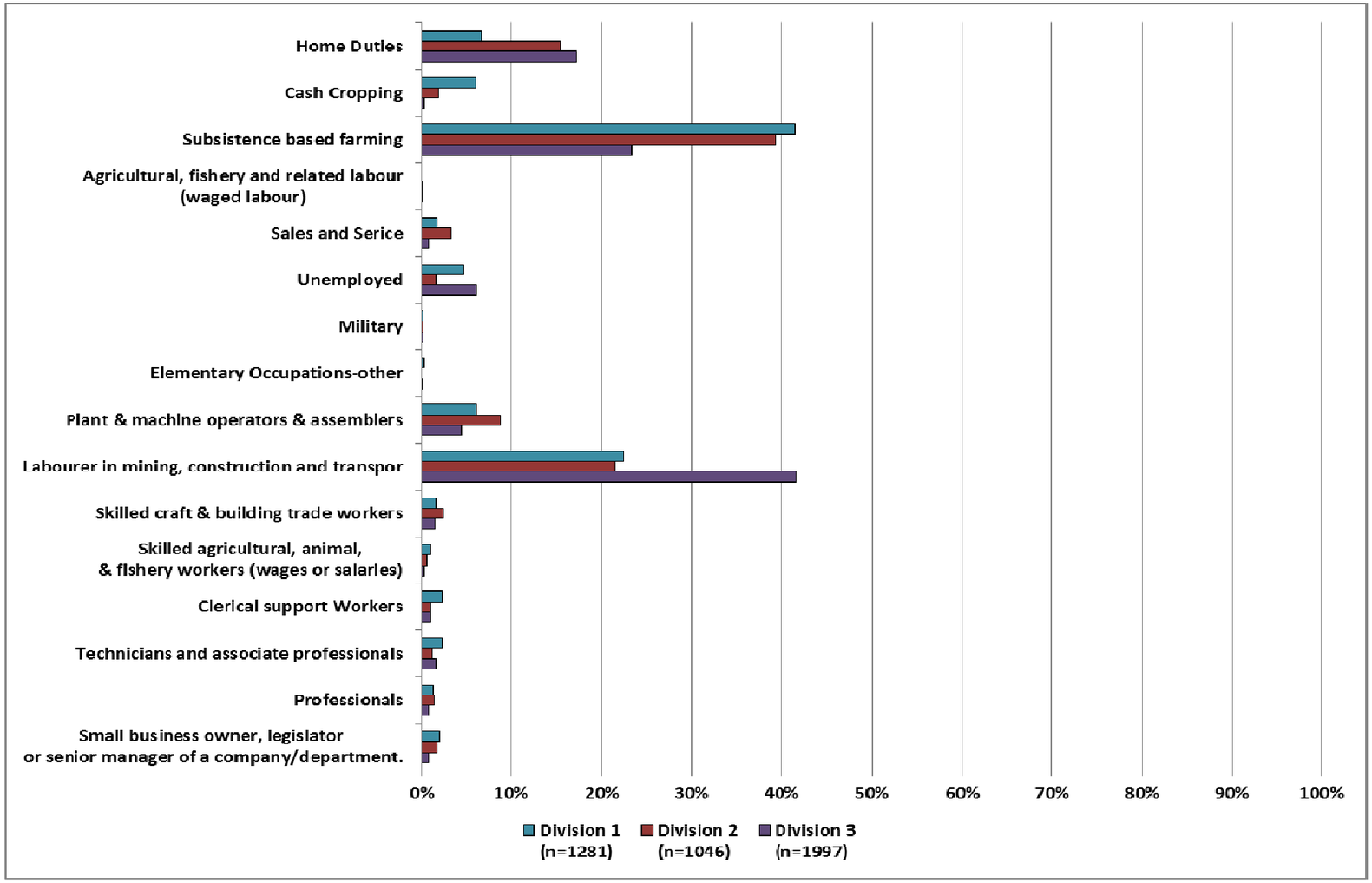
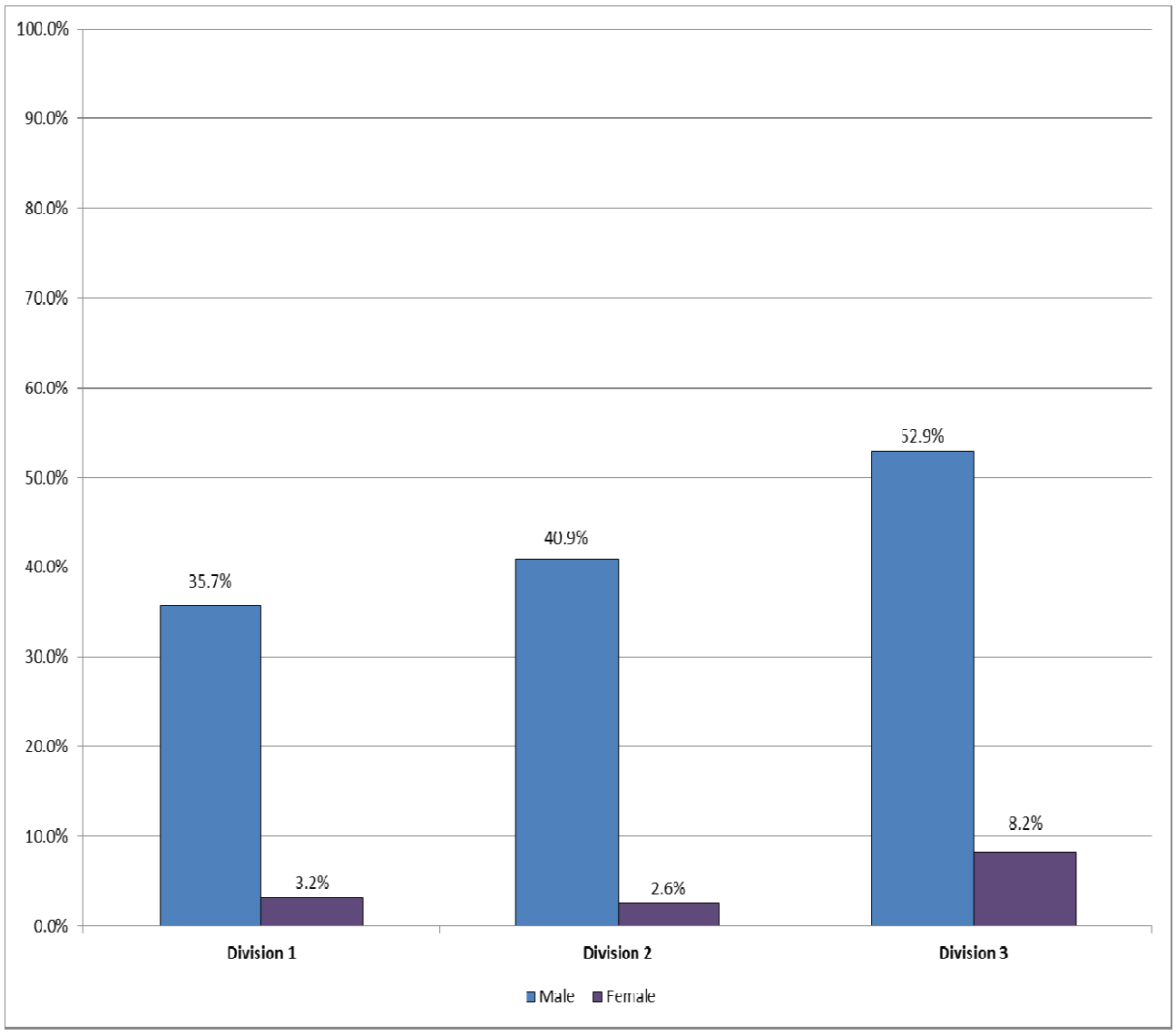


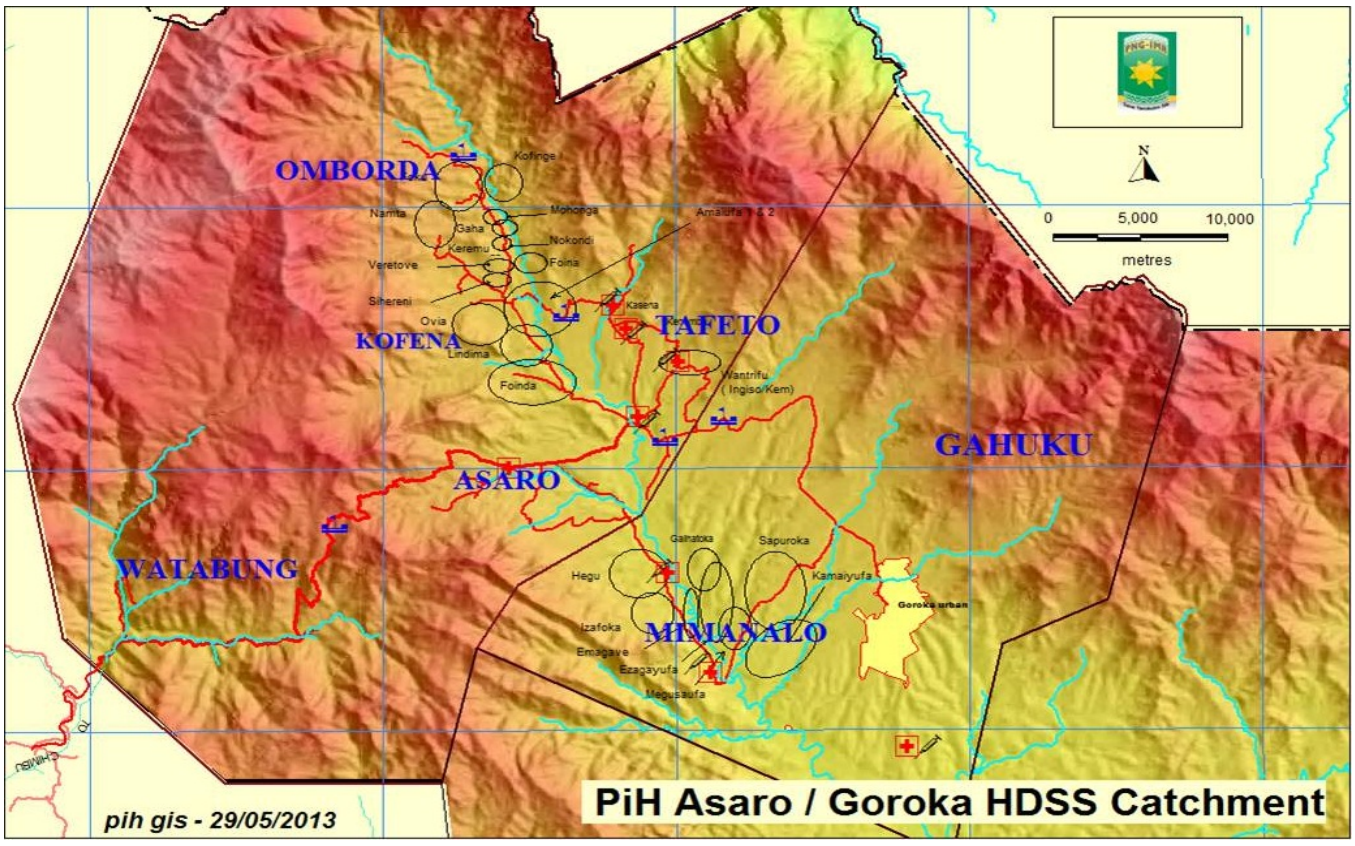
Figure 1.2.11 shows the Percentages of residents employed by division and sex. Residents who responded either as student, not relevant, or don't know to the question regarding their occupation were excluded from the equation, as these residents are likely to be children under the age of 15. The two divisions closest to the LNG project (Divisions 2 and 3) have the highest percentage of workers employed by the project. Over 50% of Males in Division 3, and 40% of males in Division 2, are employed by the LNG project. Most women do not work for the LNG project; however, the largest female working cohort is in Division 3, and likely a result of its close proximity to the HGCP plant.

Figure 1.2.11. Percentage of Residents Employed by LNG Project by Sex and Division



1.3 ASARO IHDSS

Figure 1.3.1. Map of villages covered in the Asaro iHDSS



The Population

The 2013 population in Asaro iHDSS is 14197 from 2976 households. The iHDSS covers 26 villages in Asaro valley. There are currently 28 field reporters conducted the census survey and DSS update survey.

Table 1.3.1. Total Asaro iHDSS (2013) population distribution by age and sex

Age (yrs)	All	Males	Females
All ages	**14,197**	**7201**	**6996**
0-4	2178 (15.3)	1073 (14.9)	1105 (15.8)
5-9	1498 (12.8)	763 (10.6)	735 (10.5)
10-14	1463 (10.3)	763 (10.6)	700 (10)
15-19	1200 (9.2)	619 (8.6)	581 (8.3)
20-24	1066 (7.8)	569 (7.9)	497 (7.1)
25-29	958 (8.4)	482 (6.7)	476 (6.8)
30-34	929 (6.8)	446 (6.2)	483 (6.9)
35-39	871 (7.6)	382 (5.3)	490 (7)
40-44	816 (6.2)	396 (5.5)	420 (6)
45-49	844 (4.4)	410 (5.7)	434 (6.2)
50-54	505 (3.7)	274 (3.8)	231 (3.3)
55-59	483 (3.3)	252 (3.5)	231 (3.3)
60-64	334 (2.9)	194 (2.7)	140 (2)
65-69	363 (2.3)	202 (2.8)	161 (2.3)
70-74	256 (1.3)	130 (1.8)	126 (1.8)
75-79	199 (0.8)	115 (1.6)	84 (1.2)
80-84	92 (0.5	50 (0.7)	42 (0.6)
85+	64 (0.3)	36 (0.5)	28 (0.4)
0-14	5139	2600	2540
15-64	8006	3608	3400
65+	1052	245	315

Figure 1.3.2. Population pyramid of the total Asaro (iHDSS 2013) population

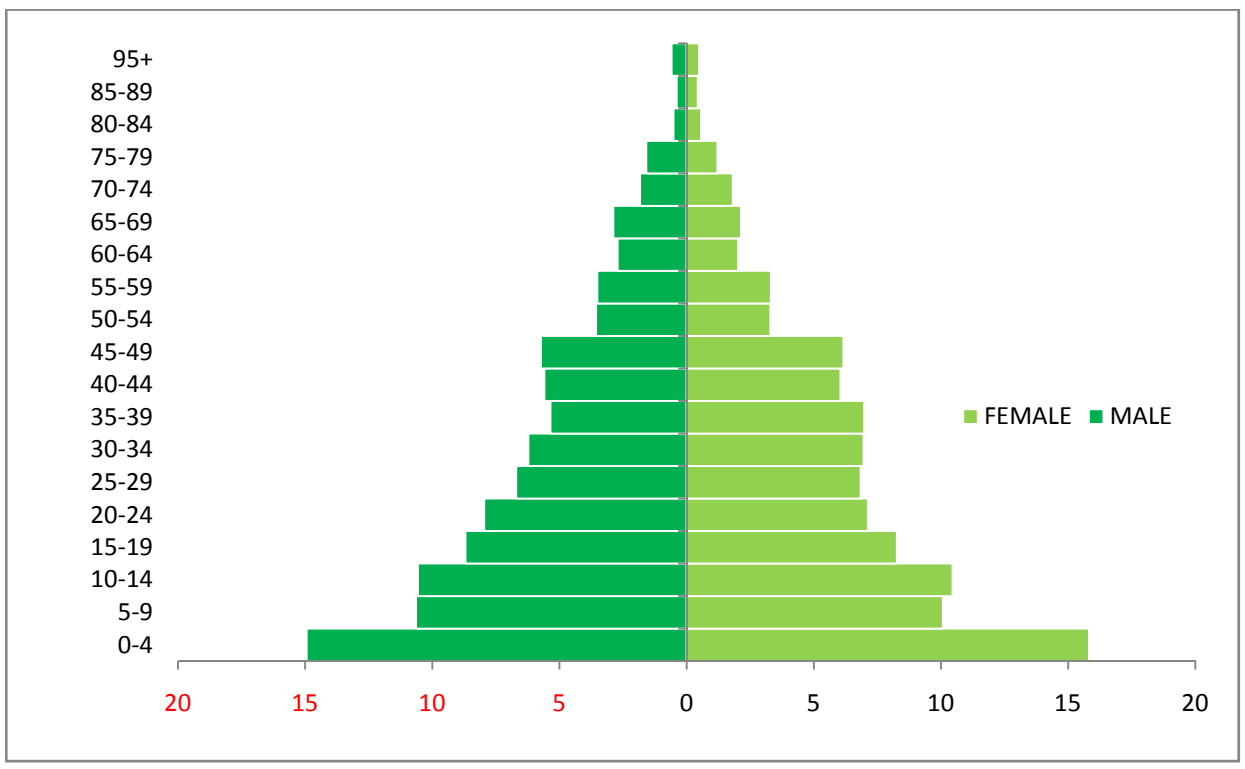


Table 1.3.2. Age and sex characteristic of the total Asaro (iHDSS 2013) population

	All	Males	Females	Male:Female
Proportion of population between 0 and 14 (%)	36.2	36.1	36.3	102:100
Proportion of population between 15 and 64 (%)	56.4	50.1	48.6	106:100
Proportion of population over 65 (%)	7.4	3.4	4.5	77:100
Median age (years)	22	21	23	-
Dependency Ratio	66.2	-	-	-

Table 1.3.3. Number of deaths and mortality rates (/1000) by age in Asaro iHDSS (2012-2013)

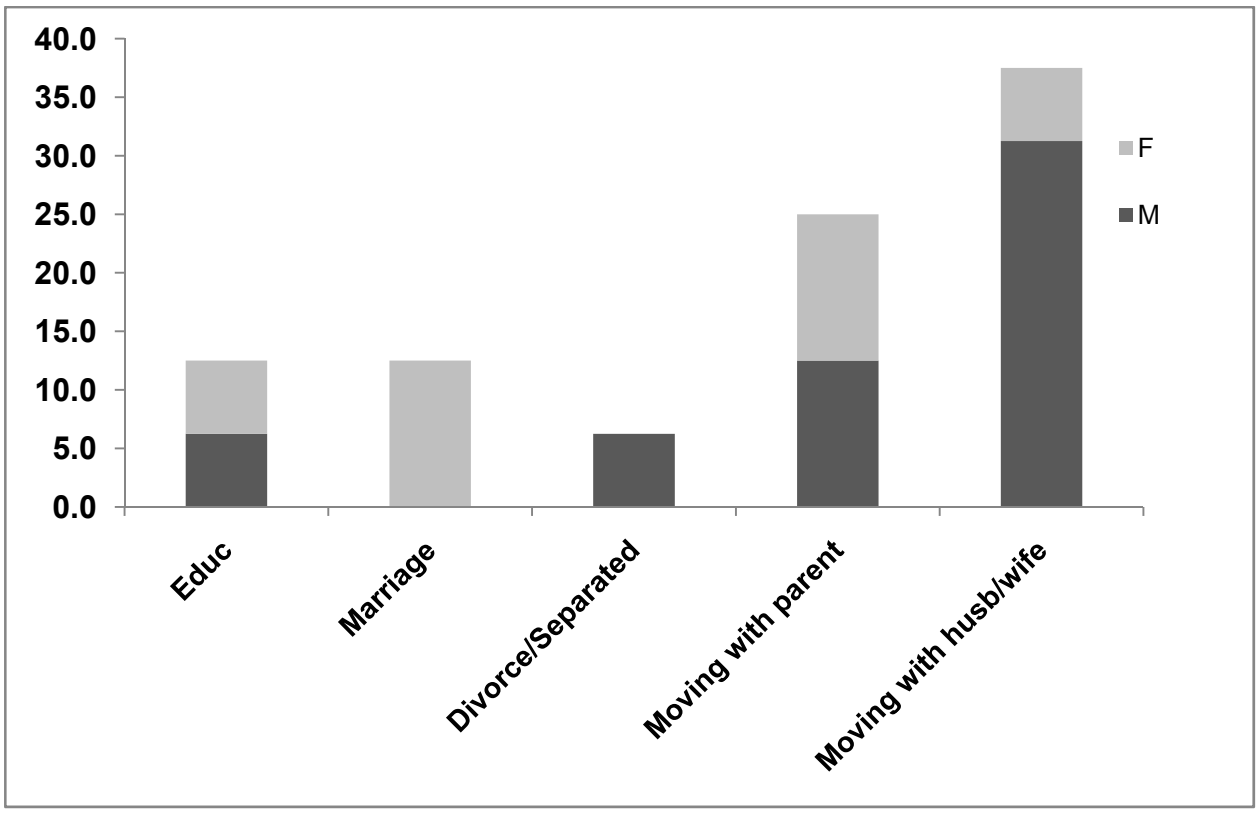
Age (yrs)	Population in 2013	Number of deaths in June 2012- June 2013	Mortality rate /1000
0-4	1201	35	29.14
5-14	3021	9	2.98
15-44	4650	51	10.97
45-59	1288	29	22.52
60-69	726	42	57.85
70+	397	35	88.16
All Ages	**11283**	201	**17.81**

The Asaro population have a substantial population of individuals who have never received any formal education (Table 1.3.4-1.3.5), 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 1.3.6-1.3.7).

MIGRATION

There are 65 out migration and 33 in migration in the first DSS update survey. More males than female migrated due to “moving with husband/wife.” These data are consistent with the observation that many males migrated into Asaro after getting married with Asaro women.

Figure 1.3.3 the reasons of migration in Asaro iHDSS



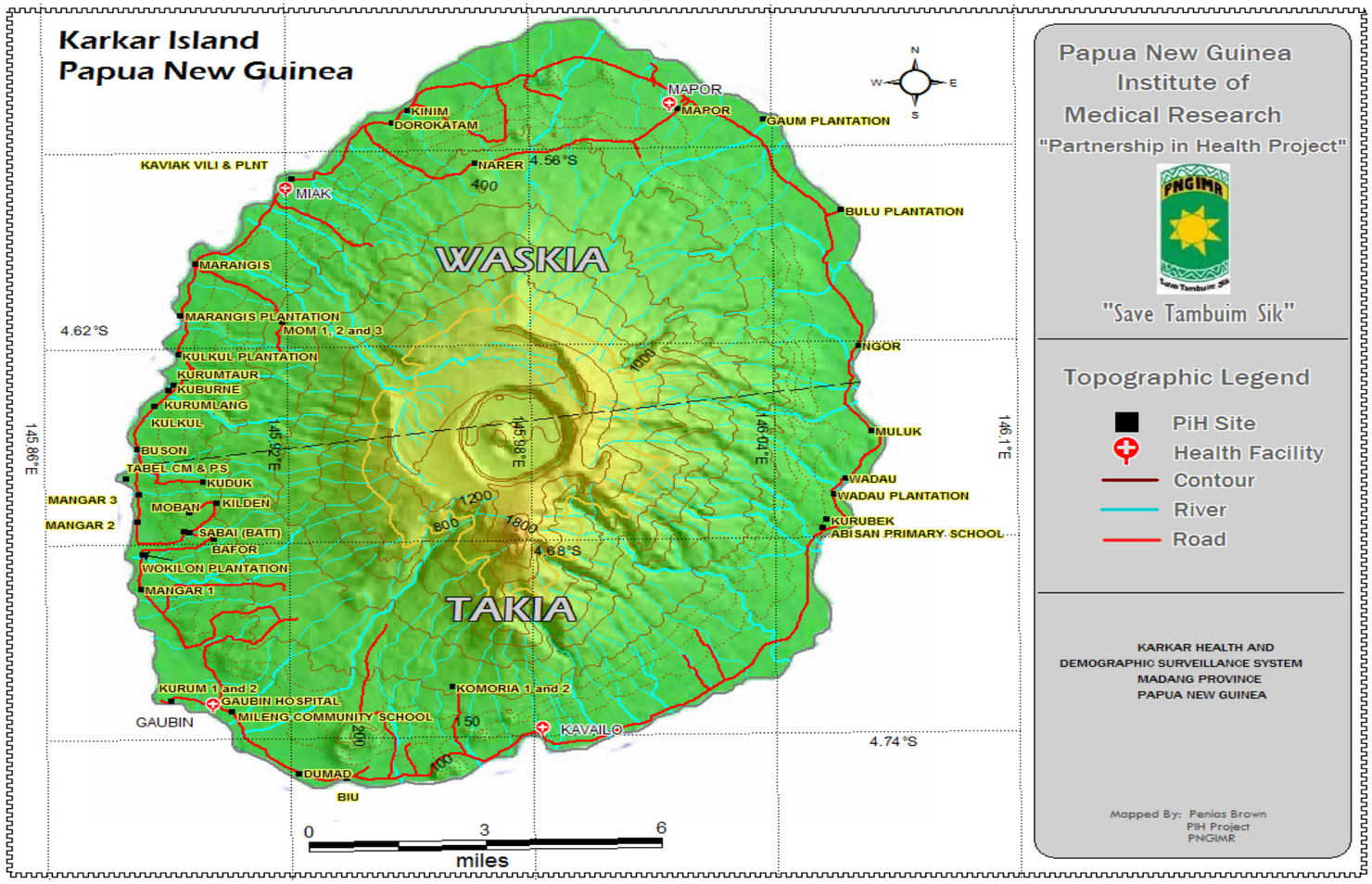
1.4 KARKAR ISLAND IHDSS

Karkar is a volcanic island located 30km off of the PNG coast in the Bismarck Sea and is part of Madang Province. 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.

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. Gaubin Hospital is the largest of the facilities and is a Lutheran run institution.

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.



· iHDSS 2012-2013

Table 1.4.1. Total Karkar (iHDSS 2013) population distribution by age and sex (%)

Age (yrs)	All	Males	Females
All ages	**18,762**	**9,882**	**8,880**
0-4	1,855 (9.9)	942 (5)	913 (4.9)
5-9	2,606 (13.9)	1,417 (8)	1,189 (6.3)
10-14	2,212 (11.8)	1,159 (6)	1,053 (5.6)
15-19	2,051 (10.9)	1,083 (6)	968 (5.2)
20-24	1,659 (8.8)	883 (5)	776 (4.1)
25-29	1,419 (7.6)	748 (4)	671(3.6)
30-34	1,205 (6.4)	630(3)	575 (3.1)
35-39	1026 (5.5)	534 (3)	492 (2.6)
40-44	903 (4.8)	472 (3)	431 (2.3)
45-49	725 (3.9)	364 (2)	361 (1.9)
50-54	699 (3.7)	377 (2)	322 (1.7)
55-59	403 (2.1)	219 (1)	184 (1.0)
60-64	327 (1.7)	190 (1.0)	137 (0.7)
65-69	187 (1.0)	93 (0.5)	94 (0.5)
70-74	196 (1.0)	103 (0.5)	93 (0.5)
75-79	82 (0.4)	44 (0.2)	38 (0.2)
80-84	25 (0.1)	11 (0.1)	14 (0.1)
85+	19 (0.1)	12 (0.1)	7 (0.0)
0-14	6,673 (36)	3,518 (18.8)	3155 (16.8)
15-64	10,417 (56)	5,500 (29.3)	4,917 (26.)
65+	509 (3)	263 (1.4)	246 (1.3)
Need to validate in the next DSS update survey	1,163 (6)	601 (3.2)	562 (3)

Figure 1.4.2. Population pyramid of the Karkar (iHDSS 2013) population

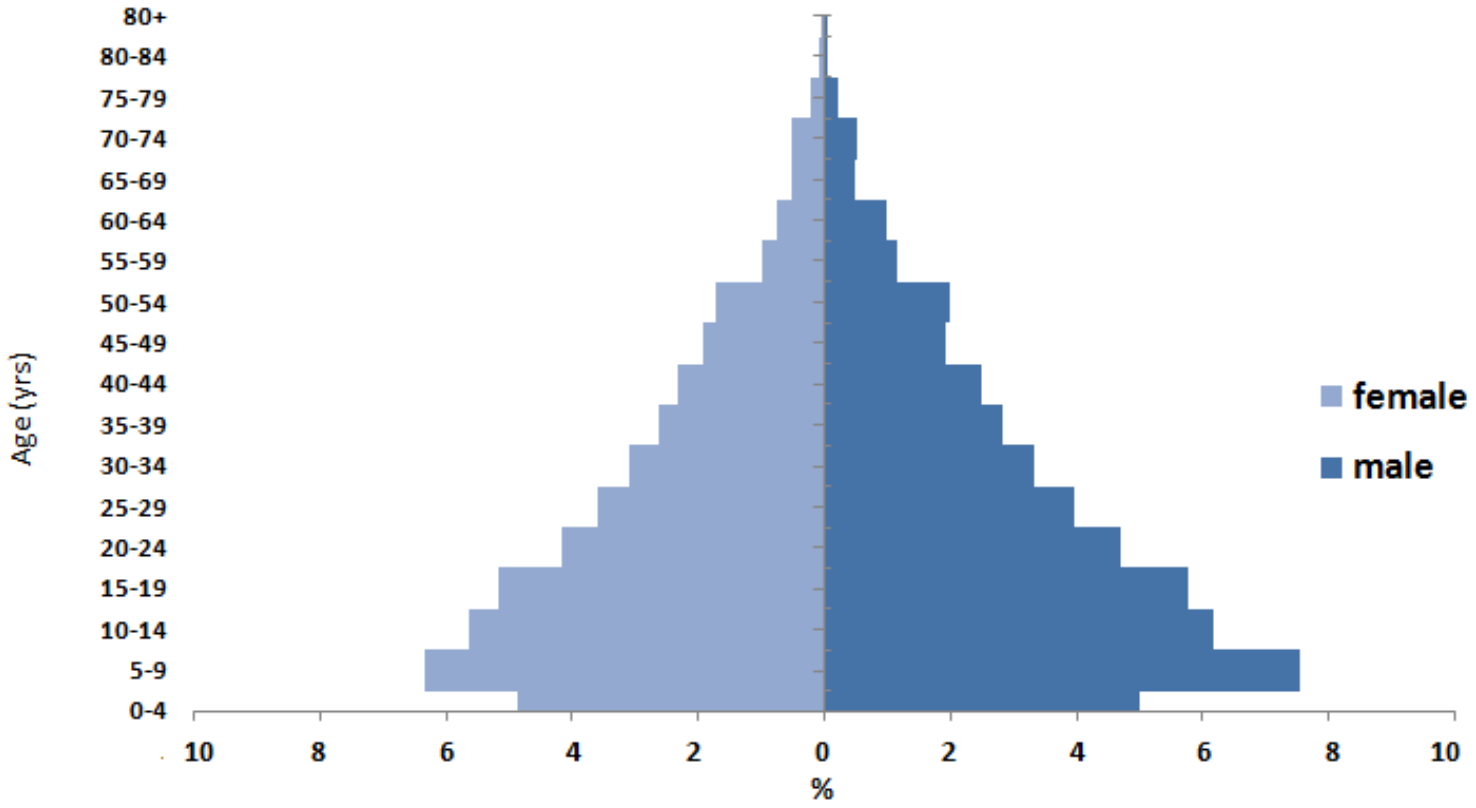


Table 1.4.2. Age and sex characteristic of a portion of the Karkar (iHDSS 2013) population

	All (%)	Males	Females	Male:Female
Proportion of population between 0 and 14 (%)	36	18.8	16.8	112:100
Proportion of population between 15 and 64 (%)	56	29.3	26.2	112/100
Proportion of population over 65 (%)	3	1.4	1.3	108:100
Median age (years)	20	20	20	-
Dependency Ratio	69.6	-	-	-

With the largest proportion of their population between the ages of 0 and 14 (Figure 1.4.2), Karkar has the highest dependency ratio observed across the four iHDSS sites (Table 1.4.2). 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 1.4.3 and 1.4.4).Between 50% and 60% (both females and males) of Karkar respondents report being primarily subsistence based.

Education:

Table 1.4.3. Educational attainment amongst males by age in Kar Kar iHDSS 2013

Takia	Male										
age years	No Education (%)	Some Primary	Completed Primary	Some Secondary	Completed Secondary	National High School	Vocational	Tertiary	Not relevant	Don't know or NA	Total
5-14	112 (8.4%)	598 (44.9%)	0	2 (0.15%)	0	1 (0.1%)	0	0	612 (46.1%)	4 (0.3%)	1329
15-24	19 (1.9%)	689 (68.9%)	142 (14.2%)	107 (10.7%)	17 (1.7%)	2 (0.2%)	15 (1.5%)	0	6 (0.6)	2 (0.2%)	999
25-34	26 (3.8%)	281 (41.4%)	158 (23.3%)	137 (20.2)	29 (4.3%)	8 (1.2%)	21 (3.1%)	15 (2.2%)	1 (0.1%)	2 (0.3%)	678
35-44	16 (3.0%)	345 (64.9%)	45 (8.5%)	78 (14.7%)	17 (3.2%)	2 (0.4%)	7 (1.3%)	14 (2.6%)	2 (0.4%)	5 (0.9%)	531
45-54	19 (5.3%)	236 (65.4%)	30 (8.3%)	46 (12.7%)	9 (2.5%)	2 (0.6%)	2 (0.6%)	15 (4.1%)	1 (0.3%)	1 (0.3%)	361
55-64	12 (6.1%)	124 (62.9%)	10 (5.1%)	24 (12.2%)	13 (6.6%)	2 (1.0%)	0	9 (4.6%)	0	3 (1.5%)	197
65-74	14 (11.3%)	73 (58.9%)	5 (4.0%)	8 (6.5%)	3 (2.4%)	0	1 (0.8%)	4 (3.2%)	6 (4.8%)	10 (8.1%)	124
75-84	3 (8.6%)	22 (62.8%)	4 (11/4%)	5 (14.3%)	0	0	0	0	0	1 (2.9%)	35
85+	0	7 (100%)	0	0	0	0	0	0	0	0	7
	221 (5.2%)	2375 (55.7%)	394 (9.3%)	407 (9.6%)	88 (2.1%)	17 (0.4%)	46 (1.1%)	57 (1.3%)	628 (14.7%)	28 (0.7%)	4261
Waskia											
age years	No Education	Some Primary	Completed Primary	Some Secondary	Completed Secondary	National High School	Vocational	Tertiary	Not relevant	Don't know or NA	Total
5-14	100 (0.5%)	627 (3.3%)	1 (0.1%)	0	0	-1%	0	0	514 (41.2%)	4 (0.3%)	1247
15-24	18 (0.1%)	715 (3.8%)	117 (12.1%)	78 (8.1%)	22 (2.3%)	5 (0.5%)	6 (0.6%)	3 (0.3%)	1 (0.1%)	2 (0.2%)	967
25-34	24 (0.1%)	301 (1.6%)	173 (24.7%)	122 (17.4%)	50 (7.1%)	10 (1.4%)	9 (1.3%)	9 (1.3%)	0	2 (0.3%)	700
35-44	12 (0.1%)	304 (1.6%)	47 (9.9%)	69 (14.5%)	22 (4.6%)	3 (0.6%)	6 (1.3%)	8 (1.7%)	0	4 (0.8%)	475
45-54	23 (0.1%)	250 (1.3%)	27 (7.1%)	47 (12.4%)	18 (4.7%)	2 (0.5%)	4 (1.1%)	7 (1.8%)	0	2 (0.5%)	380
55-64	23 (0.1%)	124 (0.7%)	14 (6.6%)	22 (10.4%)	17 (8.02%)	1 (0.5%)	4 (1.9%)	6 (2.8%)	0	1 (0.5%)	212
65-74	19 (0.1%)	36 (0.2%)	3 (4.2%)	5 (6.9%)	0	0	2 (2.8%)	3 (4.2%)	0	4 (5.6%)	72
75-84	4 (0.01%)	12 (0.1%)	0	3 (14.35)	0	0	0	1 (4.7%)	0	1 (4.8%)	21
85+	3 (0.01%)	1 (0.01%)	0	0	0	0	0	0	0	0	4
	103 (0.5%)	659 (3.5%)	382 (9.4%)	346 (8.5%)	129 (3.2%)	22 (0.5%)	31 (0.8%)	37 (0.9%)	515 (12.6%)	5 (0.1%)	4078

Table 1.4.4. Educational attainment amongst females by age in Kar Kar iHDSS 2013

Takia	FEMALE										
age years	No Education	Some Primary	Completed Primary	Some Secondary	Completed Secondary	National High School	Vocational	Tertiary	Not relevant	Don't know or NA	Total
5-14	90 (7.8%)	560 (48.4%)	1 (0.1%)	5 (0.4%)	0	3 (0.3%)	0	0	496 (42.9%)	1 (0.1%)	1156
15-24	36 (3.8%)	654 (69.2%)	148 (15.7%)	86 (9.1%)	11 (1.2%)	2 (0.2%)	4 (0.4%)	2 (0.2%)	1 (0.1%)	1 (0.1%)	945
25-34	10 (1.6%)	286 (46.1%)	162 (26.1%)	105 (16.9%)	32 (5.2%)	1 (0.2%)	2 (0.3%)	18 (2.9%)	1 (0.2%)	4 (0.6%)	621
35-44	17 (3.5%)	360 (73.2%)	44 (8.9%)	49 (9.9%)	6 (1.2%)	0	1 (0.2%)	10 (2.0%)	2 (0.4%)	3 (0.6%)	492
45-54	26 (8.1%)	223 (69.3%)	15 (4.7%)	32 (9.9%)	9 (2.8%)	1 (0.3%)	2 (0.6%)	4 (1.2%0	2 (0.6%)	8 (2.5%)	322
55-64	20 (12.7%)	102 (64.6%)	5 (3.2%)	9 (5.7%)	5 (3.2%)	0	0	1 (0.6%)	2 (1.3%)	14 (8.9%)	158
65-74	25 (23.6%)	63 (59.4%)	4 (3.8%)	0	0	1 (0.9%)	0	0	1 (0.9%)	12 (11%)	106
75-84	6 (18.2%)	15 (45.5%)	0	0	0	0	0	0	2 (6.1%)	10 (30%)	33
85+	3 (42.9%)	1 (14.3%)	1 (14.3%)	1 (14.3%)	0	0	0	0	0	1 (14%)	7
	233 (6.1%)	2264 (49%)	380 (9.9%)	287 (7.5%)	63 (1.6%)	8 (0.2%)	9 (0.2%)	35 (0.9%)	507 (13.2%)	54 (1.4%)	3840
Waskia											
age years	No Education	Some Primary	Completed Primary	Some Secondary	Completed Secondary	National High School	Vocational	Tertiary	Not relevant	Don't know or NA	Total
5-14	69 (6.4%)	480 (44.2%)	1 (0.1%)	0	0	0	0	0	436 (40.1%)	4 (0.4%)	1086
15-24	26 (3.3%)	576 (72.1%)	111 (13.9%)	61 (7.6%)	14 (1.8%)	4 (0.5%)	5 (0.6%)	1 (1.1%)	3 (0.4%)	2 (0.3%)	799
25-34	22 (3.5%)	361 (57.8%)	141 (22.6%)	68 (10.9%)	27 (4.3%)	1 90.2%)	0	2 (0.3%)	0	3 (0.5%)	625
35-44	28 (6.5%)	296 (68.7%)	50 (11.6%)	43 (9.9%)	4 (0.9%)	2 (0.5%)	2 (0.5%)	2 (0.5%)	0	4 (0.9%)	431
45-54	41 (11.4%)	264 (73.1%)	23 (6.4%)	18 (4.9%)	6 (1.7%)	0	2 (0.6%)	2 (0.6%)	1 (0.3%)	4 (1.1%)	361
55-64	34 (20.9%)	114 (69.9%)	5 (3.1%)	5 (3.1%)	2 (1.2%)	0	0	0	0	3 (1.8%)	163
65-74	29 (35.8%)	47 (58%)	1 (1.2%)	1 (1.2%)	0	0	0	0	0	3 (3.7%)	81
75-84	7 (36.8%)	11 (57.9%)	0	0	0	0	0	0	0	1 (5.3%)	19
85+	0	0	0	0	0	0	0	0	0	0	0
	256 (7.2%)	2149 (60.3%)	332 (9.3%)	196 (5.5%)	53 (1.5%)	7 (0.2%)	9 (0.3%)	7 (0.2%)	440 (12.3%)	24 (0.7%)	3565

Employment

Table 1.4.5. Occupational status amongst males by age in Kar Kar iHDSS 2013

Takia	Male								
age yrs	**Professional**	**Skilled**	**Unskilled**	**Subsistence**	**Current Student**	**Unemployed**	**Military**	**Don't know or NA**	**Total**
15-24	2 (0.2%)	2 (0.2%)	0	161 (18%)	708 (79%)	7 (0.8%)	0	16 (1.8%)	896
25-34	18 (3.8%)	8 (1.7%)	14 (2.9%)	384 (80.7%)	36 (7.6%)	12 (2.5%)	1 (0.2%)	3 (0.6%)	476
35-44	14 (3.7%)	8 (2.1%)	12 (3.2%)	335 (88.6%)	2 (0.5%)	5 (1.3%)	1 (0.3%)	1 (0.3%)	378
45-54	14 (5.4%)	6 (2.3%)	12 (4.7%)	220 (85.3%)	0	2 (0.8%)	2 (0.8%)	2 (0.8%)	258
55-65	5 (3.1%)	3 (1.9%)	5 (3.1%)	147 (0.7%)	0	0	1 (0.6%)	1 (0.6%)	162
	53 (2.4%)	27 (1.2%)	43 (2%)	1247 (57.5%)	746 (34.4%)	26 (1.2%)	5 (0.2%)	23 91.1)	2170
Waskia									
age yrs	**Professional**	**Skilled**	**Unskilled**	**Subsistence**	**Current Student**	**Unemployed**	**Military**	**Don't know or NA**	**Total**
15-24	0	2 (0.2%)	30 (3.4%)	148 (16.9%)	678 (77.2%)	5 (0.6%)	0	15 (1.7%)	878
25-34	3 (0.6%)	12 (2.2%)	72 (13.4%)	375 (69.6%)	70 (13%)	4 (0.7%)	0	3 (0.6%)	539
35-44	10 (2.8%)	12 (3.4%0	62 (17.3%)	266 (74.3%)	3 (0.8%)	3 (0.8%)	0	2 (0.6%)	358
45-54	11 (3.7%)	11 (3.7%)	67 (22.8%)	203 (69%)	0	0	0	2 (0.7%)	294
55-65	11 (6.4%)	14 (8.1%)	30 (17.3%)	113 (65.3%)	0	0	2 (1.2%)	3 (1.7%)	173
	35 (1.6%)	51 (2.3%)	261 (11.6%)	1105 (49.3%)	751 (33.5%)	12 (0.5%)	2).1%)	25 (1.1%)	2242

Table 1.4.6. Occupational status amongst females by age in Kar Kar iHDSS 2013

Takia	FEMALES								
age yrs	**Professional**	**Skilled**	**Unskilled**	**Subsistence**	**Current Student**	**Unemployed**	**Military**	**Don't know or NA**	**Total**
15-24	1 (0.1%)	1 (0.1%)	1 (0.1%)	169 (22.4%)	563 (74.7%)	6 (0.8%)	3 (0.4%)	10 (1.3%)	754
25-34	24 (7.4%)	1 (0.3%)	5 (1.5%)	273 (84%)	14 (4.3%)	1 (0.3%)	1 (0.3%)	6 (1.8%)	325
35-44	16 (6%)	0	4 (1.5%)	245 (91.8%)	1 (0.4%)	0	0	1 (0.4)	267
45-54	9 (5.7%)	0	0	148 (93.1%)	0	2 (1.3%)	0	0	159
55-65	2 (2%)	0	0	93 (94.9%)	0	0	0	3 (3.1%)	98
	52 (3.2%)	2 (0.1%)	10 (0.6%)	928 (57.9%)	578 (36.1%)	9 (0.6%)	4 (0.2%)	20 (1.2%)	1603
Waskia									
age yrs	**Professional**	**Skilled**	**Unskilled**	**Subsistence**	**Current Student**	**Unemployed**	**Military**	**Don't know or NA**	**Total**
15-24	3 (0.6%)	19 (3.6%)	18 (3.4%)	67 (12.5%)	416 (77.8%)	4 (0.7%)	2 (0.4%)	6 (1.1%)	535
25-34	3 (1.2%)	12 (4.7%)	41 (16%)	166 (64.8%)	26 (10.2%)	3 (1.2%)	0	5 (2%)	256
35-44	6 (4%)	2 (1.3%)	27 (17.9%)	109 (72.2%)	4 (2.6%)	1 (0.7%)	0	2 (1.3%)	151
45-54	4 (2.9%)	0	42 (30.9%)	89 (65.4%)	0	0	0	1 (0.7%)	136
55-65	1 (1.7%)	1 (1.7%)	8 (13.3%)	43 (71.7%)	0	1 (1.7%)	0	6 (10%)	60
	17 (1.5%0	34 (3%)	136 (12%)	474 (41.7%)	446 (39.2%)	9 (0.8%)	2 (0.2%)	20 (1.8%)	1138

Marital Status

Table 1.4.7. Marital status amongst males by age in Kar Kar iHDSS 2013

Takia	MALES						
age	Never Married	Married	Separted / Divorced	Widowed	No Relevant	Don't Know	Total
15-24	865 (86.8%)	54 (5.4%)	0	0	74 (7.4%)	3 (0.3%)	996
25-34	285 (42.1%)	371 (54.8%)	14 (2.1%)	2 (0.3%)	3 (0.4%)	2 (0.3%)	677
35-44	60 (11.3%)	454 (85.5%)	13 (2.4%)	3 (0.6%)	0	1 (0.2%)	531
45-54	19 (5.3%)	318 (88.1%)	14 (3.9%)	10 (2.8%)	0	0	361
55-64	7 (3.6%)	168 (85.3%)	9 (4.6%)	12 (6.1%)	1 (0.5%)	0	197
65-74	6 (4.8%)	92 (74.2%)	7 (5.6%)	19 (15.3%)	0	0	124
75-84	0	26 (74.3%)	1 (2.9%)	8 (22.9%)	0	0	35
85+	0	6 (85.7%)	0	1 (14.3%)	0	0	7
	1242 (42.4%)	1489 (50.9%)	58 (2%)	55 (1.9%)	78 (2.7%)	6 (0.2%)	2928
Waskia							
age	Never Married	Married	Separted / Divorced	Widowed	No Relevant	Don't Know	Total
15-24	841 (87.2%)	62 (6.4%)	1 (0.1%)	0	61 (6.3%)	0	965
25-34	335 (47.9%)	347 (49.6%)	8 (1.1%)	5 (0.7%)	2 (0.3%)	2 (0.2%)	699
35-44	64 (13.5%)	397 (83.6%)	9 (1.9%)	4 (0.8%)	1 (0.2%)	0	475
45-54	32 (8.4%)	328 (86.3%)	8 (2.1%)	12 (3.2%)	0	0	380
55-64	8 (3.8%)	173 (82%)	9 (4.3%)	20 (9.5%)	1 (0.5%)	0	211
65-74	1 (1.4%)	54 (75%)	3 (4.2%)	14 (19.4%)	0	0	72
75-84	1 (4.8%)	13 (61.9%)	0	7 (33.3%)	0	0	21
85+	1 (25%)	0	0	3 (75%)	0	0	4
	1283 (45.4%)	1374 (48.6%)	38 (1.3%)	65	65 (2.3%)	2 (0.07%)	2827

Table 1.4.8. Marital status amongst females by age in Kar Kar iHDSS 2013

Takia					FEMALES		
age	**Never Married**	**Married**	**Separted / Divorced**	**Widowed**	**No Relevant**	**Don't Know**	**Total**
15-24	719 (77.8%)	158 (17.1%)	0	47 (5.1%)	0	0	924
25-34	84 (13.6%)	479 (77.4%)	49 (7.9%)	6 (1%)	1 (0.2%)	0	619
35-44	16 (3.3%)	434 (88.2%)	26 (5.3%)	16 (3.3%)	0	0	492
45-54	6 (2%)	247 (84.3%)	15 (5.1%)	25 (8.5%)	0	0	293
55-64	0	116 (73.4%)	8 (5.1%)	33 (20.9%)	0	1 (0.6%)	158
65-74	2 (1.9%)	60 (56.6%)	1 (0.9%)	41 (38.7%)	0	2 (1.9%)	106
75-84	0	10 (30.3%)	1 (3%)	20 (60.6%)	2 (6.1%)	0	33
85+	1 (14.3%)	2 (28.6%)	0	4 (57.1%)	0	0	7
	828 (31.5%)	1506 (57.2%)	100 (3.8%)	192	3 (0.1%)	3 (0.1%)	2632

Waskia							
age	**Never Married**	**Married**	**Separted / Divorced**	**Widowed**	**No Relevant**	**Don't Know**	**Total**
15-24	605 (75.8%)	143 (17.9%)	9 (1.1%)	2 (0.3%)	39 (4.9%)	0	798
25-34	108 (17.3%)	459 (73.4%)	47 (7.5%)	8 (1.3%)	2 (0.3%)	1 (0.2%)	625
35-44	21 (4.9%)	373 (86.5%)	27 (6.3%)	10 (2.3%)	0	0	431
45-54	12 (3.3%)	296 (82.2%)	25 (6.9%)	26 (7.2%)	0	1 (0.3%)	360
55-64	5 (3.1%)	115 (70.6%)	6 (3.7%)	37 (22.7%)	0	0	163
65-74	1 (1.2%)	42 (51.9%)	3 (3.7%)	34 (42%)	0	1 (1.2%)	81
75-84	0	3 (17.6%)	0	14 (82.4%)	0	0	17
85+	0	0	0	0	0	0	0
	752 (30.4%)	1431	117 (4.7%)	131 (5.3%)	41 (1.7%)	3 (0.1%)	2475

1.5 MORBIDITY AND MORTALITY IN PIH STUDY SITES

BACKGROUND

Morbidity

The lack of reliable morbidity and mortality data is a common problem in developing countries. Unfortunately, PNG is no exception to this observation. Morbidity data is generally syndromic reporting without laboratory confirmation. Therefore, the actual "true" burden of disease can be severely miss-categorized. It has been well documented in the developing country setting that malaria is often significantly over diagnosed based on syndromic presentation, i.e., many fevers are not malaria even in a location where there is known malaria.

As part of the PiHP effort, substantial clinical and laboratory improvements have been made at key impact health centers. PNGIMR has performed training and staff augmentation at Hiri and Hides locations. In addition, rapid diagnostic testing (RDTs) for malaria capability has been developed at the clinics. Further laboratory testing is also available through the newly developed Port Moresby Infectious Diseases Diagnostic Research Laboratory located at the PNG School of Medicine. The new laboratory is now (August 2013) receiving samples from Hides and Hiri. Therefore, over time a more accurate picture of morbidity will be developed. This chapter will present the most currently available morbidity data that has been developed through key clinics in Hiri (Papa clinic) and Hides (Para and Mananda Clinics).

In the last report, clinical data through 2012 were presented. This report extends the data collection through mid-year 2013. Whenever possible, data are shown in a longitudinal fashion so that trends can be observed. While the PNGIMR monitors and collects data from all of the Hiri clinics (e.g., in addition to Papa, Porebada and Boera) only Papa data are shown as these are considered to be the most reliable and consist. Boera Clinic underwent significant renovation and improvement; however, it was not open for 9 months. Staffing and supply issues have chronically plagued Porebada Clinic. In Hides, the Para and Manada (also known as Malanda) Clinics are functioning reasonably well and have benefitted from PNGIMR

involvement. Comparison site morbidity data, particularly KarKar Island, are under development. PNGIMR has a well-established history in Asaro (Eastern Highlands); hence, longitudinal data from Asaro are available. For this report update, the focus is on the impact sites, Hiri and Hides. The next IMR report in March 2014 will have more comparative results.

Mortality

Mortality statistics are a widely-used resource for setting spending priorities, but out of 192 countries worldwide, only 23 have high-quality death registration data, and 75 have no cause-specific mortality fraction information at all [1]. Papua New Guinea (PNG) suffers greatly from a paucity of data on population health. Lack of information on mortality and morbidity trends precludes a full understanding of the forces driving population changes and means that decisions around health services and interventions are not well informed.

Economic development has globally been linked with epidemiological transitions characterized by reductions in infectious diseases and a simultaneous increase in non-communicable diseases (NCDs) as a result of associated lifestyle change. The current economic trends, mortality decline, and clinical reports in PNG would suggest that some parts of the country have begun this epidemiological transition. The extent and distribution of the transition within the country is poorly understood however.

For mortality assessment the iHDSS uses a verbal autopsy system. A verbal autopsy (VA) is a questionnaire administered to the caregivers or family members of a recently deceased person to elicit signs and symptoms and their durations as well as other relevant information about the period before death. In this study we have employed the Population Health Metrics Research Consortium (PHMRC) VA instrument to follow up on deaths in the Partnership in Health Project Health and Demographic Surveillance Sites (iHDSS).

The collection of verbal autopsies and the physician review of the VA forms have been in process since 2010 in Hiri and 2011 in Asaro. Karkar and Hides data collection started more recently in late 2012. A complete year of data collection and physician review in these latter sites will be necessary before a fuller comparison between sites can be made. Here we present all deaths thus far reviewed by a

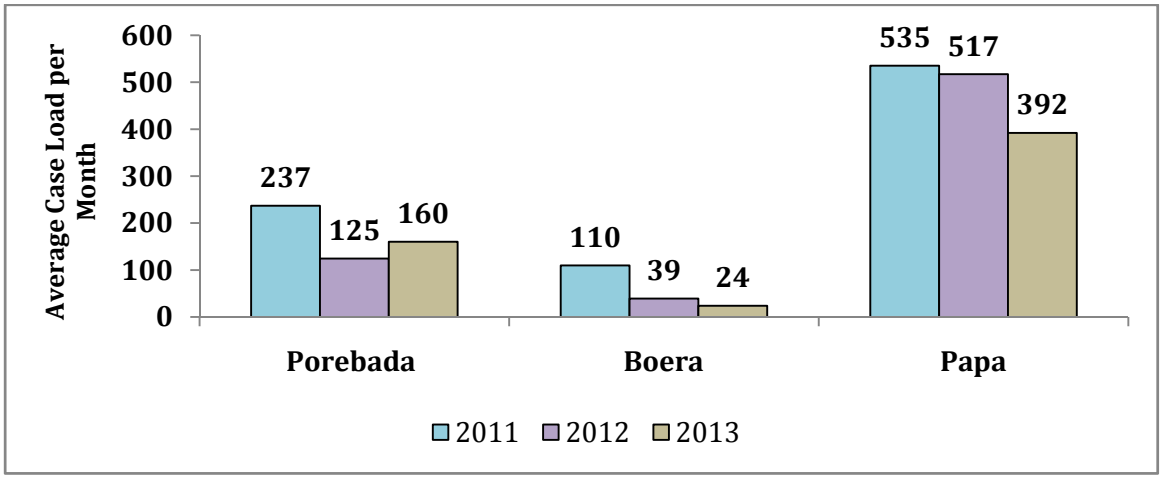
physician and ascribed a probable cause of death as a preliminary analysis of the cause-specific mortality trends becoming evident.

MORBIDITY REPORT

Hiri Villages

Data have been collected from Porebada, Boera and Papa Clinics. Figure 1.5.1 shows the monthly census figures for each of the Hiri village clinics. As previously noted, the Boera and Porebada Clinic data is not considered stable enough for analysis at this time. It is anticipated that Boera Clinic data will be useful going forward

Figure 1.5.1. Hiri Clinics Monthly Census



Papa monthly patient census has stabilized at almost 400 patients per month. This total includes both illness and preventive medical services. The Papa monthly census has significantly declined since 2011/12 by approximately 20% and indicates that the expected patient backlog has been worked. The PNG LNG made a significant focus on Papa Clinic expansion and development. Working with the Salvation Army (Papa Clinic managers) and PNGIMR, the Project has been able to

meet the increased patient demand that was anticipated to be triggered by the major LNG construction activity.Figure 1.5.2. The burden of disease seen at Papa Clinic over 2011-July 2013 time period.

As illustrated in these data, the morbidity burden is dominated by rising rates of respiratory disease including upper and lower respiratory infections, pneumonia and COPD. Skin disease continues to be important but percent of total visits is stable. Diarrheal diseases are fairly constant over the last three years. Malaria shows a persistent and significant decline and is likely related to the introduction of rapid diagnostic test kits. Non-communicable diseases (NCDs) are seen but are not prominent and at variance with the mortality pattern observed in Hiri (see next section). The low level of NCDs is not entirely surprising as most clinic visits are by women. Male villagers employed by the PNG LNG could be seen at workplace clinics. Nevertheless, NCDs are likely significantly under diagnosed and may seek medical attention in Port Moresby and/or at a late stage of disease.

The dramatic fall in malaria is likely due to the introduction of RDTs. As shown in Figure 1.5.3, the dramatic fall in malaria has been offset by a similar rise in respiratory disease diagnoses. Malaria cases are 3:1 female versus male and likely reflects clinic utilization patterns. Malaria in Hiri is generally seasonal and also impacted by variability in seasonal rains and increasing urbanization. The PNG LNG and NGOs have done bednet distribution in Hiri. Bednet utilization rates are generally better in Hiri than in many other PNG coastal areas.

Diarrheal and febrile illness is under investigation through studies using new POM Lab and results will be available for the March 2014 report. Descriptions of the febrile and diarrheal disease studies are in a separate chapter of this report. Water and hygiene are potentially significant contributors to the underlying diarrheal burden of disease and are presented in a later chapter of this report.

Figure 1.5.2. Clinical Diagnoses Papa Clinic 2011-July 2013

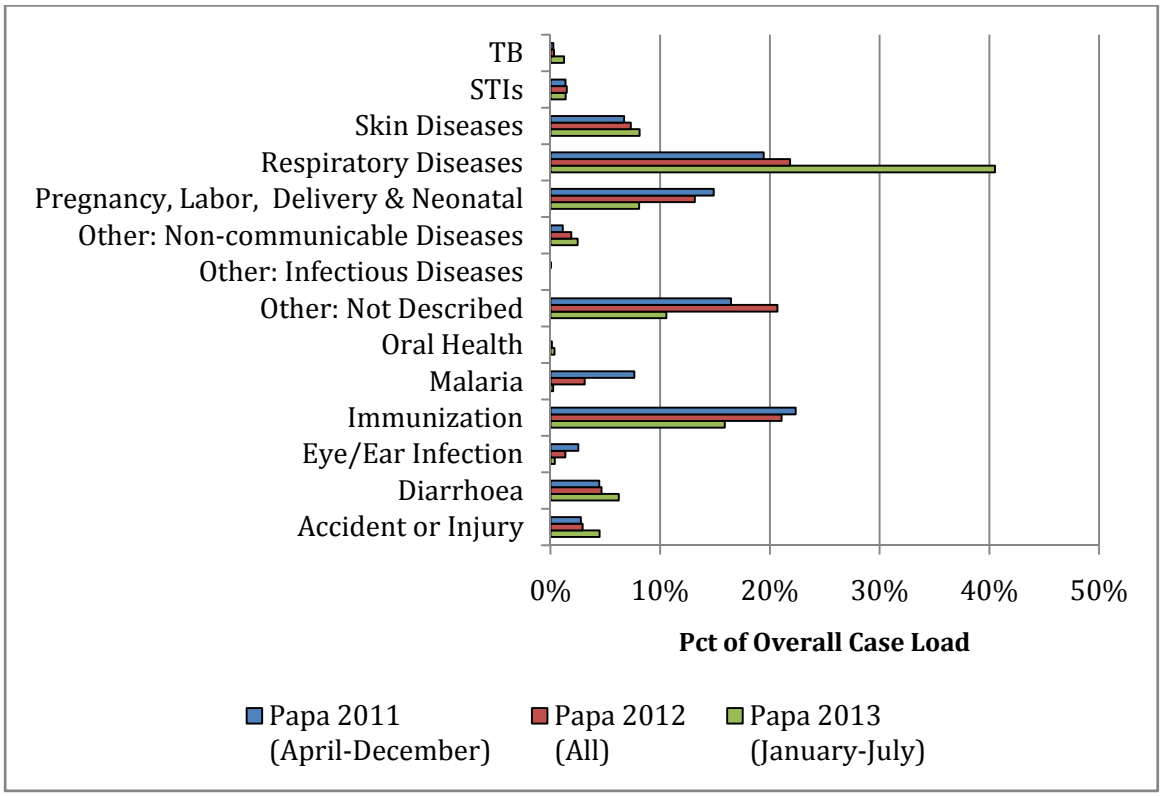
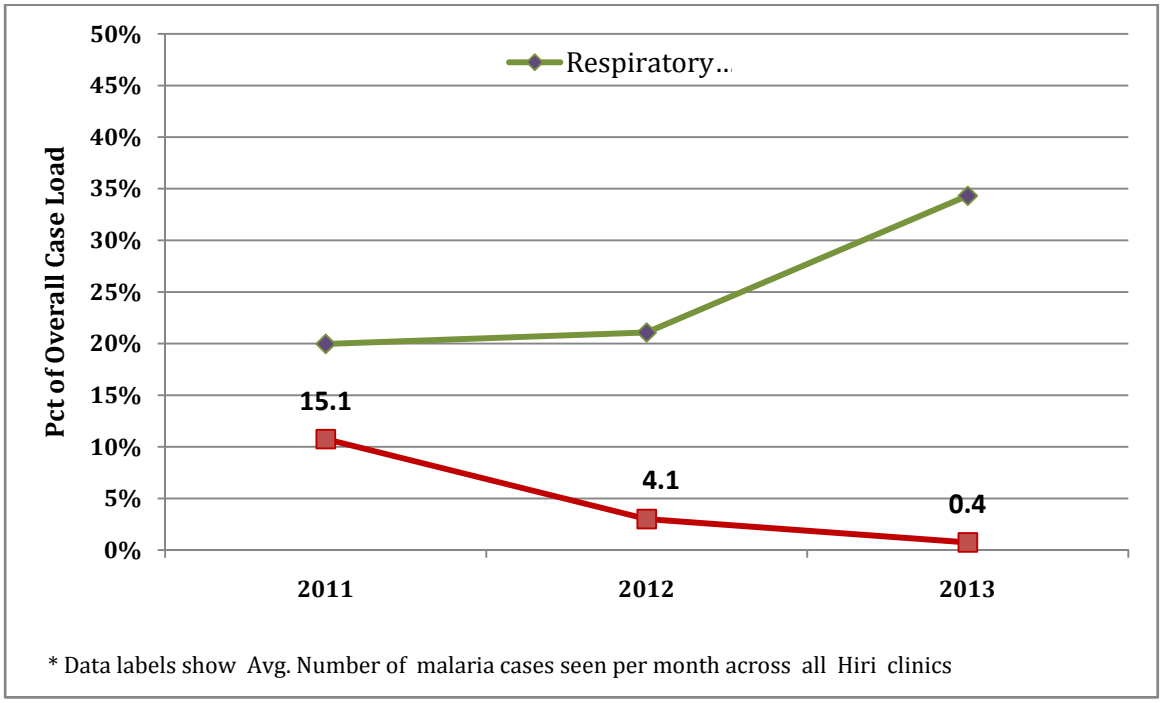


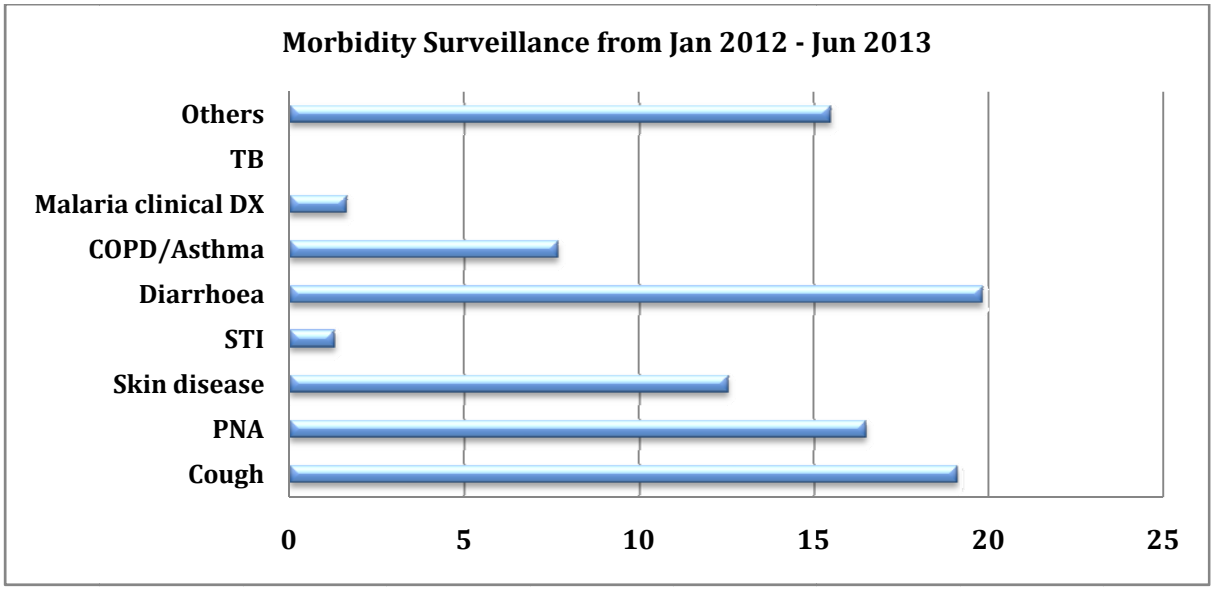
Figure 1.5.3. Respiratory and Malaria Percents 2011-2013



Hides Area

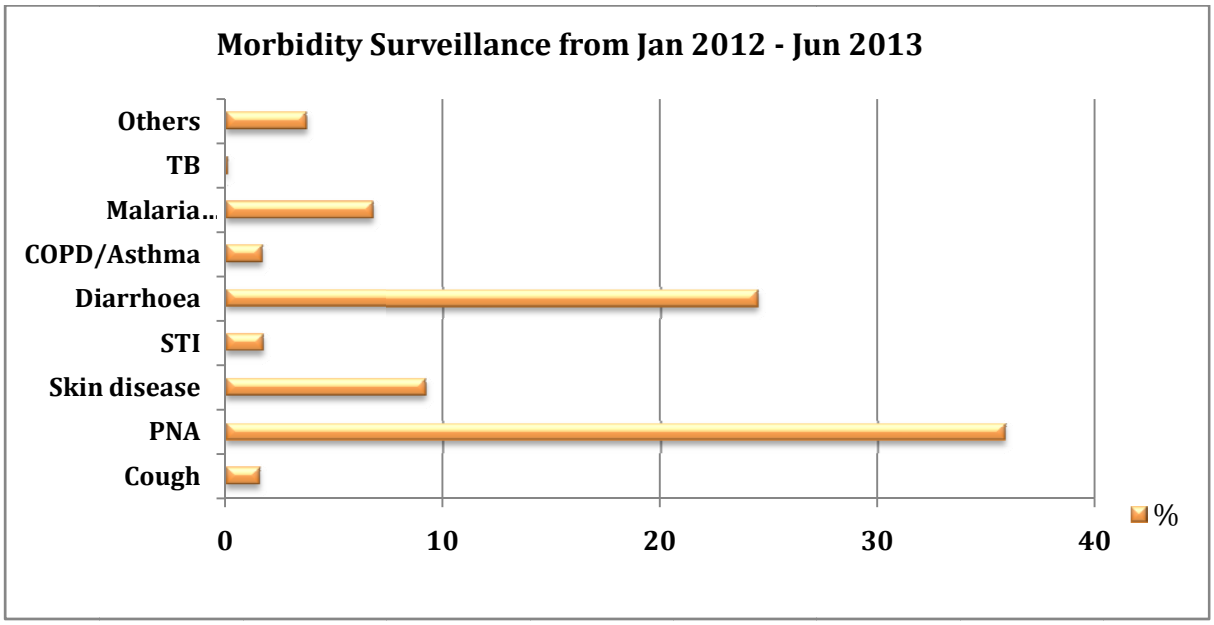
PNGIMR is involved with both the Mananda and Para Clinics. These clinics are managed by ECPNG. The most current reported clinical data are shown in Figures 1.5.4 and 1.5.5. As illustrated, the morbidity patterns closely match each other with a high overall level of (i) respiratory disease (pneumonia, asthma, COPD and chronic cough), (ii) diarrhoea and (iii) skin disease. This current disease pattern is consistent with the 2010/011 data.

Figure 1.5.4. Mananda Clinic (Hides) Morbidity Data



PNA= Pneumonia

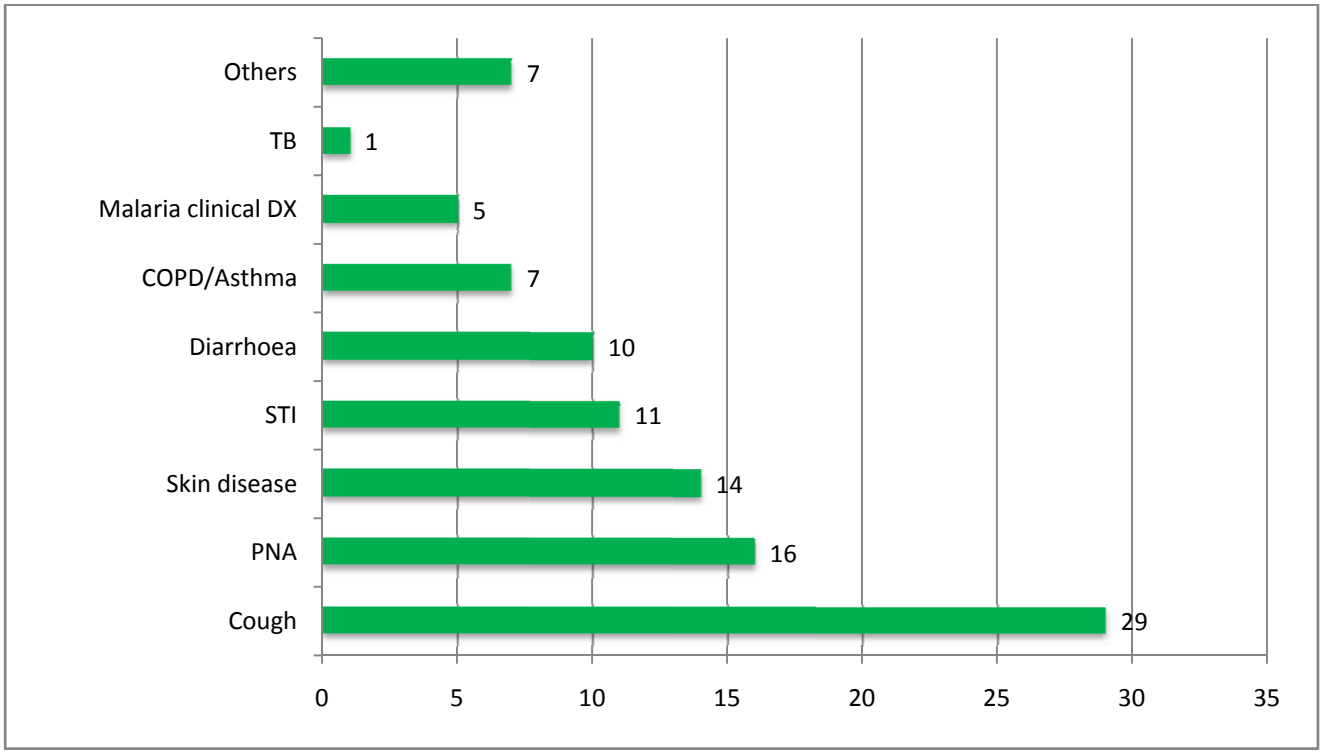
Figure 1.5.5. Para Clinic (Hides) Morbidity Data



The significant burden of respiratory diseases in Hides is well known and has been well documented by IMR in the past. Historic data also indicates that there is a significant burden of diarrheal diseases. Diarrheal and febrile illness is under investigation through studies using new POM Lab and results will be available for the March 2014 report. Descriptions of the febrile and diarrheal disease studies are in a separate chapter of this report. Water and hygiene are potentially significant contributors to the underlying diarrheal burden of disease and are presented in a later chapter of this report.

Asaro iHDSS

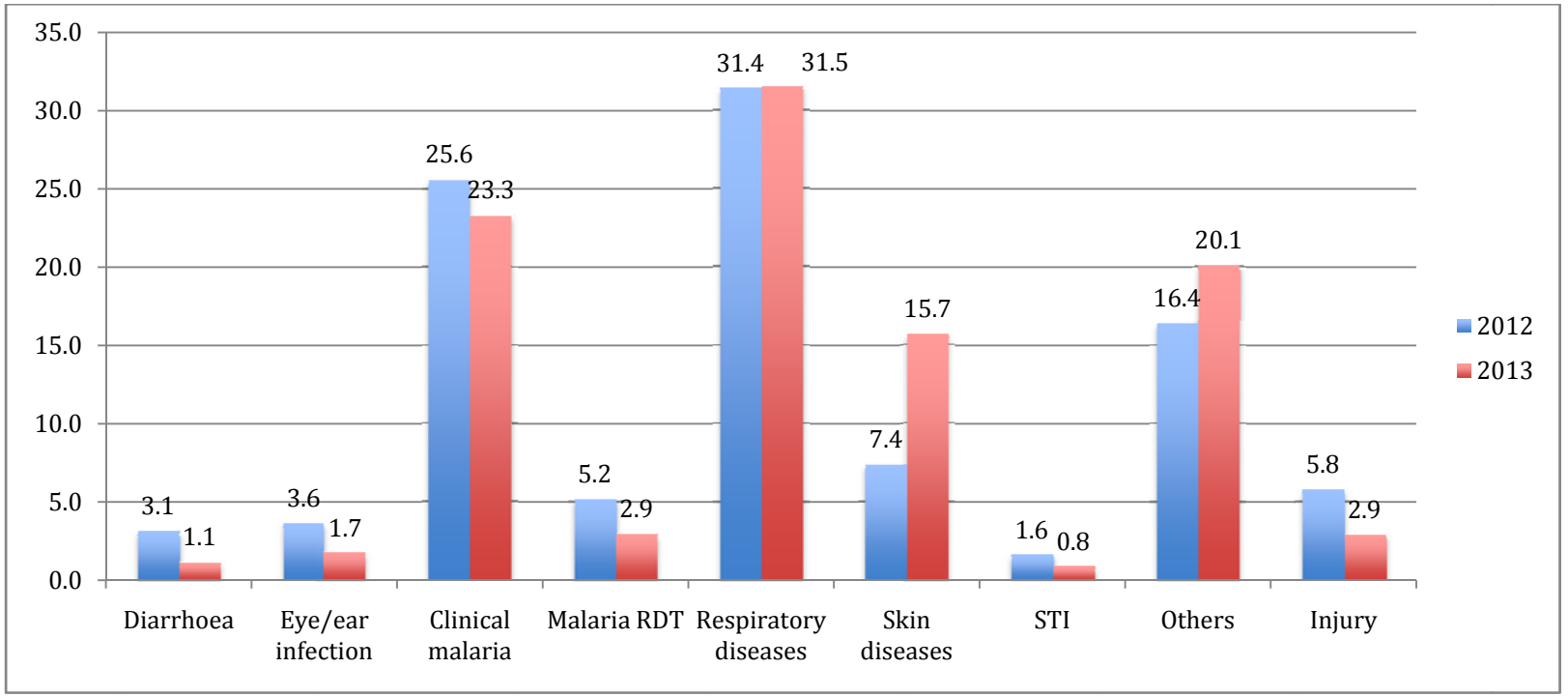
Figure 1.5.6. The causes of illness in Asaro iHDSS in January to June 2013



Similar to the other iHDSSs, cough was number one cause of illness at the health facility in Asaro iHDSS, followed by pneumonia (PNA) and skin disease (Figure 1.5.6). Respiratory diseases such as COPD and TB were the main causes of death in Asaro accounted for 40% of all deaths (N=311). This is a pattern seen in Hides iHDSS

Kar Kar iHDSS

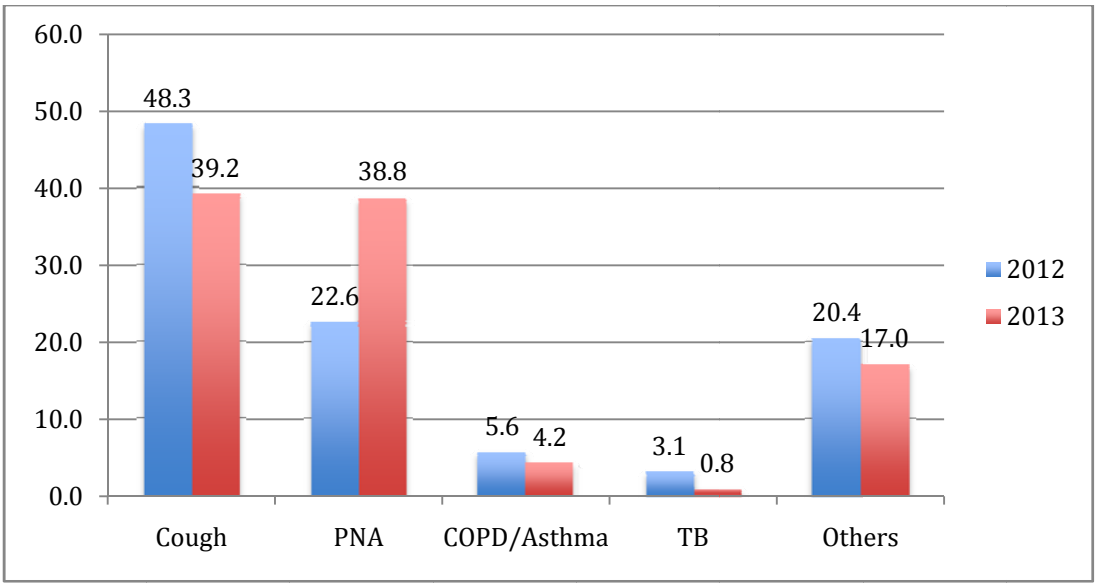
Over one third of the morbidity in Karkar was due to respiratory diseases. The rate of these diseases in 2013 was similar to 2012. Clinical malaria rate and malaria with RDT confirmed rate in 2013 were slightly lower than the rates in 2012. The skin disease primarily due to yaws, was significantly increased in 2013 (Figure 1.5.7). The pneumonia (PNA) rate was increased from 2012 to 2013 (Figure 1.5.8).



2012= January to December 2012
2013 = January to June 2013

Figure 1.5.7. Morbidity as percentages of overall case load at Goubin hospital, Kar Kar iHDSS.

Figure 1.5.8. Respiratory diseases as percentages of overall respiratory illness case load at Goubin hospital, Kar Kar iHDSS.



MORTALITY REPORT

Local reporters follow up households in the iHDSS every three months. During these visits the reporters record any in or out migrations, pregnancies, births and deaths. Identified deaths are listed and given to the verbal autopsy team. Trained field staff co-ordinate with reporters to arrange a household visit at a time and location that suits the respondent.

Aside from asking questions about the signs and symptoms the deceased experienced prior to death, the standardised questionnaire also collects information on basic demographic and socio-economic covariates as well as some health care utilisation data. VA interviewers also ask to see and copy any information on health records that might be available. All VA forms are checked by independent members of the VA team for accuracy and consistency. Any forms with problems are sent back to the field for correction prior to data entry. VA forms, and where possible any

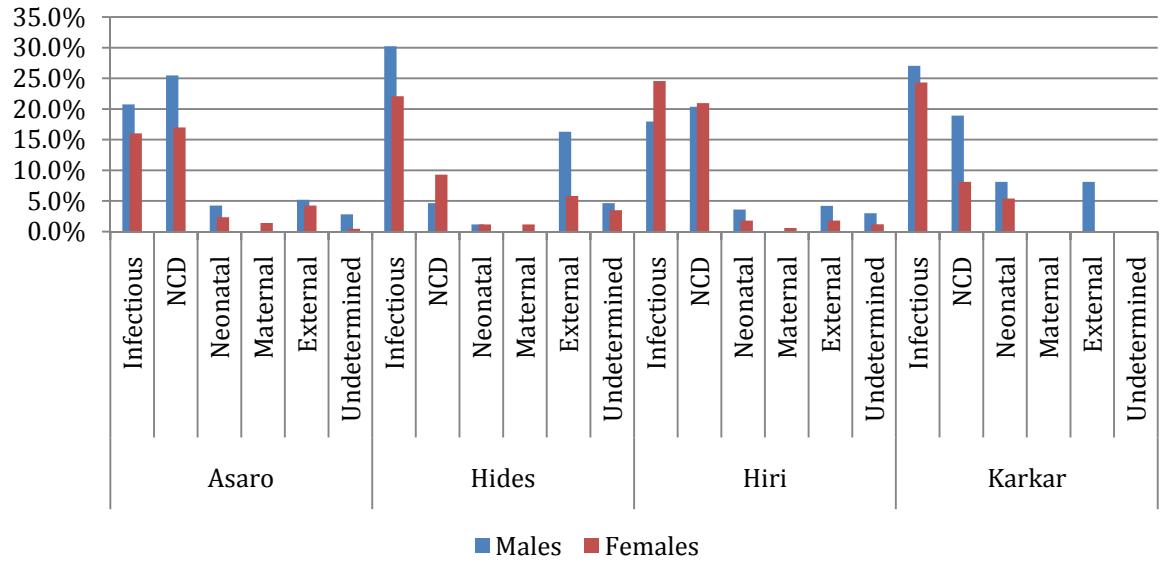
health records included with the form, are then reviewed by a trained physician who ascribes a probable cause of death.

RESULT OF MORTALITY SURVEY

To date 766 verbal autopsies have been conducted on deaths from the four iHDSS sites. Of these a total of 502 (65.5%) have been through physician review and have had a probable cause of death ascribed to them (Table 1.5.1). In all sites but Hiri, males make up a greater proportion of the total deaths reviewed to date.

Table 2.5.1. Physician reviewed verbal autopsies by site and sex

	Asaro		Hides		Hiri		Karkar		Total	
	N	**%**	**N**	**%**	**N**	**%**	**N**	**%**	**N**	**%**
Males	124	58.5%	49	57.0%	82	49.1%	23	62.2%	278	62.2%
Female	88	41.5%	37	43.0%	85	50.9%	14	37.8%	224	37.8%
Total	**212**	**100.0**	**86**	**100.0**	**167**	**100.0**	**37**	**100.0**	**502**	**100.0**



NCD Non-communicable diseases

Figure 1.5.9. Probable cause of death (grouped disease) by site and sex

Figure 1.5.9 shows the proportion of deaths caused by the different major groups of diseases. Mortality patterns in Hides and Karkar are dominated by infectious diseases, which make up more than 50% of deaths in those locations. Neonatal deaths are particularly high in Karkar constituting more than 10% of all deaths. External causes of death are especially high in Hides (20%).

In Asaro and Hiri, non-communicable diseases are more prominent than in the other two sites and make up the majority of the deaths in Asaro. Table 1.5.2 shows the proportion of the major non-communicable diseases in each of the sites. Chronic obstructive lung disease (COLD) makes a major contribution to the total number of deaths particularly in Asaro where it was responsible for 44.9% of all deaths due to non-communicable diseases and 18.9% of all deaths. 10.8% of deaths in Asaro were due to all forms of cancer. In Hiri, the majority of non-communicable disease deaths were due to all cancers (13.8%), diabetes (12.0%) and cardiovascular disease (7.2%)

Table 1.5.3. Major specific non-communicable causes of death by site

	Asaro		Hides		Hiri		Karkar		Total	
	N	**%**	**N**	**%**	**N**	**%**	**N**	**%**	**N**	**%**
CVD[2]	7	3.3%	1	1.2%	12	7.2%	1	2.7%	21	4.2%
COLD	40	18.9%	0	0.0%	4	2.4%	4	10.8%	48	9.6%
Asthma	4	1.9%	8	9.3%	2	1.2%	1	2.7%	15	3.0%
Cervical Cancer	9	4.2%	1	1.2%	5	3.0%	1	2.7%	16	3.2%
Mouth Cancer	3	1.4%	0	0.0%	4	2.4%	0	0.0%	7	1.4%
Liver Cancer	8	3.8%	0	0.0%	0	0.0%	1	2.7%	9	1.8%
Other Cancer	3	1.4%	1	1.2%	14	8.4%	1	2.7%	19	3.8%
Diabetes	3	1.4%	0	0.0%	20	12.0%	1	2.7%	24	4.8%
Other NCD[3]	12	5.7%	1	1.2%	8	4.8%	0	0.0%	21	4.2%
All NCDs	**89**	42.0%	**1**	14.0%	**69**	41.3%	**1**	27.0%	**18**	35.9%
All Deaths	**212**	100.0%	**8**	100.0%	**16**	100.0%	**3**	100.0%	**50**	100.0

CVD Cardiovascular disease

COLD Chronic Obstructive Lung Disease

NCD Non-communicable diseases

Infectious diseases make up a total of 42.4% of all deaths and constitute the majority of deaths collected from Hides and Karkar thus far (Table 1.5.3). TB is the leading cause of death in Hiri (13.8%) followed by diabetes and HIV/AIDS (12.0% and 11.4% respectively). Untreated HIV has a well-known natural history, i.e., the time from infection to full blown symptomatic AIDS is approximately seven years. Hence, the

[2] Cardiovascular disease includes acute myocardial infarction, hypertension, stroke and heart disease

[3] Causes of death included in 'Other NCDs' are epilepsy (2), dementia (4), malnutrition (2), cirrhosis (2), liver disease (1), peptic ulcer (2), renal failure (2), neurological (4), Alzheimer's (1) and congenital malformations (1).

observed HIV death cases represent past infection that undoubtedly preceeds active PNG LNG Project activity.

Table 1.5.4. Major specific infectious causes of death by site

	Asaro		Hides		Hiri		Karkar		Total	
	N	**%**	**N**	**%**	**N**	**%**	**N**	**%**	**N**	**%**
TB	17	8.0%	4	4.7%	23	13.8%	2	5.4%	46	9.2%
Extra-pulmonary TB	4	1.9%	0	0.0%	3	1.8%	2	5.4%	9	1.8%
Diarrhoea	7	3.3%	19	22.1%	1	0.6%	1	2.7%	28	5.6%
HIV/AIDS	12	5.7%	2	2.3%	19	11.4%	0	0.0%	33	6.6%
Malaria	2	0.9%	4	4.7%	10	6.0%	1	2.7%	17	3.4%
Meningitis	4	1.9%	0	0.0%	2	1.2%	3	8.1%	9	1.8%
Pneumonia	20	9.4%	11	12.8%	8	4.8%	9	24.3%	48	9.6%
Other	12	5.7%	5	5.8%	5	3.0%	1	2.7%	23	4.6%
All Infectious	**78**	36.8%	**45**	52.3%	**71**	42.5%	**1**	51.4%	**21**	42.4%
All Deaths	**212**	100.0 %	**86**	100.0 %	**167**	100.0 %	**3 7**	100.0 %	**50 2**	100.0 %

TB Tuberculosis

HIV/AIDS Human Immunodeficiency Virus/ Acquired Immunodeficiency Disorder Syndrome

Almost a quarter (22.1%) of deaths in Hides were attributed to external causes of death. Most of these were road traffic accidents (9.3%) and homicides (7.0%) (Table 1.5.4). Asaro has the second highest rate of deaths due to external causes (9.4%) and most of these were the result of violent incidents (6.1%)

[4] Causes of death included in 'Other infectious' are filariasis (1), cellulitis (1), bronchitis (4), hepatitis (5), pigbel (3), sepsis (6) and typhoid (1).

Table 1.5.5. External causes of death by site

	Asaro		Hides		Hiri		Karkar		Total	
	N	**%**	**N**	**%**	**N**	**%**	**N**	**%**	**N**	**%**
Drowning	1	0.5%	0	0.0%	5	3.0%	1	2.7%	7	1.4%
Choking	0	0.0%	1	1.2%	0	0.0%	0	0.0%	1	0.2%
Falls	1	0.5%	2	2.3%	0	0.0%	0	0.0%	3	0.6%
Fire	2	0.9%	2	2.3%	0	0.0%	0	0.0%	4	0.8%
RTA	2	0.9%	8	9.3%	1	0.6%	0	0.0%	11	2.2%
Suicide	1	0.5%	0	0.0%	2	1.2%	0	0.0%	3	0.6%
Violence	13	6.1%	6	7.0%	2	1.2%	2	5.4%	23	4.6%
All	**20**	**9.4%**	**19**	**22.1%**	**10**	**6.0%**	**3**	**8.1%**	**52**	**10.4%**
All	**212**	**100.0**	**86**	**100.0**	**16**	**100.0**	**37**	**100.0**	**502**	**100.0**

RTA Road traffic accidents

The deaths that have been physician reviewed and presented here are distributed across age groups differently in each of the sites (Table 1.5.5). The majority of deaths presented from Asaro, for example occurred in individuals 55 years and older. This is in contrast to Hiri where almost 30% of death took place amongst young adults between the ages of 15 and 34. Deaths presented from Hides and Karkar are limited in number and should be interpreted carefully, these sites indicate a greater proportion of deaths in neonates and infants under one year of age.

Table 1.5.6. Verbal autopsies from all sites with probable causes of death by age and site

Age	Asaro		Hides		Hiri		Karkar		Total	
	N	%	N	%	N	%	N	%	N	%
<1	17	8.0%	12	14.0%	12	7.2%	9	24.3%	50	10.0%
1 to 4	9	4.2%	11	12.8%	9	5.4%	2	5.4%	31	6.2%
5 to 14	8	3.8%	11	12.8%	4	2.4%	1	2.7%	24	4.8%
15 to 24	4	1.9%	4	4.7%	17	10.2%	2	5.4%	27	5.4%
25 to 34	30	14.2%	7	8.1%	30	18.0%	2	5.4%	69	13.7%
35 to 44	20	9.4%	12	14.0%	15	9.0%	4	10.8%	51	10.2%
45 to 54	17	8.0%	11	12.8%	23	13.8%	1	2.7%	52	10.4%
55 to 64	39	18.4%	9	10.5%	24	14.4%	4	10.8%	76	15.1%
65+	68	32.1%	9	10.5%	33	19.8%	12	32.4%	122	24.3%
Total	**212**	**100.0**	**86**	**100.0**	**16**	**100.0**	**37**	**100.0**	**502**	**100.0**

Deaths from infectious diseases are spread across all age groups while deaths due to non-communicable diseases tend to occur in older age groups (Table 1.5.6). Many of these NCD deaths, however, are still premature in nature occurring in those under the age of 65. Indeed, the majority of NCD deaths occurred at relatively young ages between 35 and 64 years old (50.5%) and this is particularly true in the cases of diabetes, cardiovascular disease and cervical cancer (Table 1.5.7).

The majority of deaths in age groups under 35 were attributable to infectious diseases. In age groups 15 to 34 this is mostly the result of TB and HIV/AIDS infections (Table 1.5.8). In PNG, unlike sub-Saharan Africa, TB is not necessarily tied to HIV. There is an extremely high level of TB in PNG without associated HIV co-morbidity. This finding is discussed in the Kikori TB section of this report.

Table 1.5.7. Cause of death (grouped diseases) by age group

Age	Infectious		NCD		External		Maternal		Neonatal		Unknow		Total
	N	%	N	%	N	%	N	%	N	%	N	%	N
<1	18	8.5%	1	0.6%	2	3.8%	0	0.0%	29	100.0%	0	0.0%	50
1 to 4	25	11.7%	3	1.7%	3	5.8%	0	0.0%	0	0.0%	0	0.0%	31
15-24	17	8.0%	4	2.2%	5	9.6%	1	14.3%	0	0.0%	0	0.0%	27
25-34	36	16.9%	14	7.8%	11	21.2%	5	71.4%	0	0.0%	3	14.3%	69
35-44	22	10.3%	11	6.1%	15	28.8%	1	14.3%	0	0.0%	2	9.5%	51
45-54	13	6.1%	35	19.4%	1	1.9%	0	0.0%	0	0.0%	3	14.3%	52
55-64	20	9.4%	45	25.0%	7	13.5%	0	0.0%	0	0.0%	4	19.0%	76
65+	43	20.2%	66	36.7%	4	7.7%	0	0.0%	0	0.0%	9	42.9%	122
Total	**213**	**100.0%**	**180**	**100.0%**	**52**	**100.0%**	**7**	**100.0%**	**29**	**100.0%**	**21**	**100.0%**	**502**

NCD Non-communicable diseases

Table 1.5.8. Major specific non-communicable causes of death by age group

	CVD		COLD		Asthma		Cervical Cancer		Mouth Cancer		Liver Cancer		Other Cancer		Diabetes		Other		All NCD		All Deaths
	N	%	N	%	N	%	N	%	N	%	N	%	N	%	N	%	N	%	N	%	N
<1	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	1	2.0	1	2.0	50
1 to 4	0	0.0	0	0.0	1	3.2	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	2	6.5	3	9.7	31
5 -14	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	1	4.2	1	4.2	24
15-24	2	7.4	1	3.7	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	1	3.7	4	14.8	27
25-34	3	4.3	0	0.0	0	0.0	3	4.3	2	2.9	2	2.9	4	5.8	0	0.0	0	0.0	14	20.3	69
35-44	2	3.9	1	2.0	1	2.0	3	5.9	0	0.0	1	2.0	1	2.0	1	2.0	1	2.0	11	21.6	51
45-54	6	11.5	4	7.7	4	7.7	2	3.8	1	1.9	2	3.8	2	3.8	10	19.2	4	7.7	35	67.3	52
55-64	5	6.6	10	13.2	4	5.3	6	7.9	2	2.6	2	2.6	2	2.6	9	11.8	4	5.3	44	57.9	76
65+	3	2.5	32	26.2	5	4.1	2	1.6	2	1.6	2	1.6	8	6.6	4	3.3	7	5.7	65	53.3	122
Total	**21**	**4.2**	**48**	**9.6**	**15**	**3.0**	**16**	**3.2**	**7**	**1.4**	**9**	**1.8**	**17**	**3.4**	**24**	**4.8**	**21**	**4.2**	**178**	**35.5**	**502**

CVD Cardiovascular disease

COLD Chronic Obstructive Lung Disease

NCD Non-communicable diseases

Table 1.5.9. Major specific infectious causes of death by age

	TB		Extra-pulmonary TB		Diarrhoea		HIV		Malaria		Meningitis		Pneumonia		Other Infectious		All infectious		All Deaths
	N	%	N	%	N	%	N	%	N	%	N	%	N	%	N	%	N	%	N
<1	1	2.0	0	0.0	5	10.0	0	0.0	2	4.0	0	0.0	7	14.0	3	6.0	18	36.0	50
1 to 4	2	6.5	0	0.0	11	35.5	3	9.7	0	0.0	2	6.5	5	16.1	2	6.0	25	80.6	31
5 -14	1	4.2	2	8.3	5	20.8	1	4.2	2	8.3	2	8.3	3	12.5	3	12.	19	79.2	24
15-24	6	22.2	0	0.0	0	0.0	6	22.2	4	14.8	1	3.7	0	0.0	0	0.0	17	63.0	27
25-34	9	13.0	1	1.4	1	1.4	14	20.3	4	5.8	1	1.4	2	2.9	4	5.8	36	52.2	69
35-44	7	13.7	2	3.9	2	3.9	7	13.7	0	0.0	0	0.0	1	2.0	3	5.9	22	43.1	51
45-54	6	11.5	1	1.9	1	1.9	0	0.0	0	0.0	1	1.9	2	3.8	2	3.8	13	25.0	52
55-64	6	7.9	2	2.6	1	1.3	2	2.6	0	0.0	1	1.3	8	10.5	0	0.0	20	26.3	76
65+	8	6.6	1	0.8	2	1.6	0	0.0	5	4.1	1	0.8	20	16.4	6	4.9	43	35.2	122
Total	**46**	**9.2**	**9**	**1.8**	**28**	**5.6**	**33**	**6.6**	**17**	**3.4**	**9**	**1.8**	**48**	**9.6**	**23**	**4.6**	**213**	**42.4**	**502**

TB Tuberculosis

HIV/AIDS Human Immunodeficiency Virus/ Acquired Immunodeficiency Disorder Syndrome

Table 1.5.10. External causes of death by age group

	Drowning		Falls		Fires		RTA		Suicide		Violence		All External		All Deaths
	N	**%**	**N**	**%**	**N**	**%**	**N**	**%**	**N**	**%**	**N**	**%**	**N**	**%**	**N**
<1	0	0.0%	0	0.0%	0	0.0%	1	2.0%	0	0.0%	0	0.0%	2	4.0%	50
1 to 4	1	3.2%	2	6.5%	0	0.0%	0	0.0%	0	0.0%	0	0.0%	3	9.7%	31
5 -14	0	0.0%	1	4.2%	3	12.5%	0	0.0%	0	0.0%	0	0.0%	4	16.7%	24
15-24	0	0.0%	0	0.0%	0	0.0%	1	3.7%	1	3.7%	3	11.1%	5	18.5%	27
25-34	1	1.4%	0	0.0%	0	0.0%	4	5.8%	1	1.4%	5	7.2%	11	15.9%	69
35-44	2	3.9%	0	0.0%	1	2.0%	3	5.9%	1	2.0%	8	15.7%	15	29.4%	51
45-54	0	0.0%	0	0.0%	0	0.0%	0	0.0%	0	0.0%	1	1.9%	1	1.9%	52
55-64	1	1.3%	0	0.0%	0	0.0%	1	1.3%	0	0.0%	5	6.6%	7	9.2%	76
65+	2	1.6%	0	0.0%	0	0.0%	1	0.8%	0	0.0%	1	0.8%	4	3.3%	122
Total	**7**	**1.4%**	**3**	**0.6%**	**4**	**0.8%**	**11**	**2.2%**	**3**	**0.6%**	**23**	**4.6%**	**52**	**10.4%**	**502**

RTA Road traffic accidents

Half of the deaths due to external causes of death occur between the ages 25 and 44 (Table 1.5.6). External causes of death are responsible for substantial proportion of deaths amongst adults. 29.4% of deaths amongst those between 35 and 44 are due to external causes (Table 1.5.9). The majority of deaths due to external causes are violent in nature (48.9% of all external deaths).

DISCUSSION

The data presented here is preliminary and there are a number of limitations to this analysis. Firstly, deaths in this analysis have been considered in their totality and not by the year in which the death occurred. This is because collection and physician review of deaths is on-going. Complete data one or two years of surveillance is available for the Hiri and Asaro sites but physician review of all cases is currently on-going. Data collection in Hides and Karkar started later and the total numbers of deaths reviewed from these sights are small and should be interpreted with caution. Secondly, no standard approach to physician review has been agreed [2, 3]. In order to ensure the highest accuracy in ascribing a probable cause of death to a VA physician review some researchers recommend that, reviews be conducted independently by two physicians [4]. Where disagreements arise a third physician might be consulted and a consensus must be achieved [5]. At present there are no trained physicians dedicated to the task of reviewing VA forms for the PiHP project and forms have to transported to be reviewed by those available making double review challenging. Lastly, this analysis only examines one probable underlying cause of each identified death. A number of conditions, such as diabetes and TB, are often associated with one another and many deaths are likely to be due to multiple causes of death.

Despite these limitations, clear trends are becoming apparent from this unfolding study. Communities like those in Hides and Asaro, which have had less exposure to urbanisation than the other sites may present patterns of disease that have not yet entered or are at the early stages of an epidemiological transition. Table 10 presents some cause-specific deaths rates in PNG. The PiHP data series cannot be directly compared to these figures which represent deaths in health facilities aggregated at

the provincial level but these figures are indicative of the range of different mortality patterns observed across the areas where our surveillance is currently active. The National Capital District is where Port Moresby is located and is the most urbanised area of PNG. The Hiri West impact site in the PiHP project is very near to the National Capital District and the figures below are consistent with our findings in the area. Most notable are the very high rates of TB deaths, a large number of HIV/AIDS deaths and relatively high levels of NCD deaths compared to other regions presented here. Like our results, diarrhoea and acute respiratory diseases dominate as causes of death in health facilities in the Southern highlands (now Hela province).

While our Asaro rates of acute respiratory disease are reflected in the hospital records presented in Table 10, the high rates of COLD identified through VAs is not. One reason for this is likely to be low attendance at health facility when COLD was the cause of a terminal illness [6]. Another reason may be that health facilities in PNG do not report the underlying cause of death on death certificates but instead use the reason for admission as the cause of death. For example, cor pulmonale, most commonly a consequence of COLD, is often reported as a cause of death with other heart diseases.

We have identified deaths attributable to HIV/AIDS predominantly in Asaro and Hiri West. This is consistent with the hospital records collected by the National Health Plan where HIV/AIDS is one of the ten leading causes of death in Eastern Highlands and the National Capital District where Asaro and Hiri West are located (or a are proximal to) respectively.

Table 1.5.11 Tope ten causes of death from health facilities in four provinces and the National Capital District (Source: Papua New Guinea National Health Plan 2008)

	National Capital District	Central Province	Southern Highlands	Eastern Highlands	Madang Province
Pneumonia/ARI		16.14	21.88	8.29	6.71
Accidents and injury		11.32			5.34
Sepsis	10.92	10.48	7.88	9.18	10.53
Malaria and other	4.15	9.43	7.44	6.24	13.11
Chronic respiratory		8.6	4.6		9.15
TB	15.07	8.6	5.69	6.6	7.77
Perinatal conditions		6.71	13.35	18.54	12.5
Cardiovascular	9.11	5.66	2.84	5.53	5.03
Anaemia		3.77	6.13		
Obstetric and		3.77			
Cancer	9.51			4.37	5.34
HIV and other STIs	6.76			6.95	
Other NCDs	6.36		4.81		
Neurological	5.76				
Diarrhoea and enteric			10.72	8.65	
Other genito-urinary	4.76				
Other gastro-intestinal	4.76			4.99	5.03
% of all deaths	**77.16**	**84.48**	**85.34**	**79.34**	**80.51**

ARI Acute respiratory infections

TB Tuberculosis

HIV Human immunodeficiency virus

STIs Sexually transmitted infections

NCDs Non-communicable diseases

PRESENTATION

Maraga M et al. Mortalityand causes of dealth in four sites across Papua New Guinea. Paper presented to *the Advances in TB: Australian and Regional Perspectives symposium* Paper presented to the *49th Annual Medical Symposium*, Lae, Papua New Guinea, 2-6 September, 2013.

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CHAPTER 1.6 WEALTH ANALYSIS

Introduction

During the large-scale construction phase of the PNG LNG, residents of the Hides and Hiri impact sites have had 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. There is a strong and well-known relationship between socio-economic status and household level health status. Therefore, 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 outcomes. The project construction activity has occurred over a multi-year year period (2009- present); however, peak construction has been passed (mid-2013) and a period of demobilization is ongoing. There will continue to be employment and economic activity during the 30+ years of operations; therefore, it is extremely important to document, analyze and monitor both household/community level socio-economic status and its relationship to key health performance indicators. The iHDSS is an ideal platform for efficiently surveying and analyzing both socio-economic and health indicators. The iHDSS has two impact areas, Hiri (LNG villages) and Hides along with matched controls, Karkar Island (matched to Hiri) and Asaro (matched to Hides). This chapter presents results based on an extensive socio-economic survey (SES) conducted across all sites. Control site data are undergoing QA/QC and are not shown but will be available for the next update in 2014. The key impact area data sets are presented. A comparison between Hiri and Hides is also shown as it provides significant insight into potential impacts and also serves to validate the overall statistical analysis techniques.

- **Socio-economic status and health are key areas assessed by the iHDSS**
- **Key health outcomes are strongly tied to socio-economics**
- **Wealth analysis has been performed for Hiri and Hides impact areas**

Background

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 [4]; 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 three surveys:

(i) Baseline survey conducted as part of the Social Impact Assessment (SIA) in 2008 that shows the economic status of the impact sites before the large-scale construction phase began in 2009/10; Hides baseline surveys were performed in 2004/5 and also for the Komo area in 2009.

(ii) A pilot SES conducted in 2012 by PNGIMR; and

(iii) A large census-style SES survey conducted by PNGIMR in 2013. This survey is based on the same questions as the 2012 SES, but contains a substantially more households and is considered to be the definitive comparison data set.

Hiri Analysis

Table 1.6.1. compares the SIA, the 2012 pilot survey SES, and the 2013 surveys for the monitored Hiri villages, i.e., Porebada, Lealea, Boera, and Papa. Although Kido is considered a potential financial beneficiary, this village is not part of the Hiri iHDSS

and is not included in standard iHDSS surveys for the LNG villages. Kido is within five kilometers of the offshore pipeline; however, there is no direct overland connection between Kido and the other LNG villages.

The counts reflect those households whose information was used in the wealth analysis and not the total number of households surveyed. The differences in counts occurs because a small number of households did not respond to a sufficient number of survey questions needed for analysis; as such, they were removed so that their null values did not adversely affect the analysis.

The 2007 and 2012 surveys were convenience samples, i.e., they were not community censuses or stratified random samples drawn from a fully characterized listing frame. For the 2007 and 2012 surveys, a target number of households were identified and survey enumerators selected households if a head of household was available for questioning. In 2013, PNGIMR followed up their 2012 pilot effort with a census-style SES survey, i.e., nearly all available households were queried. Table 1 also shows the percentage of households surveyed, with total household count determined by the 2011/2 IMR census data. The 2013 analysis is extremely robust and should provide significant insight into PNGLNG's impact on household socio-economic status.

Table 1.6.1. Difference between SIA and IMR surveys- Hiri LNG Villages

	SIA 2007	**IMR 2012**		**IMR 2013**	
	Households	*Households Surveyed*	*Pct.of Total Households Surveyed*	*Households Surveyed*	*Pct. of total Households Surveyed*
Total Households Surveyed	282	195	14%	1070	79%
Porebada	127	92	16%	426	73%

Boera	54	33	13%	193	79%
Papa	40	21	12%	147	83%
Lealea	61	33	10%	304	89%

- **Sequential SES data covering 2007, 2012 and 2013 are available**
- **The 2013 SES is extremely large and robust**
- **2013 SES sample sizes are 3-5 times higher than baseline SIA households**

Wealth Analysis

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. There are ongoing efforts by the National Statistical Office of PNG to perform a new LSMS survey.

Aside from the 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 developing country settings, researchers have looked for simpler surrogate metrics. As well

demonstrated in the published literature[1, 2], 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 2012/2013 studies can be found in Table 2. Because these studies were done by two different organizations (the 2007 SIA was performed as part of the overall impact assessment for the PNG LNG Project), there is not a 100% match in the type of asset analyzed; however, there is significant asset overlap.

Table 1.6.2 Assets used in MCA Analysis

SIA 2007	**IMR 2012& 2013**
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 SharedBank Account	Owns SharedBank Account
	Outer wall material

	Farms cash Crop
	Treated and/or Protected Water Source
	Water Available all Year
	Access to Land and/or Garden
	Access to Separate Cooking Area
	Owns Washing machine
	Owns Tables
	Owns Chairs
	Owns Mattresses
	Owns Framed Bed
	Owns Gas cooker
	Owns Electric cooker
	Owns Toaster
	Owns Clock/watch
	Owns Bicycle

- **Asset analysis is a simple and reliable surrogate for complex consumption expenditure surveys**
- **Asset mixes from pre-project baseline to 2013 have been compared**

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), use of electricity, 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 [5].

In order to account for the potential predictive power of categorical variables, we use a discrete variable analogue of PCA, i.e., Multiple Correspondence Analysis (MCA) [3]. MCA is analogous to PCA in that it bases ones relative wealth on household level asset mixture. However, MCA is able to use categorical variables; therefore, it is more suitable for analysis with variables such as water quality, housing structure type and toilet facility. 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,

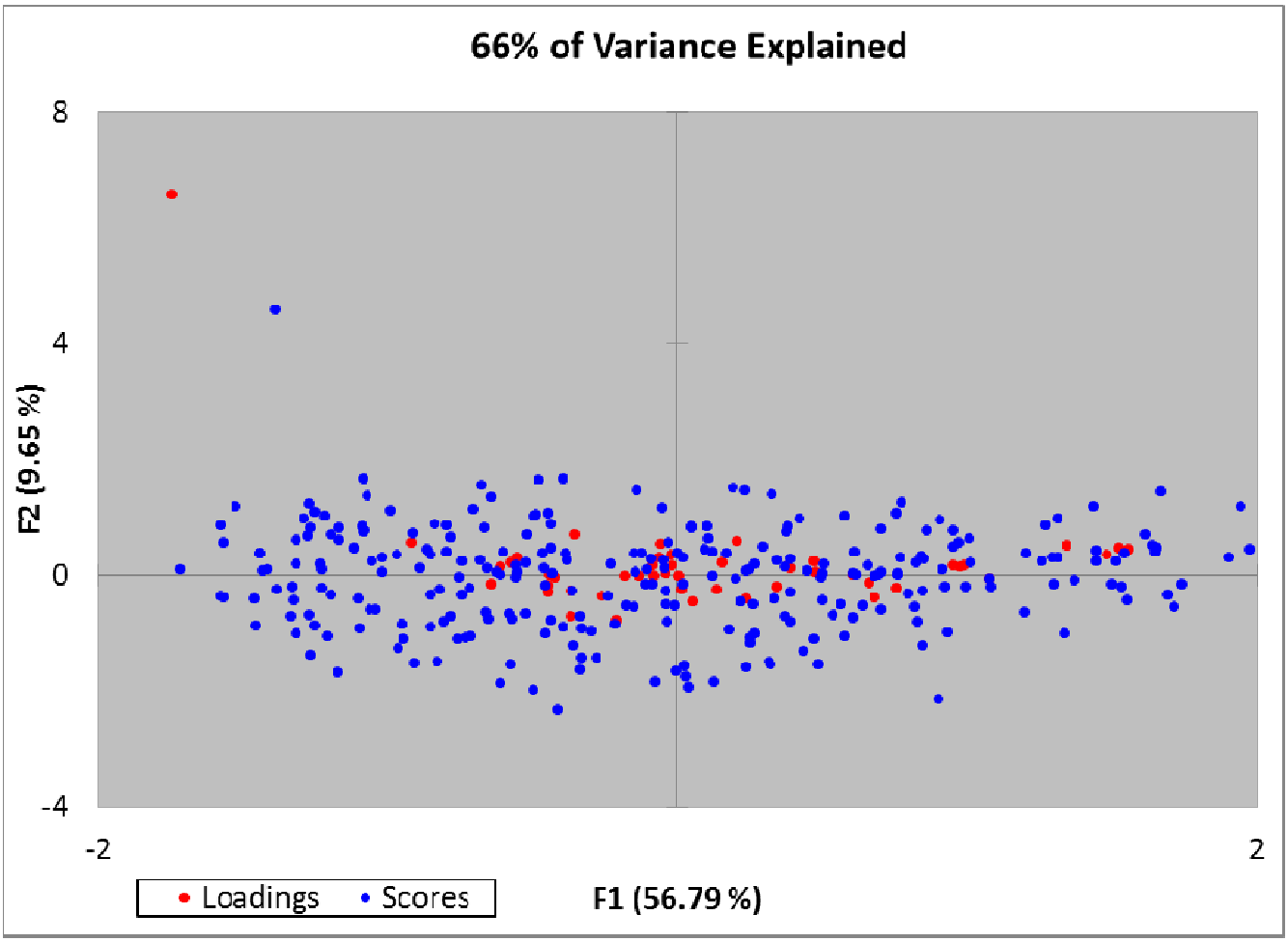
while a score of positive 3 represents a high level of household wealth; a score of zero represents an average level of household wealth.

- **A total component score of -3 represents a high level of household poverty**
- **A score of +3 represents a high level of household wealth**
- **A score of 0 represents an average level of household wealth**

Finally, it is critical to understand that the analysis creates a forced distribution, i.e., all households are "ranked." Therefore, a household with a certain asset profile in 2007 that neither gained or lost assets will likely change position along the -3 to +3 continuum in 2013 as other households will have gained and lost; hence, the forced distribution will move a household into a different numerical "silo." A forced distribution means that some households will be "poorer" relative to others. It is possible for all households to become wealthier but a forced distribution sets a new "0" level and distributes households on either side. The distribution of households is 'uneven," i.e., it can be right or left skewed depending upon the level of key assets accumulated by each household. In subsequent sections, the change from baseline to the 2013 survey data will be presented. In addition, there will be comparisons between Hiri and Hides that will illustrate the relative wealth distributions of the two areas and the comparative changes over time for the two impact areas. The comparison between the impact areas and their respective controls is pending completion of the Karkar survey and QA/QC of the Asaro data set.

As an example, Figure 1.6.1 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 1.6.1. 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 1.6.1 shows that there is an even distribution of households across the wealth spectrum. Only one principle component (F1) is needed to explain the majority of 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 that has much less explanatory power.

The use of these superposition biplots, (Figure 1.6.1), is not a powerful tool for looking at the change in wealth over time. The overlay of multiple year-worth of data points would be confusing and difficult to interpret. Fortunately, the majority of variance for all villages (across all surveys) can be explained using the first principle component. Thus, it is possible to create histograms based on each household's first component score.

- **For each histogram, an increase the first component score means a corresponding increase in household wealth**

Figure 1.6.2 shows the histograms of the first principle component scores across timefor the combined LNG villages, using the 2007 SIA (a), the 2012 IMR pilot SES (b) and the 2013 "census Level" IMR SES (c). There appears to be an increase in the number wealthy individuals after each survey point, as the percentage of households that score above "0" increased from 2007 to 2012, and from 2012 to 2013. The Figure 1.6.2 data are aggregated across all four of the LNG villages. A more granular analysis will be presented in subsequent sections and appears to be far more revealing of potential positive PNG LNG project impacts at the individual village level.

There is also an increase in the percent of households in 2013 below "0" versus 2007 baselinefor the combined LNG villages. The cause of the increase in households below "0" is unknown and likely multi-factorial. The potential role of induced in-migration is uncertain but may be an unquantifiable contributory factor, i.e., relatively poor in-migrants looking for employment opportunities or benefit streams. Within the existing Motuan culture that dominates Hiri, in-migrants are overwhelmingly likely to have some family connection to a long-term resident. Disaggregated analysis provides greater insight and is presented in subsequent sections.

Figure 1.6.2. First Principle Component Wealth Score Over Time - All LNG (Hiri) Villages

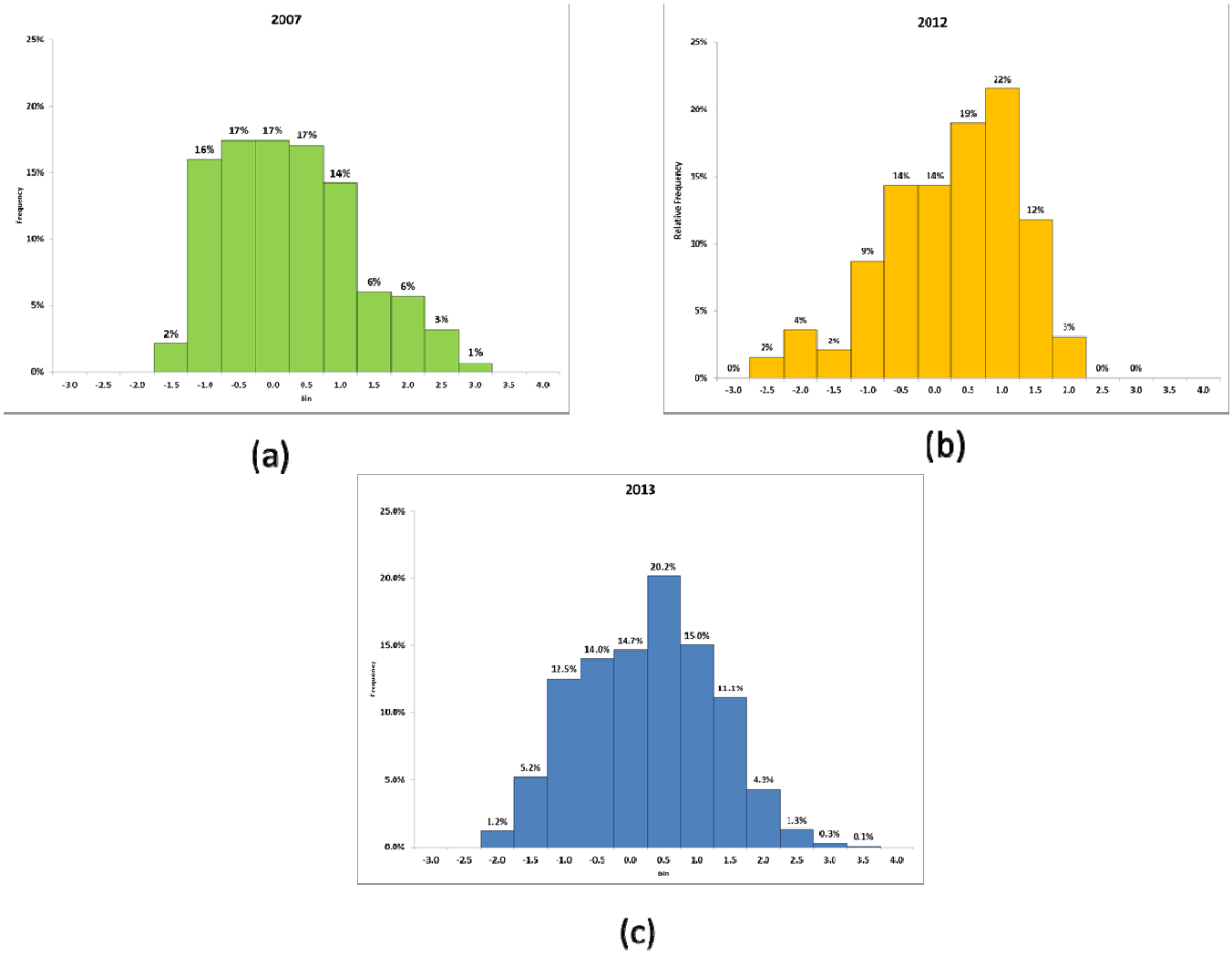


Figure 1.6.3 shows which assets have the greatest effect on wealth and poverty. Owning assets such as computers and generators, and having access to gas or electric fuel, as well an improved pit latrine greatly increase a household's relative wealth. Conversely, not having these assets, as well as having a house made of bush (semi-permanent) materials strongly pulls a household towards poverty. For example, 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 2013, 92% 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 0.2 points towards the wealth score, whereas not owning a phone contributes -2.3 points towards a poverty score. Though most assets can be explained by using only the first principle component, some assets have very high scores on the second component. Thus, an assets relative position on the Y-axis indicates that a particular asset had a large effect on household wealth on the second component.

Table 1.6.3. Asset Ownership Comparison 2007-2013 Hiri (LNG Villages)

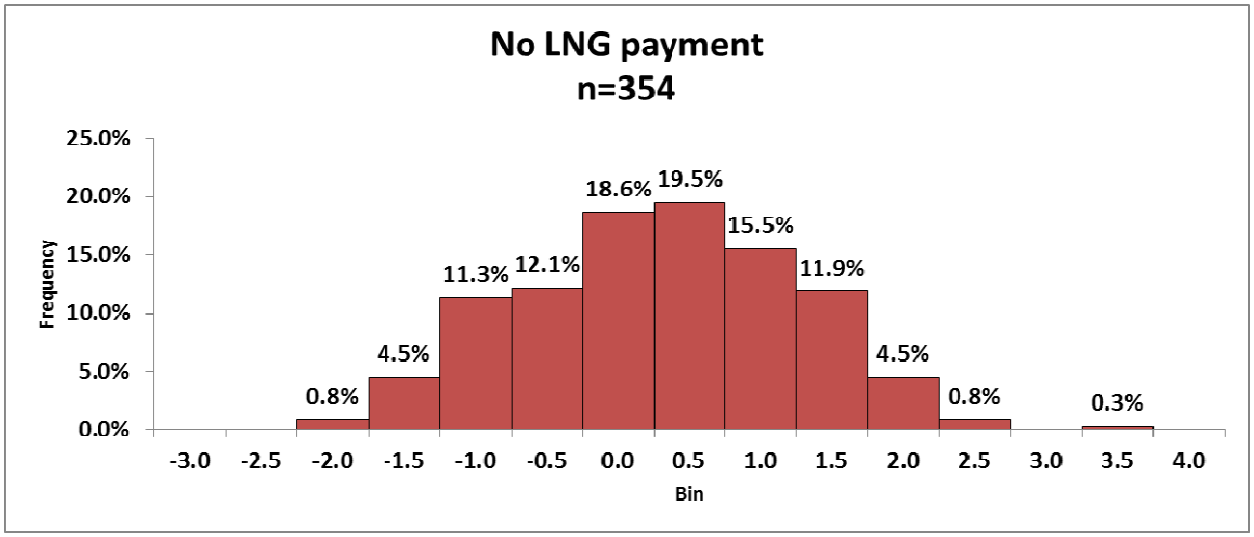
Asset Type Owned	Percent of Households that Own Asset		
	2007	2012**	2013
Mobile Phones*	49%	95%	92%
Bank accounts	42%	75%	83%
Computer	8%	23%	15%
Electric Lighting	73%	75%	76%
Electric Cooking Fuel	10%	34%	11%
Mosquito Netting (treated or untreated)	72%	83%	80%
Permanent Housing	72%	64%	80%

***** *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 in 2012.*** 2012 survey was a limited pilot study.

Figure 1.6.3. 2013 Asset Combinations Associated with Relative Levels of Wealth (scores) All Villages

While Figure 1.6.2 shows that the overall wealth has increased over the 6 years since the 2007 SIA baseline, it is not clear that this increase in wealth is directly related to the LNG project, particularly since the data are presented for all LNG villages combined. In order to examine the effects of the LNG project, it is necessary to separate out the household component scores based upon those who have received income, i.e. some monetary payment, compensation, and/or employment resulting from the LNG project and those that have not. Figure 1.6.4 presents the results for Hiri as a whole. The "received income" data is based on specific household survey questions. There was no simple or obvious way to cross check respondent reporting accuracy. Under or over respondent reporting is a source of uncertainty and potential bias.

Figure 1.6.4. 2013 Household Wealth Scores by LNG Status- All Villages



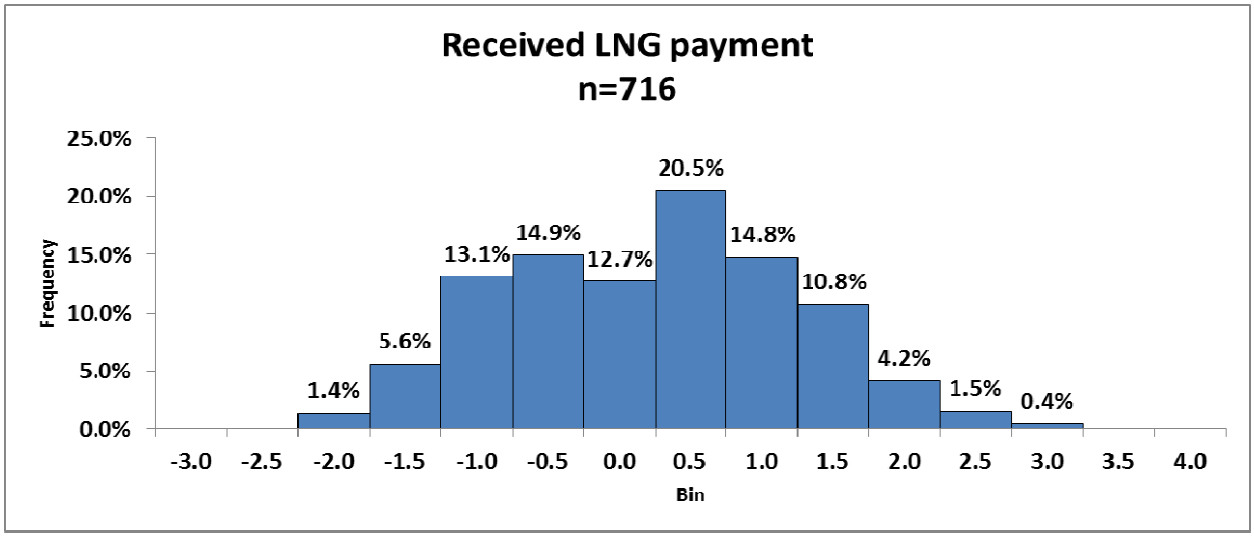
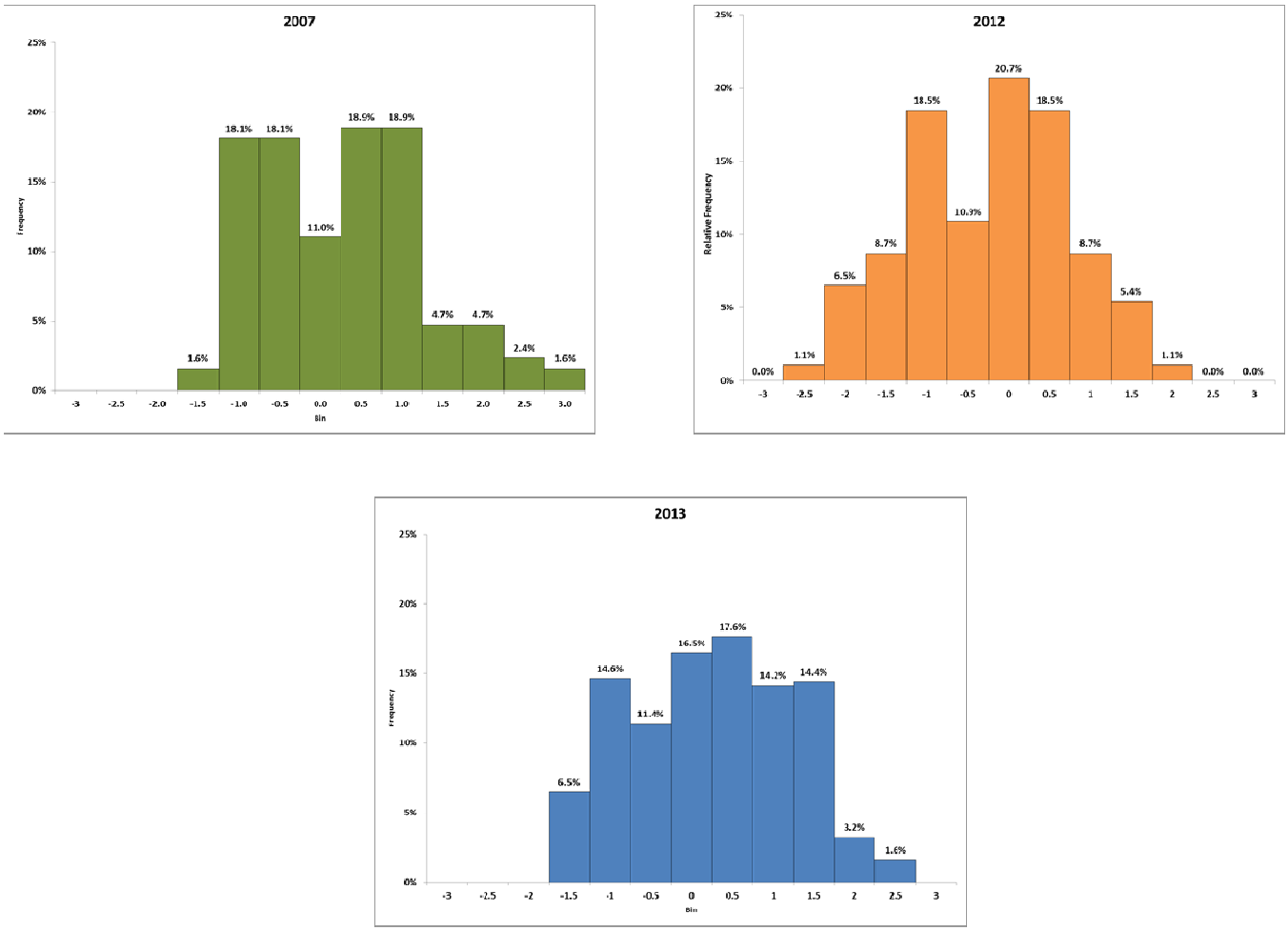


Figure 1.6.4 shows that there are only minor differences in household scores when looking at LNG payment status. Superficially, the lack of a difference between “No Payment” and “LNG Payment” seems to imply that the LNG project has not had a major impact on overall Hiri household wealth. However, the effects of the LNG project may differ from village to village so a more granular analysis is necessary, particularly since direct and indirect employment levels are not evenly distributed across the villages. In addition, the “baseline” poverty/wealth level of the LNG villages was not uniform. Anecdotally, Porebada and Lealea were larger (in terms of population) and more developed/prosperous than Boera or Papa. Boera and Papa are the closest villages to the LNG plant and received more preferential employment treatment during construction. Therefore, it was anticipated that the potential positive monetary impact of construction on Boera and Papa would be significantly greater than for either Porebada or Lealea.

- **Positive monetary impacts on LNG villages will likely be related to baseline condition and population size.**
    - **Porebada is approximately five times larger than Boera or Papa**
    - **Lealea is approximately three times larger than Boera or Papa**
- **Boera and Papa are anticipated to show significant positive impacts.**
- **Porebada and Lealea are anticipated to show neutral to slightly positive effects.**

The change in wealth over time for Porebada is examined in Figure 1.6.5. From 2007 to 2012, it appears as if the village has become worse off; however, from 2012 to 2013 the village appears to have become better off. In comparing 2007 to 2013, the 2013 households have higher wealth scores overall. Thus, it is likely that the low sample size for 2012 data has increased the margin of error, causing a downward skew in the wealth analysis. The 2013 data set should be used for further discussion and analysis.

Figure 1.6.5. First Principle Component Wealth Score Over Time - Porebada



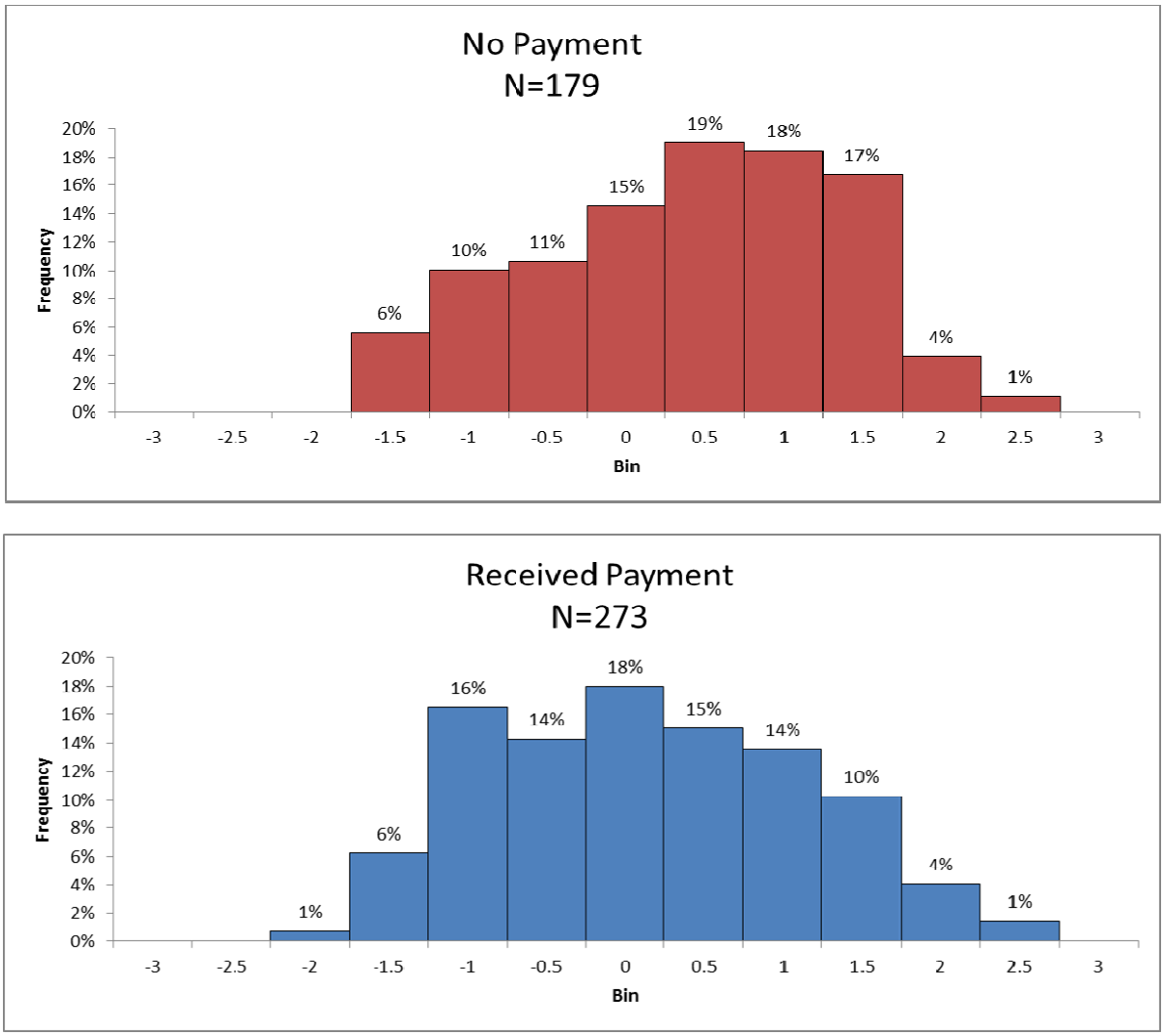
The variables that have the greatest effect on household wealth are shown in Figure 1.6.6. Similar to Figure 1.6.3, these effects are shown on two axes. The first component explains the majority of variance (56.2% explained); however, a handful of variables have high scores on the 2nd component and need to be included, even though their overall explanation of variance is low (7.0%). A variable's location on the x-axis has the most explanatory power, with its location on the y-axis being marginally important if located on the extreme ends.

Figure 1.6.6. shows that, unsurprisingly, wealthier household tend to have (i) relatively expensive durable goods, (ii) more permanent housing fixtures (such as the house itself, as well as the roof, wall and floor), and (iii) a better sanitation system that includes a flush toilet. Poorer household tend to have worse toilet facilities and are semi-permanent houses with non-manufactured (bush) housing materials.

Figure 1.6.6. 2013 Asset Combinations Associated with Relative Levels of Wealth (scores) Porebada

As per Figure 1.6.4., the wealth scores of Porebada households are divided according to whether or not the household received any payment from the LNG payment. The results are shown in Figure 1.6.7. Based up the two histograms it appears that the LNG project has had no significant effect on overall household wealth, as those that have received any LNG payment are no better off than those who have received no payment. In many instance, those who have had no payment are better off than those who did, as the percent of households that have a wealth score between 0 and 2 are higher in the no payment households and the proportion of household with scores between -2 and 0 are higher in the histogram of households receiving an LNG payment.

Figure 1.6.7. 2013 Household Wealth Scores by LNG Status- Porebada



While it may seem that the LNG has had no effect on overall household wealth, the results for Porebada are actually much more complex. Table 1.6.4 shows the percentage of workers (those eligible to work and not defined as either unemployed, or consigned to home duties or subsistence farming) that ***do not work*** for the LNG project by village. As the table illustrates, Porebada has the highest percentage of workers who do not work for the LNG project at 79.3%. Given this large workforce external to LNG employment, it is not surprising that these households may be able to accumulate wealth outside of the LNG project and thus have wealth scores as large those households that may be employed by the project. These data indicate that Porebada was less affected by the PNG LNG Project.

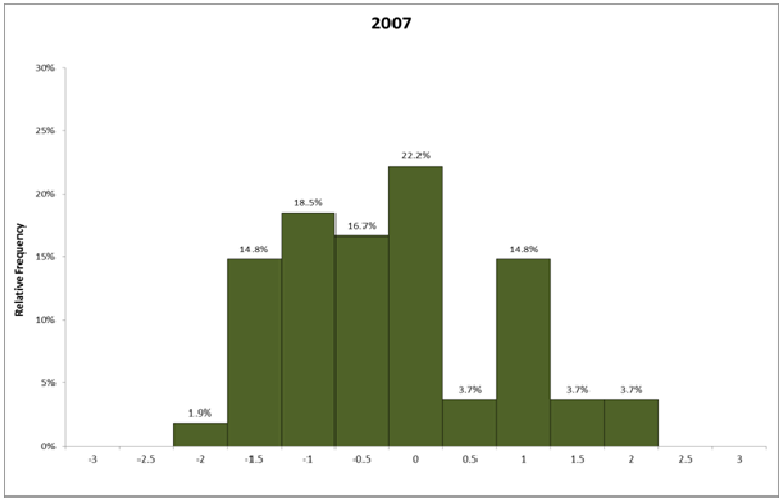
Table 1.6.4 Percentage of eligible Workers *NOT* employed by LNG project by Village-Hiri

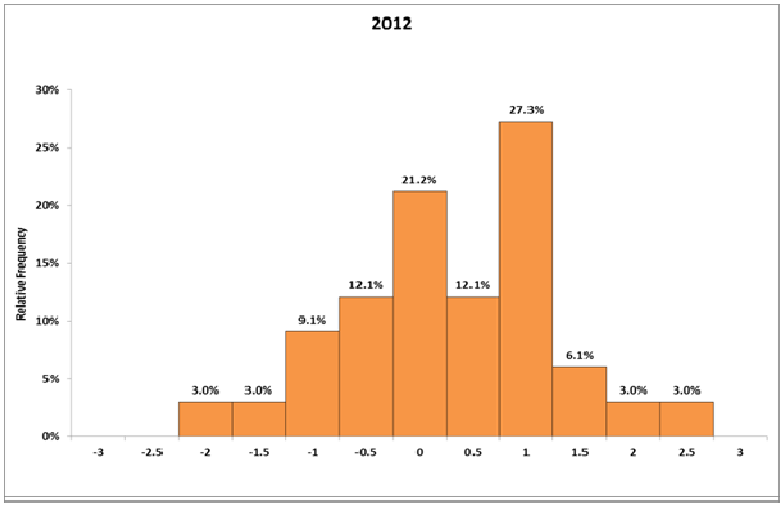
	Total Not Employed by LNG project	Total Eligible Workers	Percent Not Employed by LNG project
Porebada	1124	1418	79.3%
Boera	110	462	24%
Papa	121	324	37.3%
Lealea	273	471	58.0%

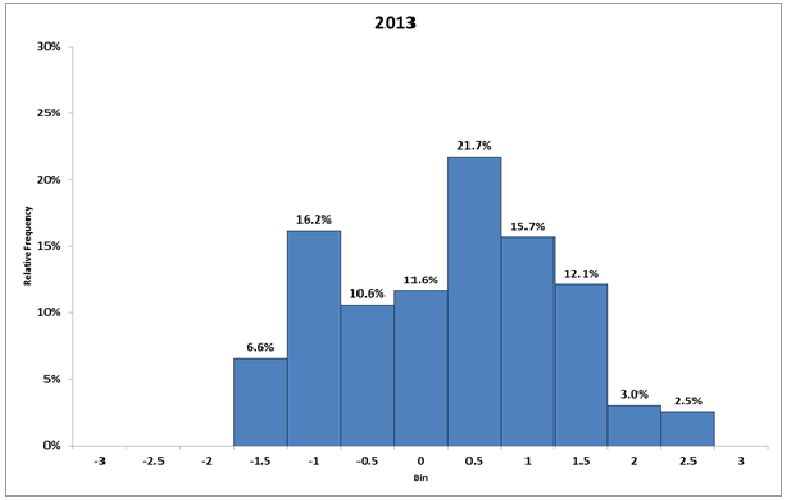
- **There are marked differences across communities in terms of employment impacts from the PNG LNG**
- **As a percentage, Boera and Papa experienced 2-3 times greater employment levels than Porebada**
    - **Small population denominator of Boera and Papa make differences more prominent**

In contrast to Porebada, the village of Boera provides a more telling example of PNG LNG employment impact. Boera had only a smaller percent of its eligible workforce not involved in PNG LNG work. The change of wealth over time for Boera is shown in Figure 1.6.8. There has been a substantial increase in wealth since 2007 baseline. The most dramatic shift occurred from 2007 to 2012, where the majority of households went from having a score below zero to having the majority with a score above 0. From 2012 to 2013, the poorest households are becoming slightly wealthier with many of households shifting to the right by 0.5 points. However, the 2012 data were a convenience survey; therefore, greater weight should be placed on the 2013 results.

Figure 1.6.8. First Principle Component Wealth Score Over Time – Boera







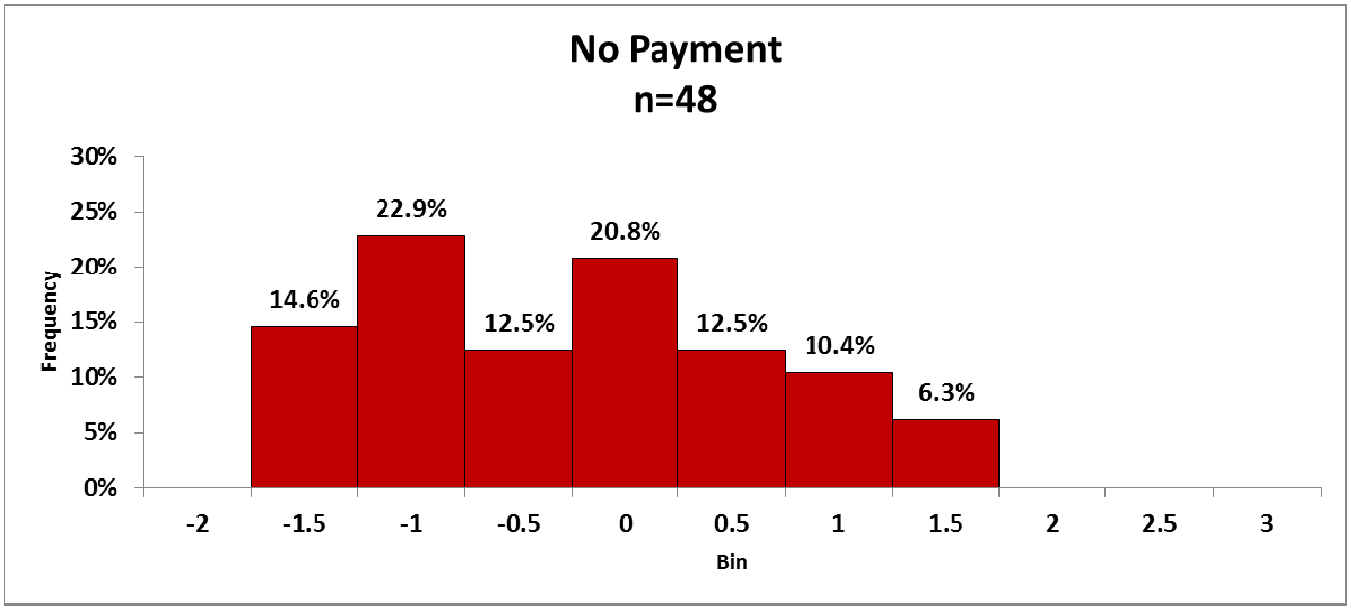
The assets that have the greatest effect on wealth for Boera are shown in Figure 1.6.9. Almost 53% percent of the variance can be attributed to the scores on the first component, whereas 7% of the variance can be explained using the second component. Like Porebada, permanent housing and the associated fixtures, flush toilets, and expensive assets contribute to wealth, while a dearth of these assets leads to greater poverty.

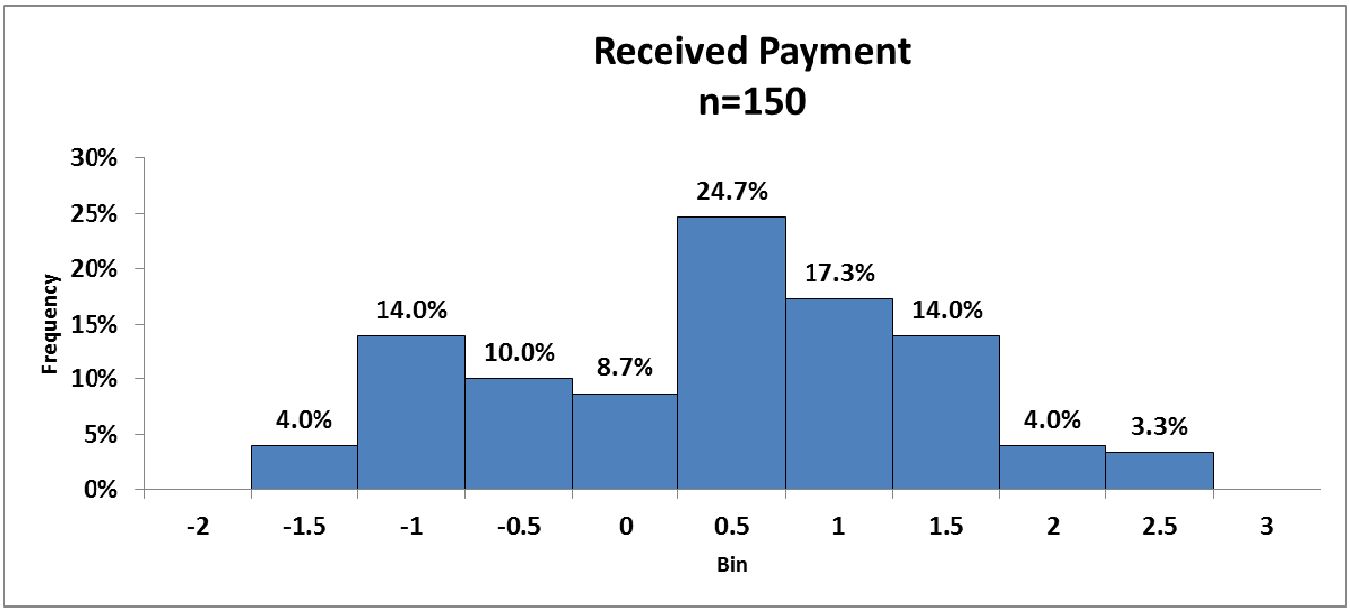
Histogram scores for Boera households are shown in Figure 1.6.10. Unlike Porebada, where there appeared to be no difference (and often LNG payment households were often worse off), those Boera households that received income are clearly better off than those who didn't. As shown in Table 1.6.4, this is likely because (i) most of the eligible Boera workforce is involved in the LNG project, with only 24% of eligible workers not involved in the project and (ii) the smaller population tends to magnify impacts.

- **Positive monetary impacts on Boera are present.**
- **Construction demobilization is likely to be an economic challenge for Boera**

Figure 1.6.9. 2013 Asset Combinations Associated with Relative Levels of Wealth (scores) Boera

Figure 1.6.10. 2013 Household Wealth Scores by LNG Status- Boera



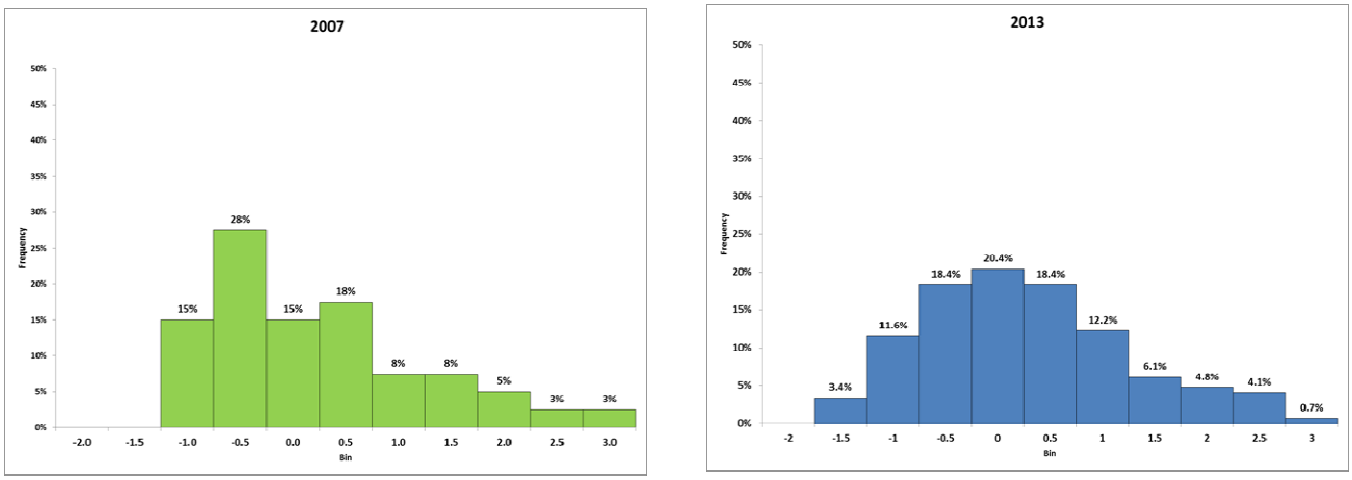


The wealth comparison for Papa is shown in Figure 1.6.11. The sample size for the 2012 SES was only 21, which is too small to do an MCA analysis; thus, the 2012 histogram is omitted from the present analysis. With a sample size of 40, the 2007 survey is small; however, it is mathematically sufficient for analysis. While other villages have shown more of an overall increase in wealth over the 6-year period, the overall increase in Papa is much smaller. Papa continues to see a high level of population growth relative to the other villages, which may be “diluting” the benefits

at the individual household level. Unfortunately, it is not possible to isolate new residents from old residents in the MCA analysis.

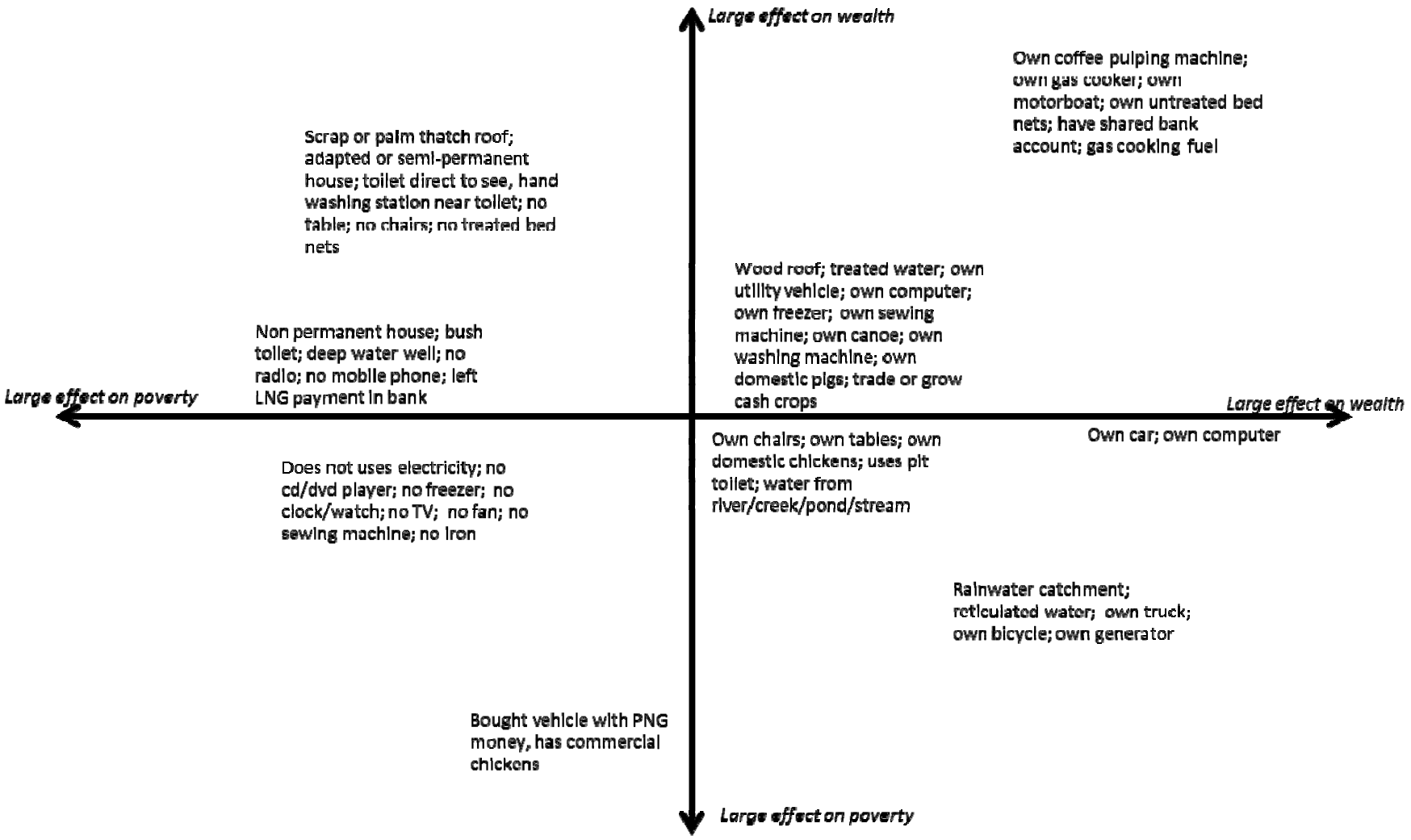
- **Modest but positive monetary impacts on Papa are present.**
- **Construction demobilization is likely to be a real but modest economic challenge for Boera.**

Figure 1.6.11. First Principle Component Wealth Score Over Time – Papa



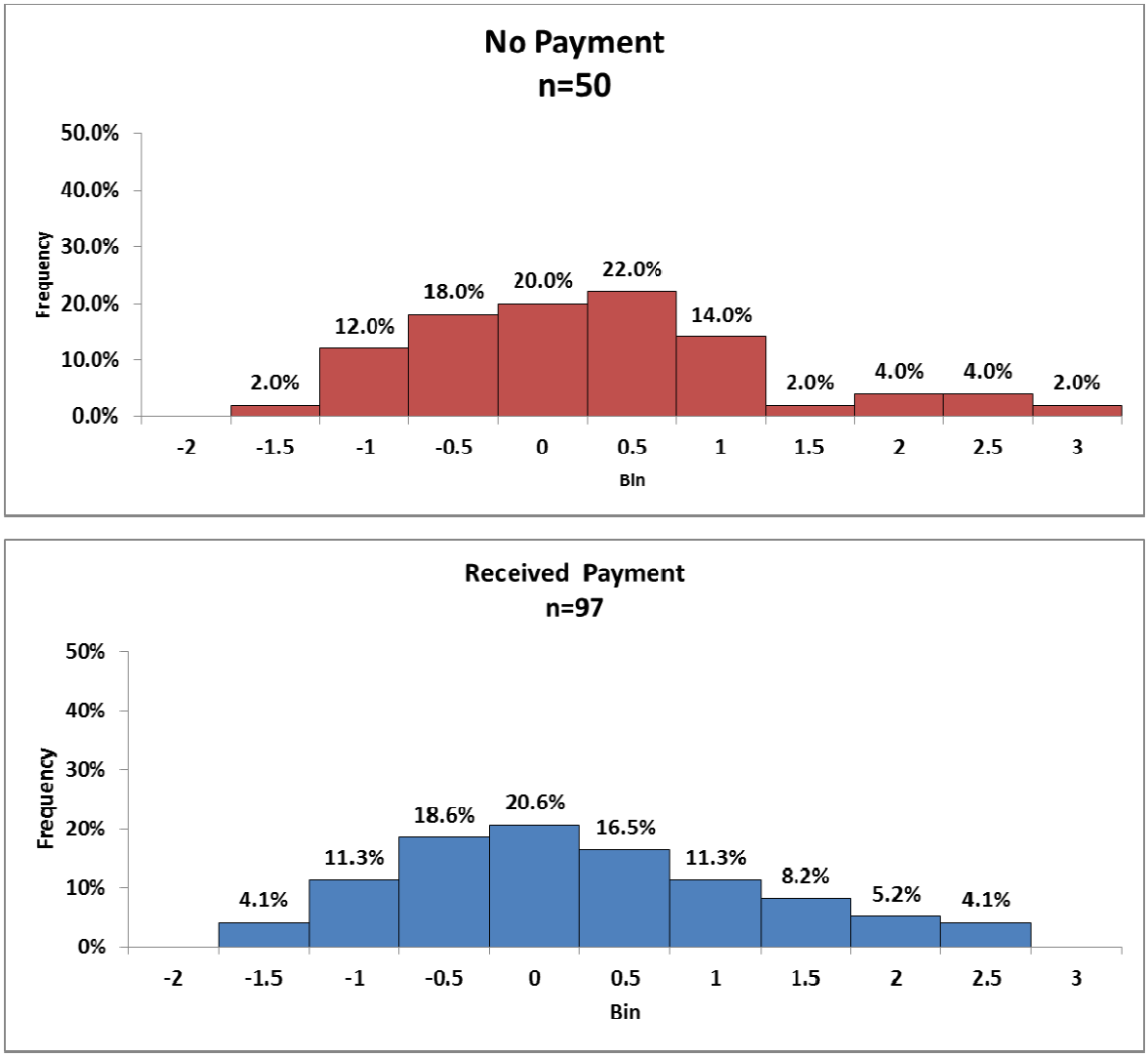
The asset mixture for 2013 Papa households is shown in figure 1.6.12. Almost 52% of the variance can be explained using the first component, with another 7% explained by the second component. Similar to the other villages, permanent housing, flush toilets, and expensive durables goods lead to greater wealth, while an absence of any durable goods, semi-permanent housing, and poor toilet facilities lead to an increased level of poverty.

Figure 1.6.12. 2013 Asset Combinations Associated with Relative Levels of Wealth (scores) Papa



The wealth score comparison by LNG payment status for Papa is shown in Figure 1.6.13. Based on this graph it is clear that the LNG payments have had a positive effect on household wealth. Interestingly, the overall effect on wealth appears to be smaller than Boera, yet larger than Porebada or Lealea (which will be shown subsequently). This may be because Papa has the second lowest percentage of eligible workers who do *not* work for the project. Hence, there is likely a correlation between the effect of LNG payments and the overall percentage of eligible workers who are a part of the LNG project.

Figure 1.6.13. 2013 Household Wealth Scores by LNG Status- Papa



The wealth scores over time for Lealea are shown in Figure 1.6.14. There has been a substantial increase in wealth from 2007 to 2013, with a large majority of households scoring between 0.5 and 1 on the wealth index. Relative poverty has also decreased by 2013, with less than 15% of households scoring below 0, compared to 36% of households in 2007. While there has been a drop off in the high end, this may be explained by other households obtaining new assets that were once out of reach; thus, diminishing the previously rare assets relative weight towards household wealth.

Figure 1.6.14. First Principle Component Wealth Score Over Time – Lealea

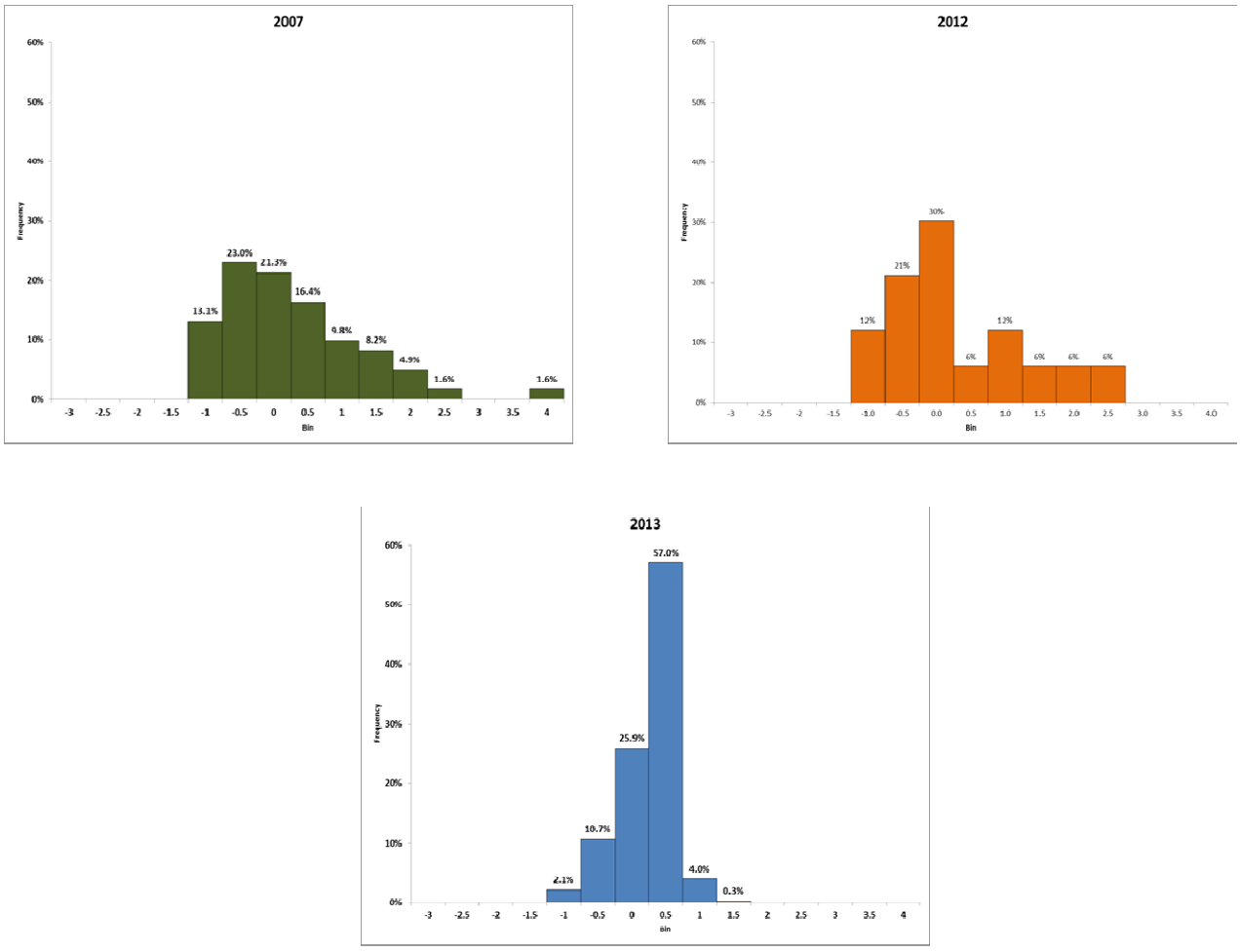


Figure 1.6.15 shows the assets with the highest amount of impact on household wealth and poverty. Nearly 38% of the variance can be explained by the first components, while 17% can be explained by the second component, the highest of any of the villages. The same variables that have contributed to wealth or poverty in the other villages have the same affect in Lealea. A lack of common assets like bed nets, phones, or mattresses, contributes to poverty, as does a non-permanent house. Conversely, expensive assets, such as refrigerators computers, and cars, as we flushed toilets, contribute to greater household wealth.

As shown in Figure 1.6.16, the comparison of wealth scores by LNG payment status indicates that receiving an LNG payment does not have a strong effect on wealth. Like Porebada, Lealea has a high percentage of eligible workers do not work for the LNG project.

Figure 1.6.15. 2013 Asset Combinations Associated with Relative Levels of Wealth (scores) Lealea

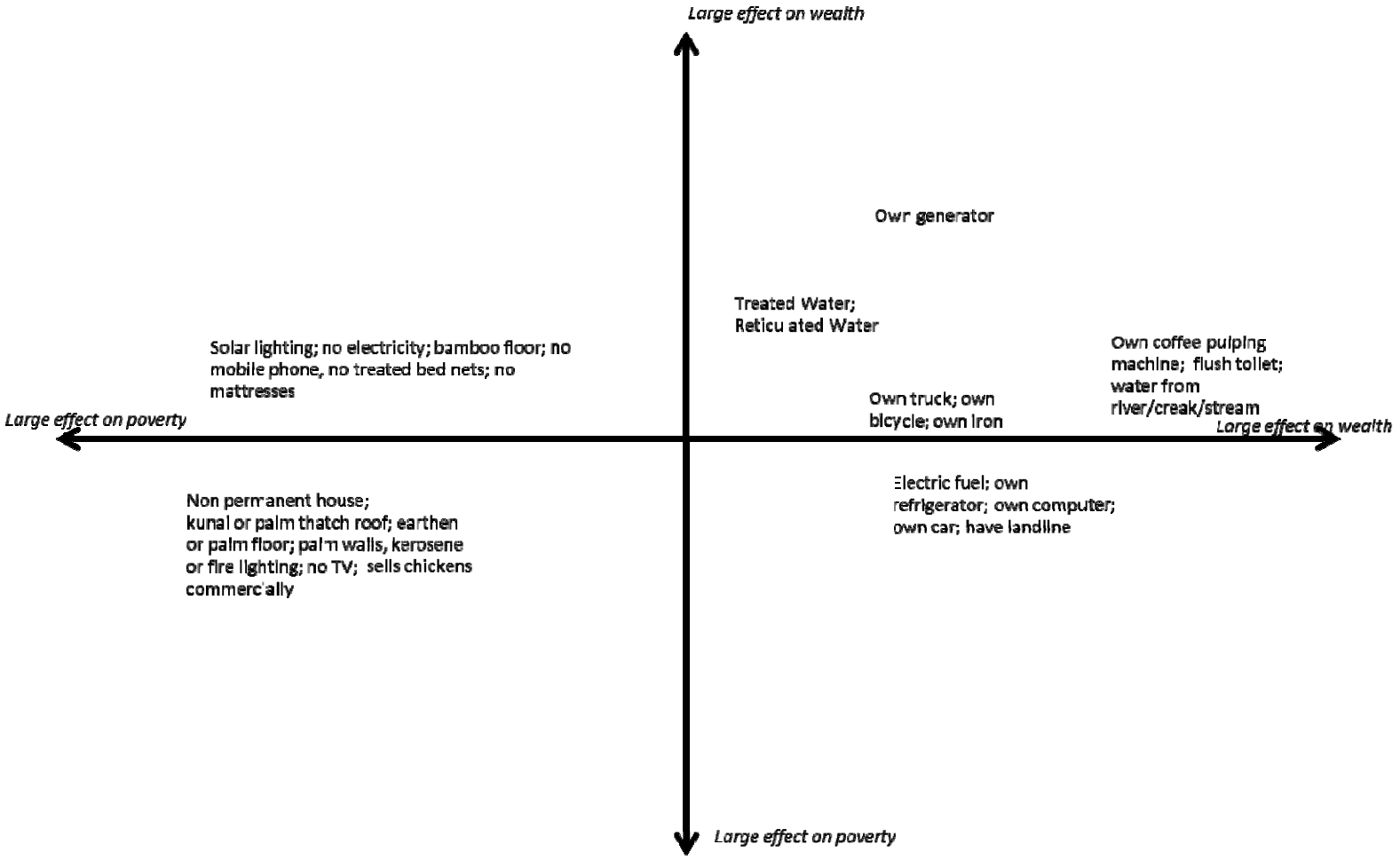
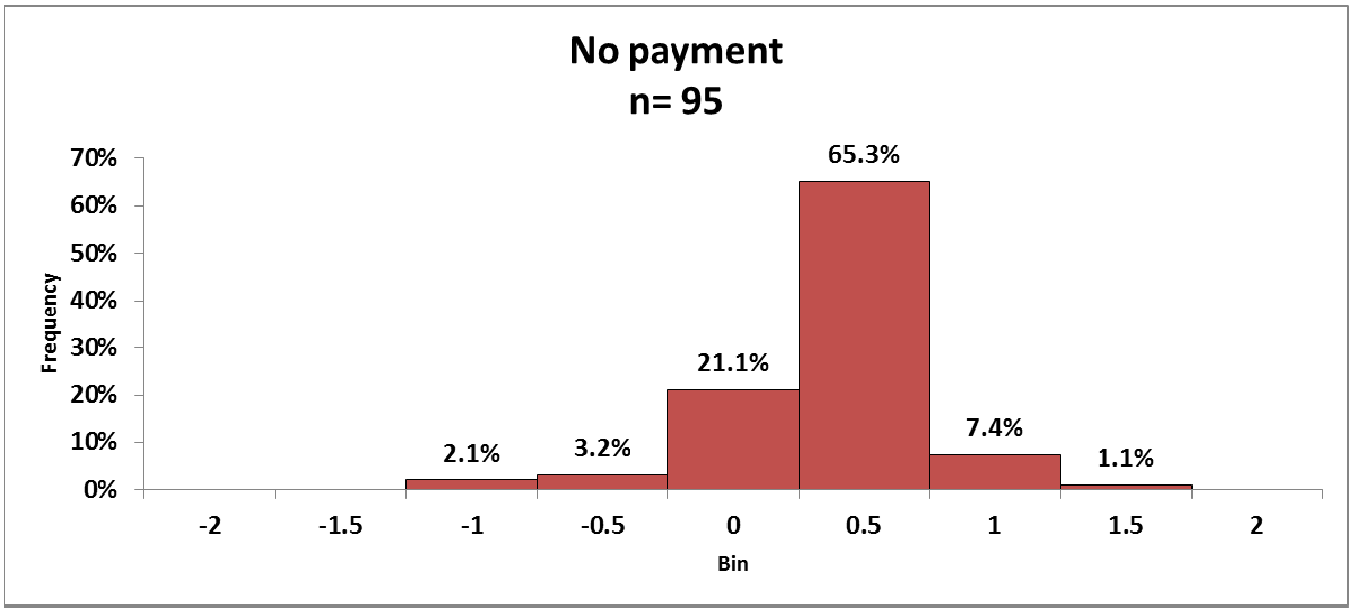
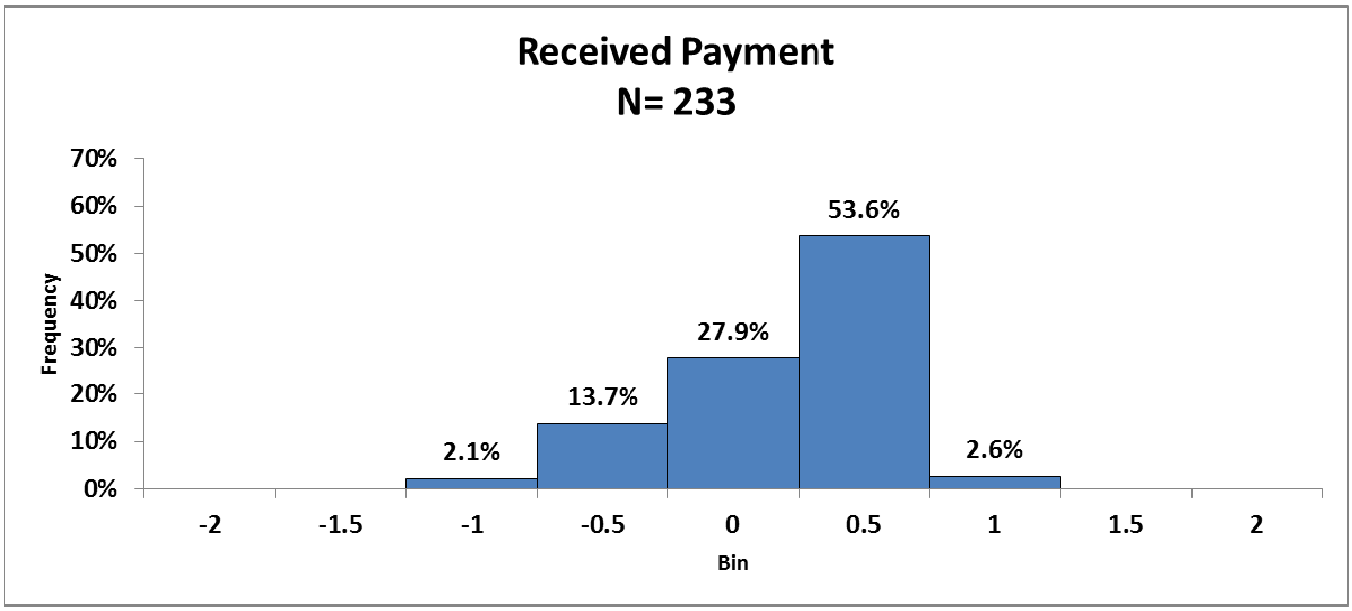


Figure 1.6.16. 2013 Household Wealth Scores by LNG Status- Lealea





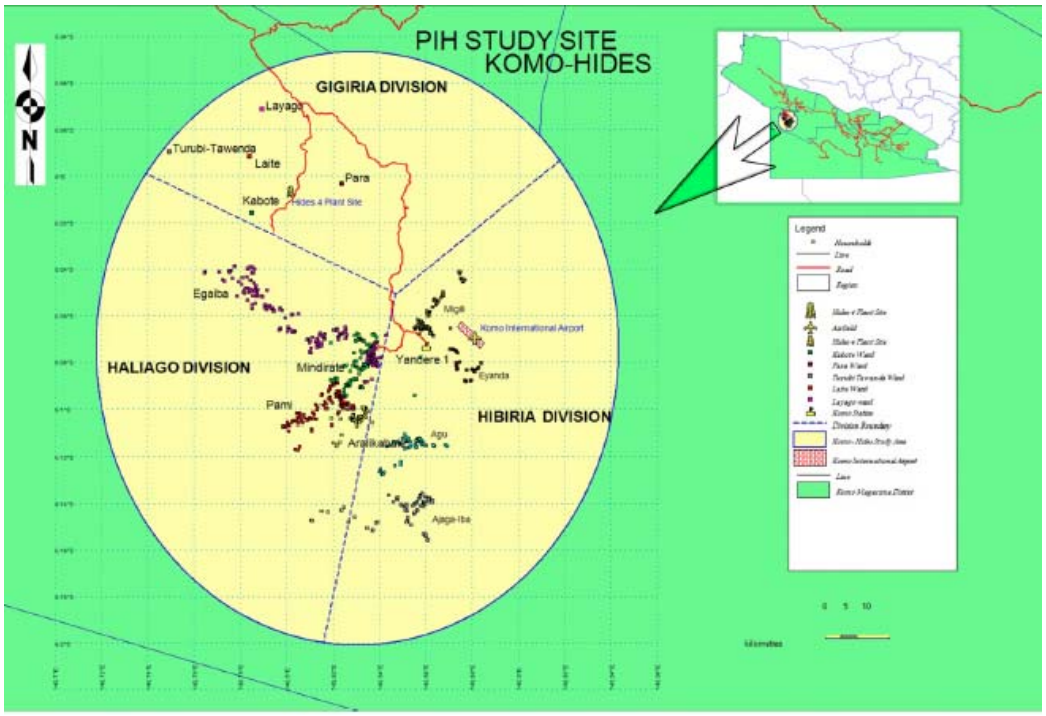
- **Neutral monetary impacts on Lealea are observed.**

In the next section, the Hides SES will be analyzed.

Hides/Komo Analysis

The Hides area is completely different than Hiri in terms of culture, ethnicity, and geography. As shown in Figure 1.5.17, the IMR survey evaluated Hides in three geographical areas: Haliago (Division 1), Hibiria (Division 2) and Gigiria (Division 3). Three divisions represent the most likely geographical are of potential impacts and are designed to capture 13-15,000 individuals. The HGCP is located in Division 3 and the Komo Airfield, Division 2. The key medical clinics are the Para Health Clinic (Division 3) and Mananda Clinic (Division 1). The Hides demography data are shown in Chapter 1 of the overall report. The Eastern Highlands Asaro site is the matching control location for Hides. Asaro SES data are under review and will be included in the next update. However, a comparison between Hides and Hiri will presented at the end of this section

Figure 1.6.17 iHDSS Hides Survey Areas



As it pertains to wealth, housing and assets, Table 1.6.5 shows all three divisions across time, i.e., from baseline to 2013 survey results. The results indicate that households do not appear to have spent significant amounts of money on major household durable goods. The lack of major infrastructure, i.e., electricity, is clearly a

critical contributor to the observed pattern of consumer durable acquisition. Household bank accounts have significantly increased and this is undoubtedly due to the major construction and employment activities generated by the PNG LNG.

Table 1.6.5. Hides Assets over Time

Asset Type Owned	Percent of Households that Own Asset					
	Division 1		Division 2		Division 3	
	2007	2013	2007	2013	2005	2013
Mobile Phones	0.0%	89.4%	0.0%	83.9%	0.3%	91.9%
Bank accounts	26.8%	33.6%	14.2%	26.7%	11.8%	48.1%
Computer	2.4%	0.8%	1.2%	0.6%	2.5%	1.9%
Mosquito Netting (treated or untreated)	26.8%	33.4%	8.3%	13.0%	12.3%	61.2%
Uses Electricity	2.4%	2.6%	0.0%	1.2%	1.2%	1.2%
Flush Toilet	0.0%	0.1%	2.4%	0.4%	2.6%	0.5%
Permanent Housing	2.4%	3.7%	0.0%	2.1%	1.9%	6.4%

- **Some significant changes in the pattern of consumer durables in Hides household have occurred.**
- **Lack of infrastructure, e.g., electricity, is a major constraint on consumer**

durable acquisition.

A major difference between Hiri and Hides is that residents of Hides were almost exclusively subsistence farmers prior to commencement of the LNG project. Table 1.6.6 looks at the male workers who are not farmers (cash cropping or subsistence) and what percentage of them are employed by an entity other than the LNG project.

Table 1.6.6 Percentage of Eligible Workers *NOT* employed by LNG project by Village

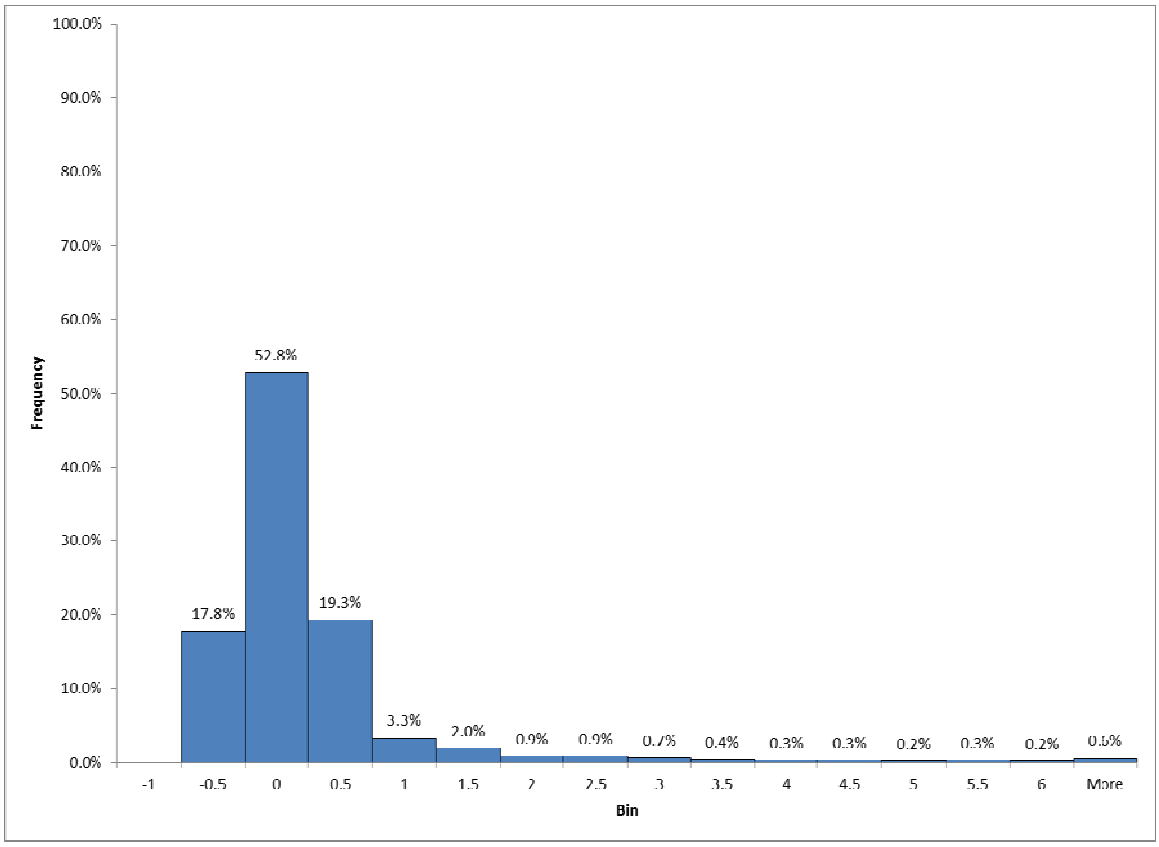
	Total Not Employed by LNG project	Total Non-Farm Workers	Percent Not Employed by LNG project
Division 1	89	525	17.0%
Division 2	381	437	12.8%
Division 3	1005	1056	4.8%

Figure 1.6.18 shows the histogram of the first principle component scores for the entire Hides area for 2013. Just as with Hiri, ***a higher score indicates a higher level of wealth***. The spread of data demonstrates a large homogeneity across Hides where almost 53% of households are at “0” and 88% of households are within -0.5 and +0.5. There is a small of extensive right-sided “tail” that indicates that a few households have significant wealth relative to everyone else.

- **Hides is dominated by subsistence agriculture.**
- **There is strong homogeneity across wealth distribution based on 2013 survey results.**

- **There are a few Hides households that have done exceptionally well.**

Figure 1.6.18. 2013 First Principle Component Wealth-Hides All divisions



The assets, most contributing to wealth or poverty, are shown in Figure 1.6.19. The substantial tail can be better understood by looking at the assets that have a large effect on wealth scores. 63.3% of the variance can be explained on the first component, while 9.4% can be explained on the second component. Similar to Hiri, the assets with the largest effect on wealth are those that are either expensive durable goods (such as computers or refrigerators), or housing improvements such as flush toilets (or just permanent housing, for the matter).

As Table 1.6.5 illustrates, the data indicate that Huli households do not necessarily spend their income on housing improvements. The majority of Hides Division residents have neither permanent housing, nor electricity. As such, durable goods

that rely on these factors tend to be weighted very heavily, as only a few households have electricity and even fewer have these expensive assets.

Figure 1.6.19. 2013 Asset Combinations Associated with Relative Levels of Wealth (scores) Hides All Divisions

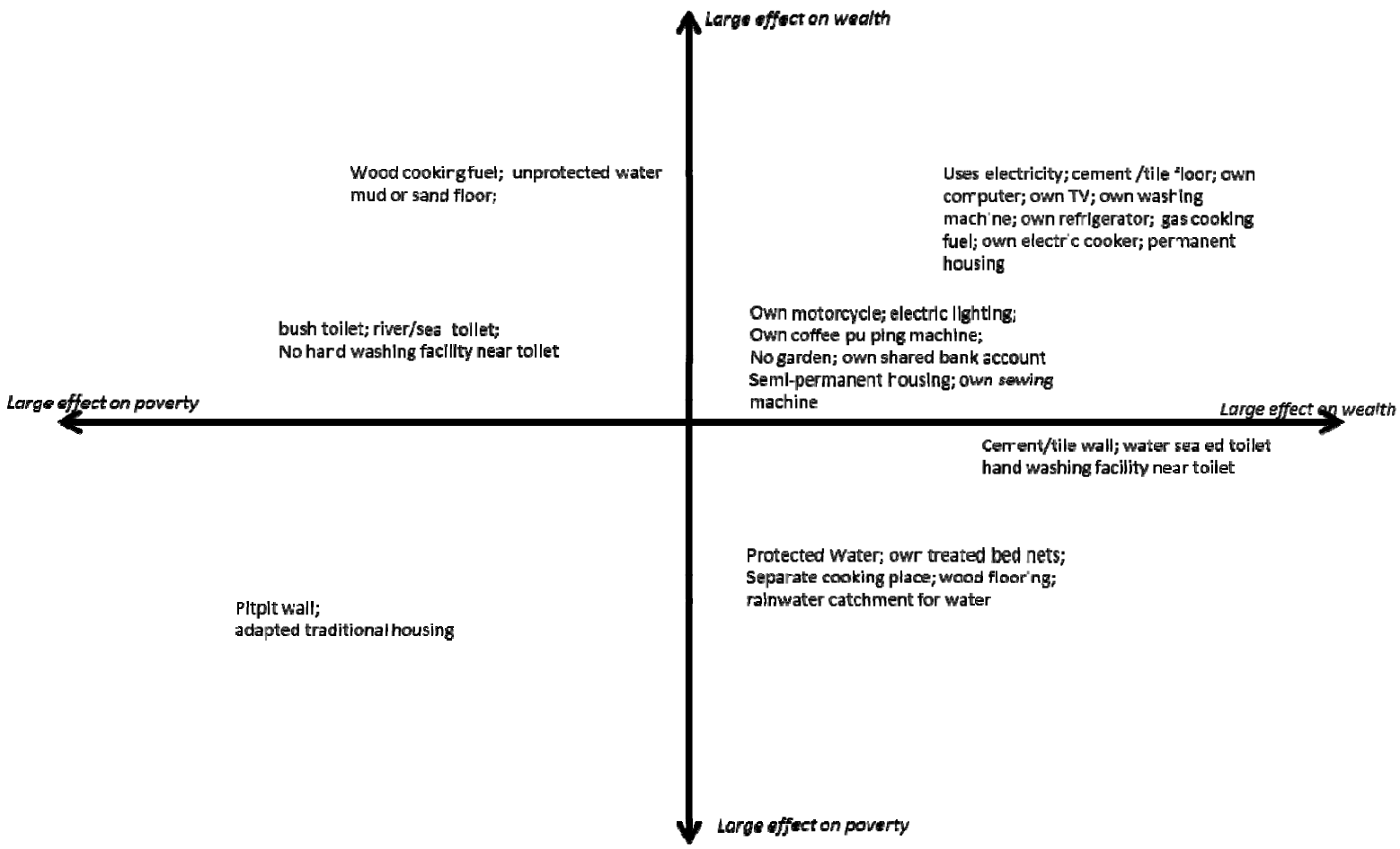
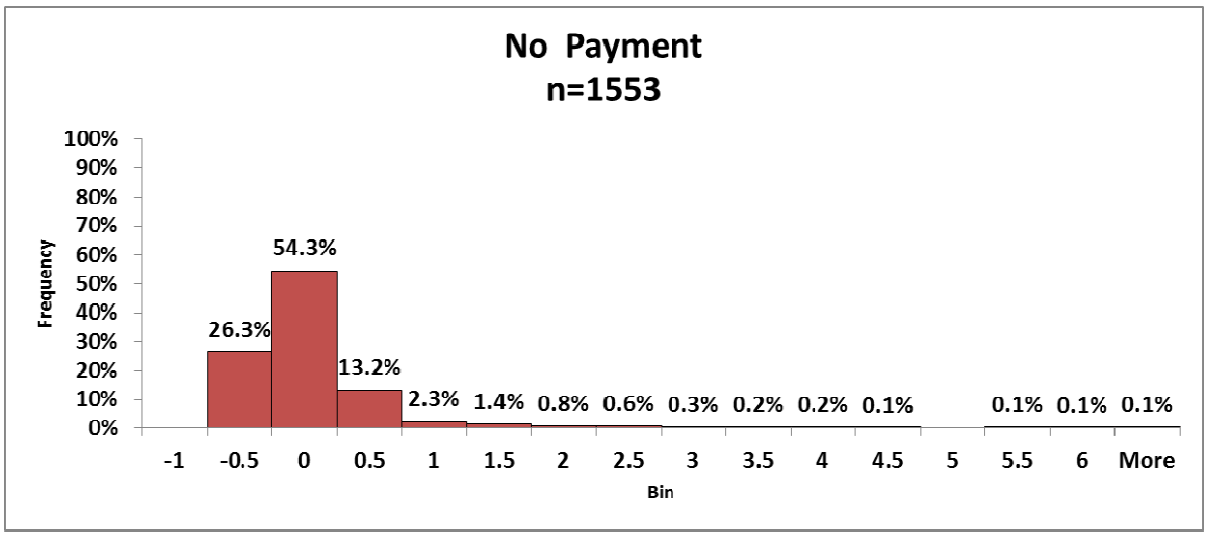


Figure 1.6.20 divides the wealth scores along which households received LNG payments and which did not. There is a substantial difference between the two, with the households that received LNG payments being better off than those that did not. The number of households scoring below a score of 0 is over 20 percentage points higher for those households that did not receive an LNG payment.

- **Receiving LNG monies has had a significant impact.**

Figure 1.6.20. 2013 Household Wealth Scores by LNG Status- Hides All Divisions



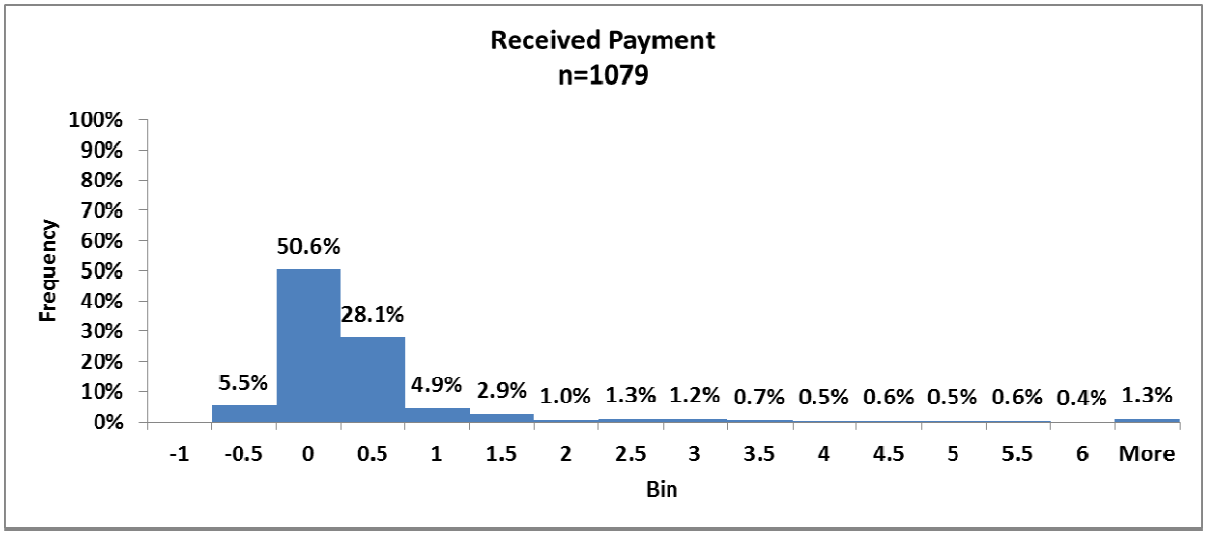
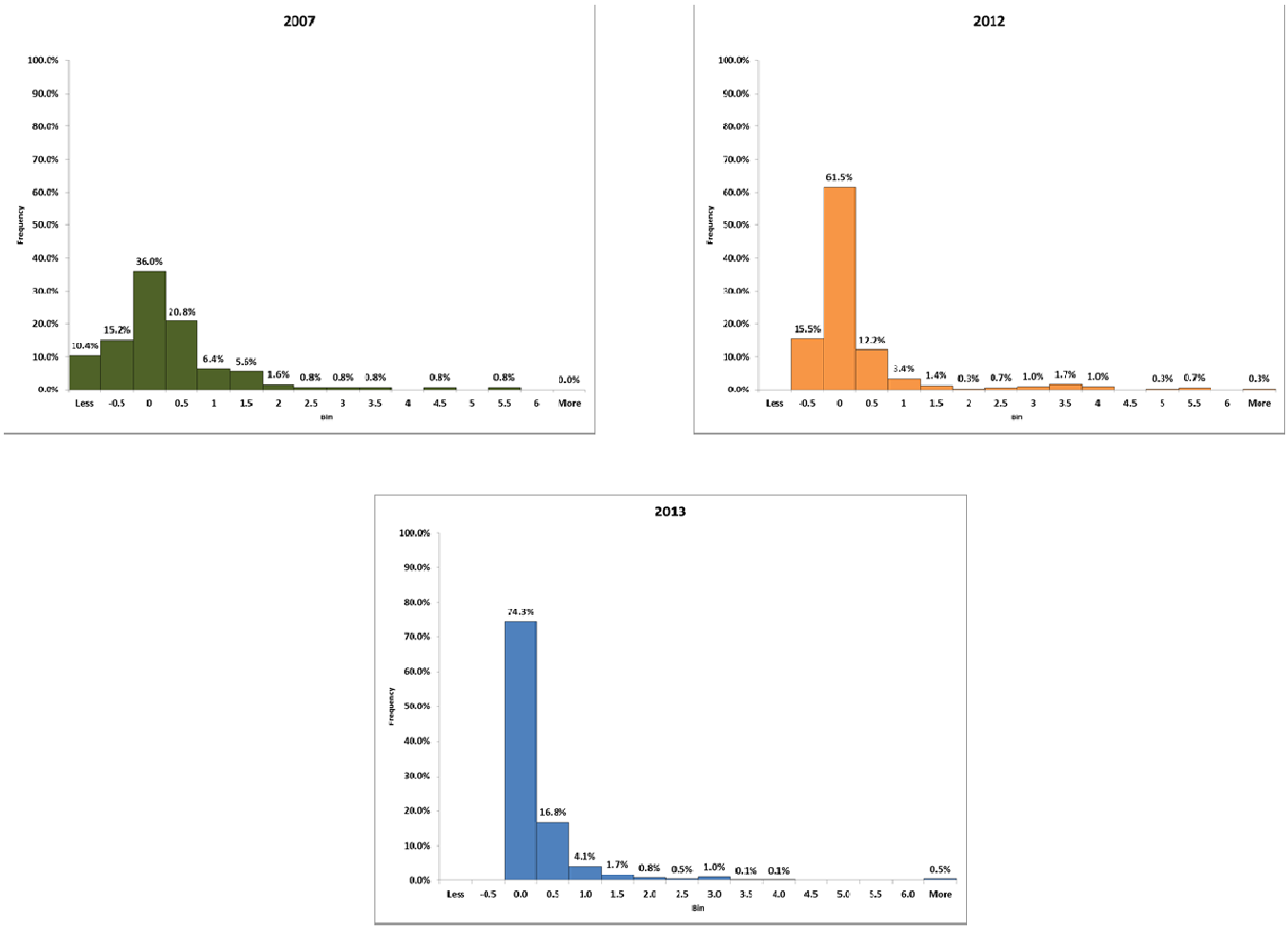


Figure 1.6.21 shows the histograms of the first principle component scores for Hides Division 1 over time. This figure demonstrates that the households in Hides have substantially improved from 2007, and continued to improve from 2012 to 2013. While nearly 25% of households scored below a 0 in their 2007 wealth scores, no household had a score of below 0 in the 2013 survey. The 2012 pilot survey results had a relatively small sample size and are less robust than the 2013 survey. Unlike Hiri, where there is a more even distribution of wealth scores, the Hides Division 1 wealth scores are primarily between 0 and 0.5, with few residents scoring above a 1.

Figure 1.6.21. First Principle Component Wealth Score Over Time – Hides Division 1



The assets that contribute to wealth or poverty for Hides Division 1 are found in Figure 1.6.22. High end assets, like freezers, refrigerators and computers contribute greatly to wealth, as do housing improvements such as flushed toilets and electricity. Most other assets have negligible effects on wealth or poverty, the low-end assets (such as mobile phones) tend to owned by the vast majority of residents.

Figure 1.6.22. 2013 Asset Combinations Associated with Relative Levels of Wealth (scores) Hides Division 1

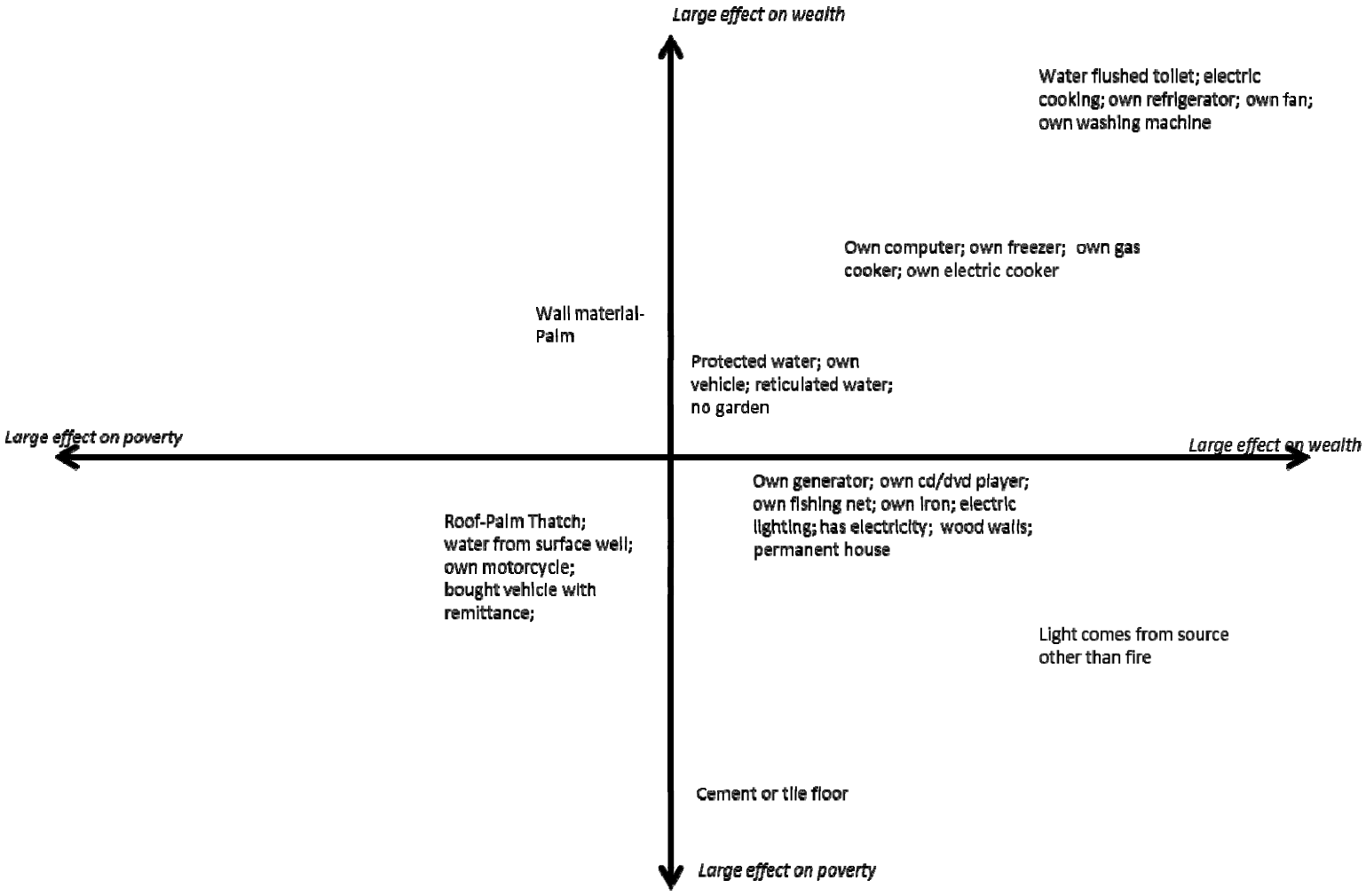
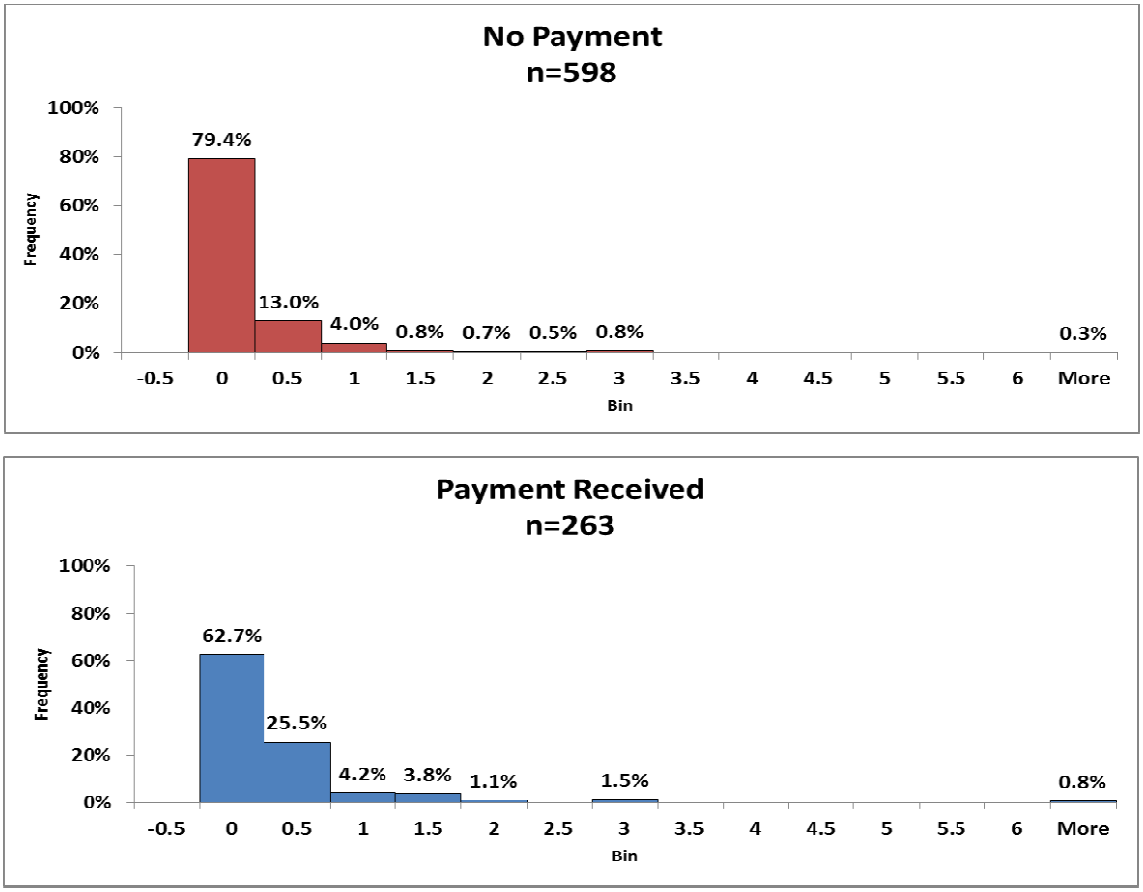


Figure 1.6.23 looks at the difference in wealth scores between those who have received LNG payments and those that have not. Those who have received an LNG payment have more households score above 0.5 than those do not, a difference of 17.3 percentage points. This large difference is likely due to the fact that outside of the LNG project, there are minimal "industrial" wage opportunities; instead, employment is dominated by subsistence farming or cash cropping. In general, those who are receiving LNG payments would be expected to be better off. On average, receiving an LNG payment improves a household's wealth score by 0.2 points. Interestingly, there appears to be no correlation between working for the LNG project and having household improvements such as electricity, which would enable the purchase of other highly weighted assets such as computers or freezers.

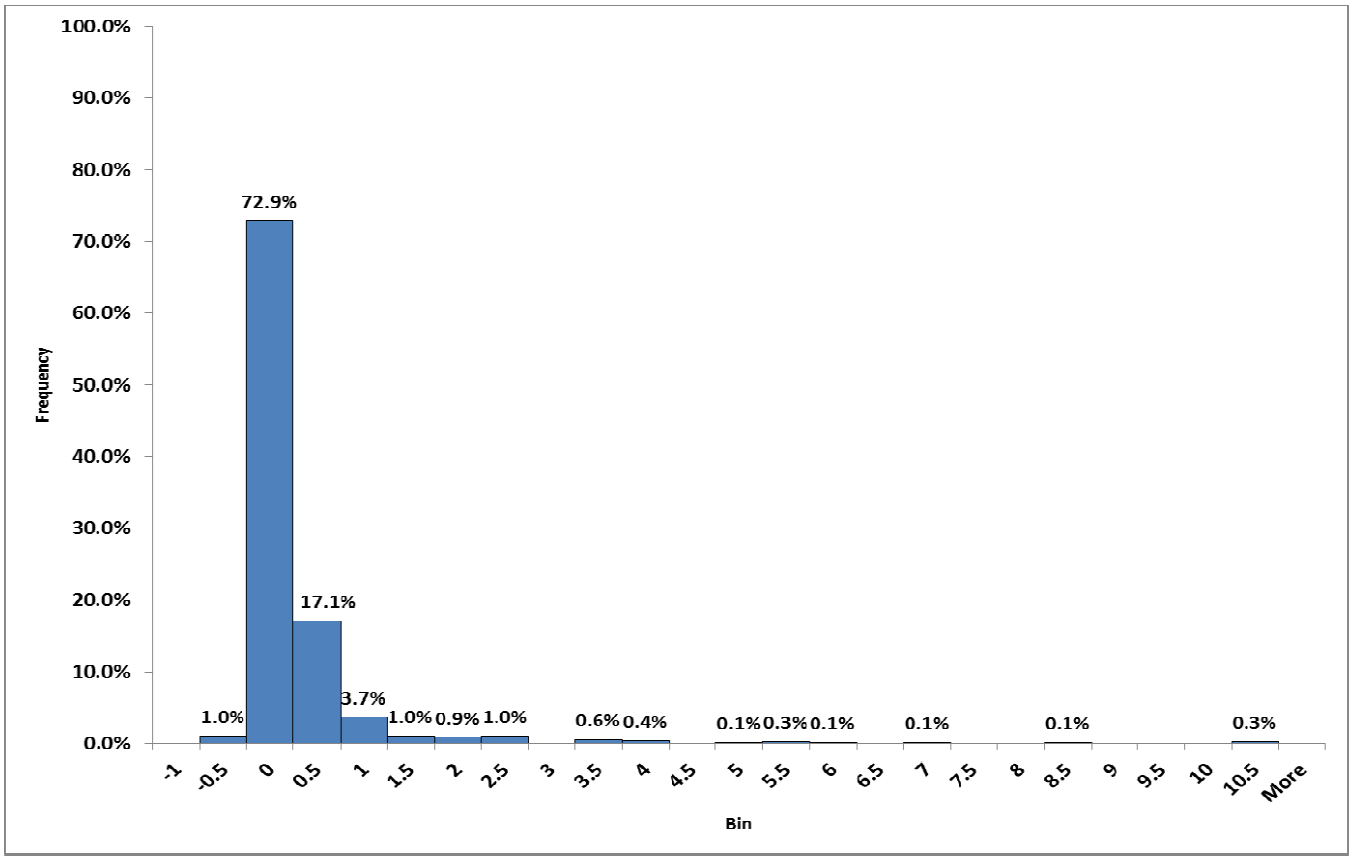
- **Receiving LNG monies has had a significant positive impact on Division 1 households.**

Figure 1.6.23. 2013 Household Wealth Scores by LNG Status- Hides Division 1



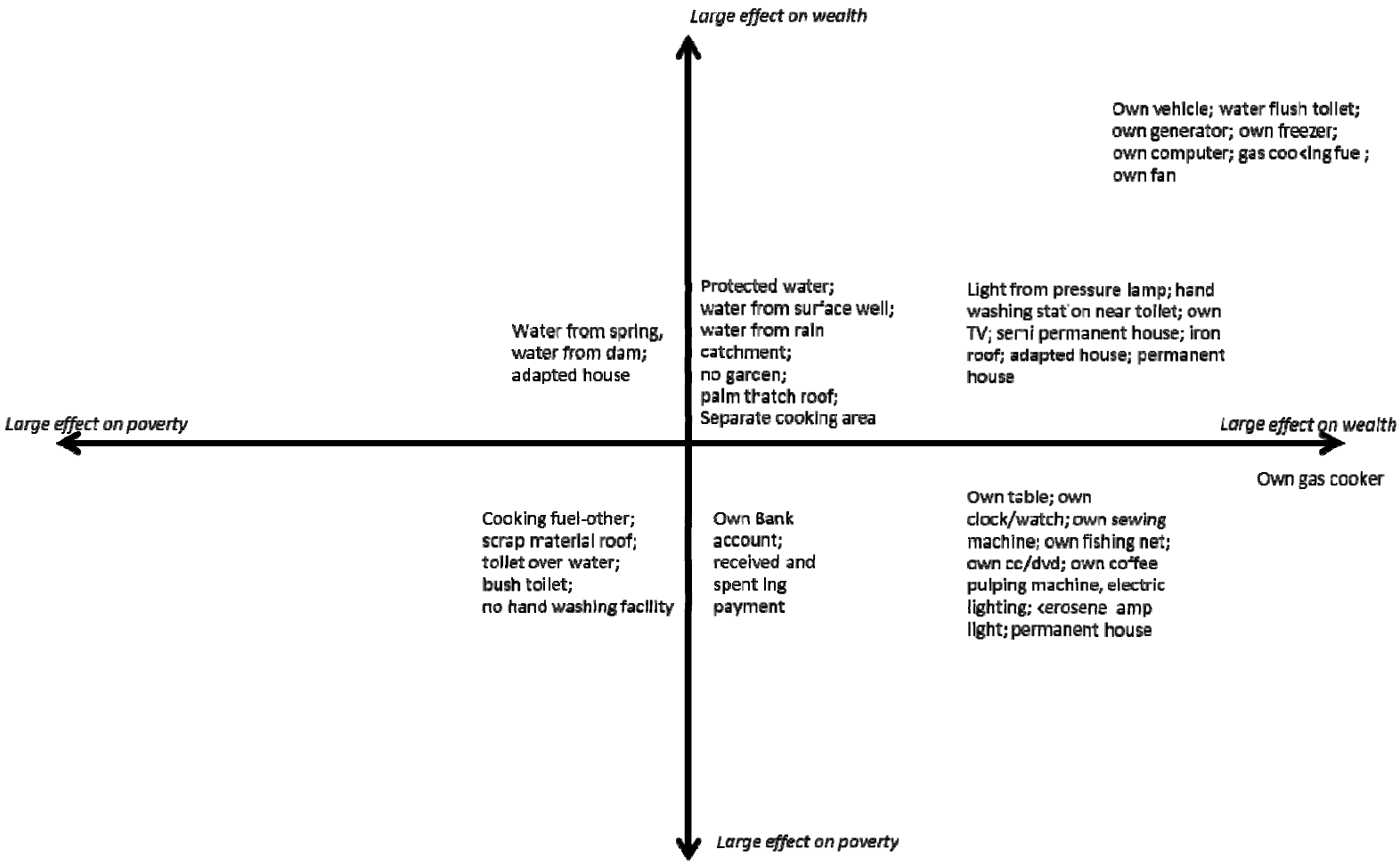
The wealth scores for Division 2 are shown in Figure 1.6.24. There is no data available prior to the 2013 SES as the 2012 pilot study was confined to Division1 households. Given there similar distribution of wealth as in Division 1, and the lack of any other industry prior to the LNG project, it is likely that Division 2 has seen similar wealth trends, wherein the conditions of the poorest households have improved, but most other residents have stayed in the 0-1 range of wealth scores.

Figure 1.6.24. First Principle Component Wealth Score for 2013 – Hides Division 2



The asset distribution for Hides Division 2 can be found in Figure 1.6.25. As illustrated, 51.7% of the variance can be explained with the first component, while another 7.1% can be explained with the second component. Similar to Division 1, the majority of the highly weighted assets require housing improvements, such as the use of electricity, or require a substantial amount of income for purchase, such as a vehicle. As per Division 1, there appears to be no correlation between working for the LNG project and ownership of these high valued items.

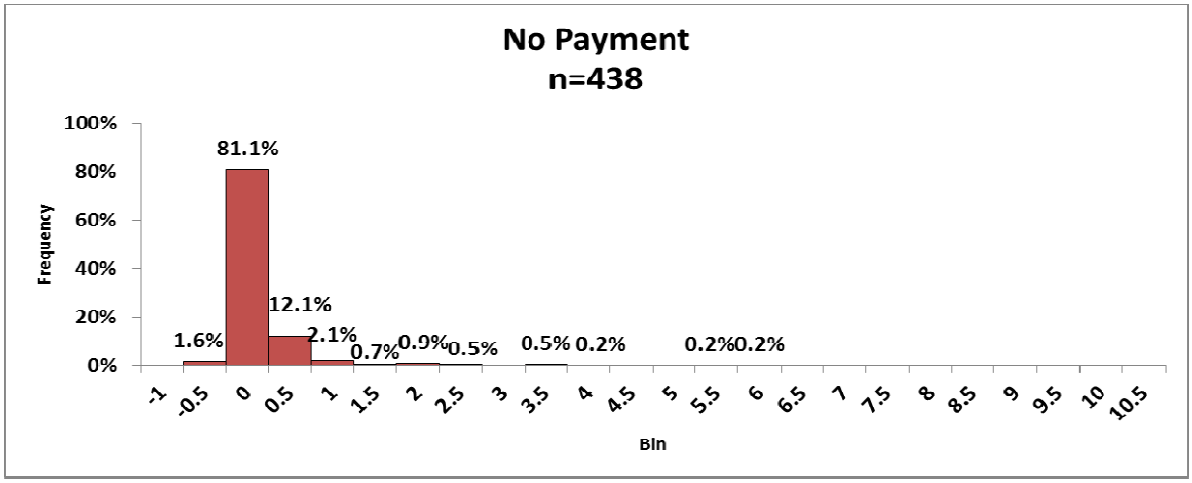
Figure 1.6.25. 2013 Asset Combinations Associated with Relative Levels of Wealth (scores) Hides Division 2

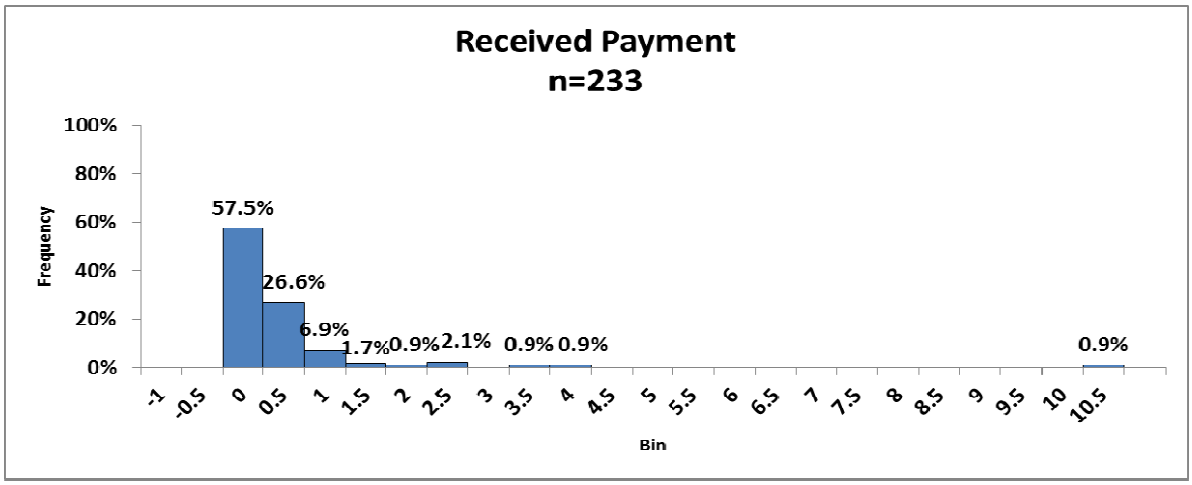


The distribution of Hides Division 2 wealth scores according to LNG payment status is given in Figure 1.6.26. As was the case with Hides Division 1, Division 2 households that received LNG payments tend to have higher wealth scores. The frequency of those who have received LNG payments and score over a 0.5 is 23.5 percentage points higher than those who did not receive any payment.

While both Division 1 and 2 have a high proportion of non-farm workers that work for the LNG plant, as shown in Table 1.6.6, Division 2 has the higher amount. This may in part explain why LNG payments have a larger impact on wealth scores in Division 2 than in Division 1.

Figure 1.6.26. 2013 Household Wealth Scores by LNG Status- Hides Division 2

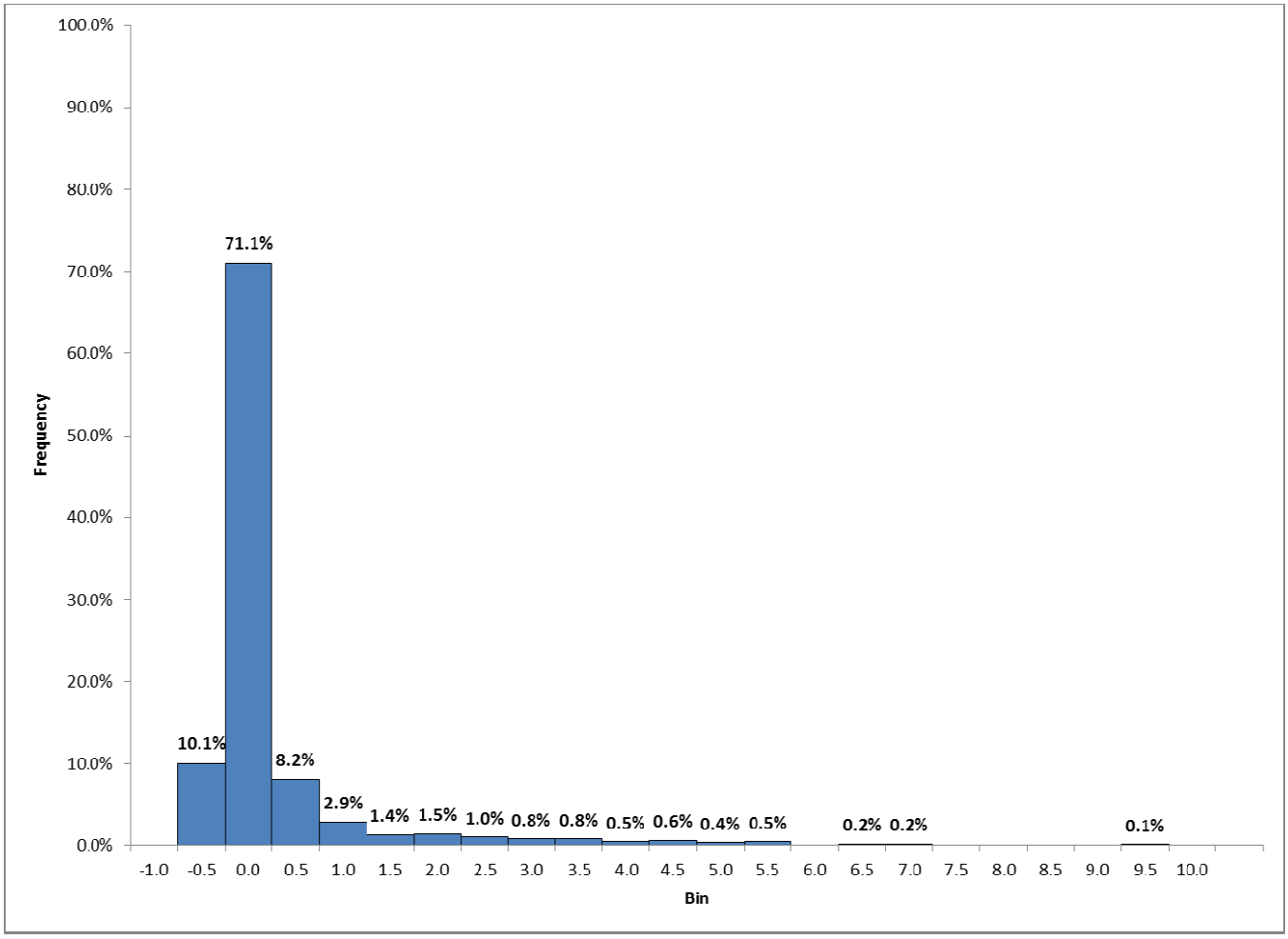




- **Receiving LNG monies has had a significant positive impact on Division 2 households.**

The wealth scores for Division 3 are shown in Figure 1.6.27. Like Division 2, there are no previous data available that can be used for intra-construction period sequential comparison. Similar to the other divisions there is a substantial tail towards the right of the graph.

Figure 1.6.27. First Principle Component Wealth Score for 2013 – Hides Division 3

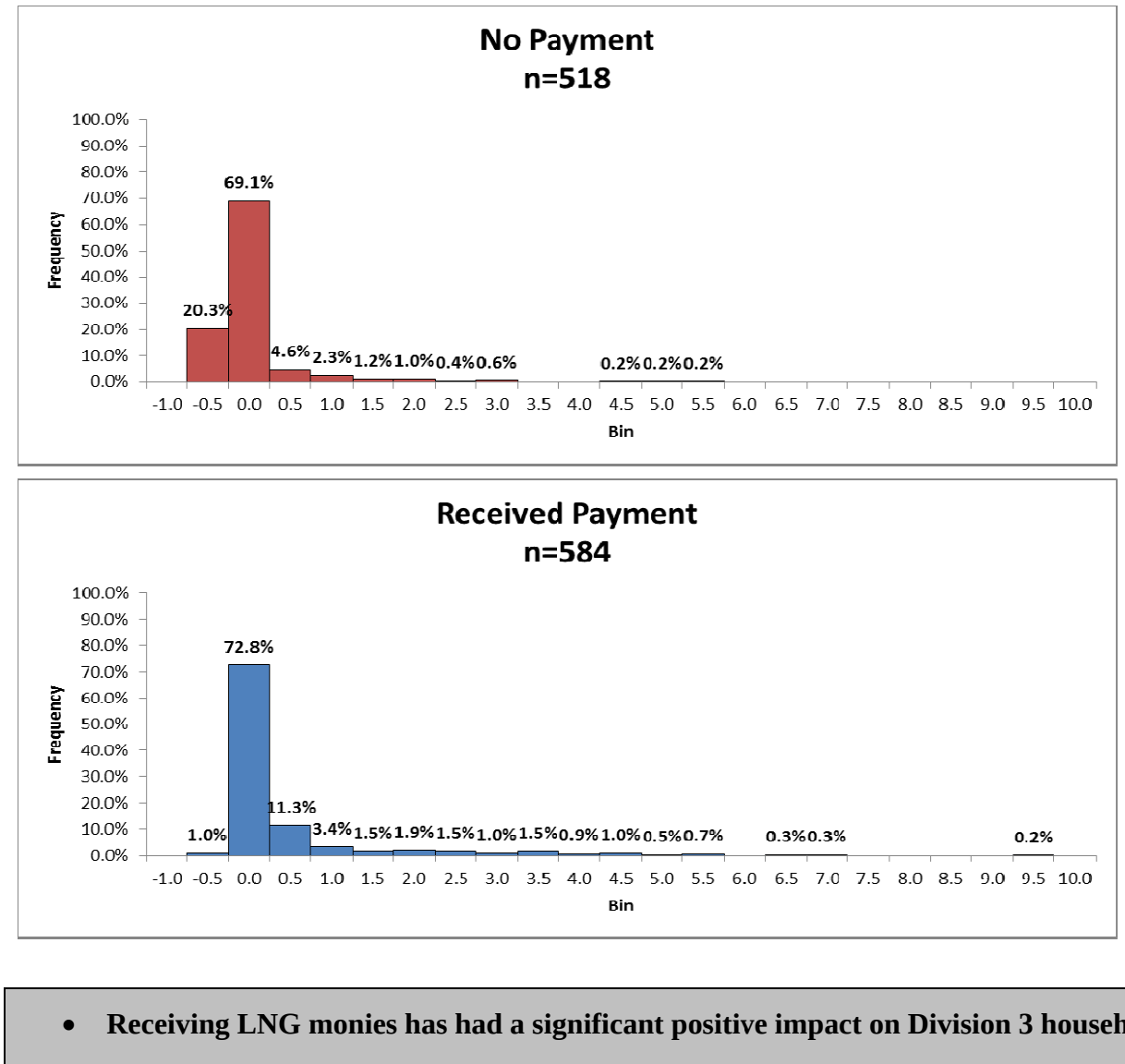


The asset mixtures that contribute to wealth are found in Figure 1.6.28. Division 3 continues the trend where high end variables, permanent housing, and improvement to housing structure strongly contribute to wealth, while non-permanent housing, and a lack of basic or commonly owned assets contribute to poverty. 61.4% of the variance between asset effects can be explained with the first component, while 8.0% of the explained variance can be found using the second component. A variable's location on the x-axis has the most explanatory power, with its location on the y-axis being marginally important if located on the extreme ends.

Figure 1.6.28. 2013 Asset Combinations Associated with Relative Levels of Wealth (scores) Hides Division 3

Figure 1.6.29 delineates wealth scores based upon the households that received an LNG payment and those that have not. Like the other two divisions, those who have received an LNG payment are substantially better off. In the case of Division 3 there, only 6 households that received a LNG payment (1% of the population) had a score below 0, while over 100 households that did not receive an LNG payment had a score below zero. The total number of households that scored above a 0.5 is also over 15 percentage points higher for those that received an LNG payment.

Figure 1.6.29. 2013 Household Wealth Scores by LNG Status- Hides Division 3



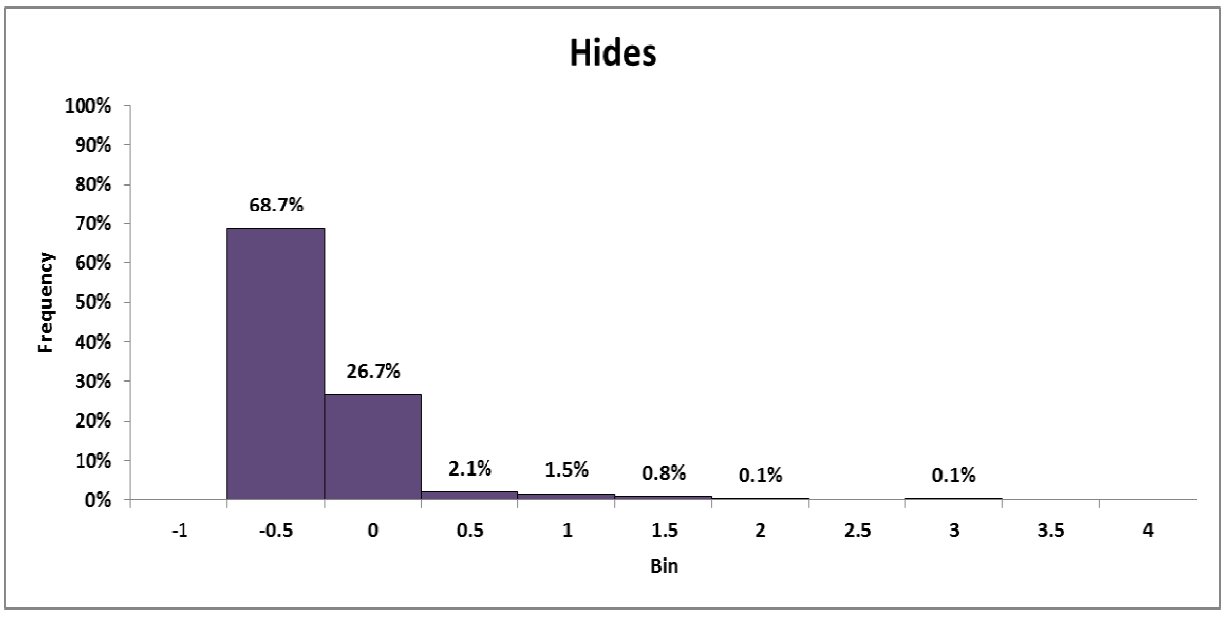
- **Receiving LNG monies has had a significant positive impact on Division 3 households.**

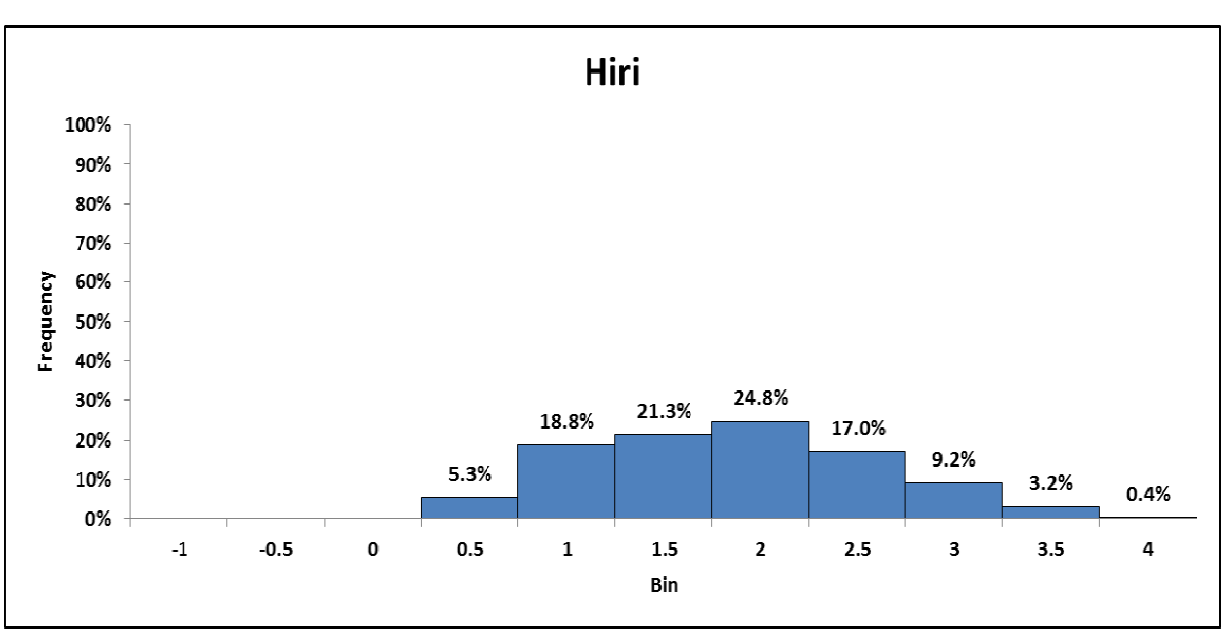
Hides versus Hiri

While Hiri is not the matched comparison site to Hides, it is nevertheless instructive to illustrate and analyze the wealth and behavior differences between the two PNG LNG impacted

locations. Figure 1.6.30 integrates the baseline Hides (all divisions) and Hiri data in a stacked comparison.

Figure 1.6.30. Hides versus Hiri Baseline Comparison





It can be readily observed that almost 95% of Hides households were poorer than the lowest level Hiri household. At baseline, Hides was overwhelmingly poorer than the lowest scoring Hiri households. This objective finding is compatible with and confirms the conclusions in the original PNG LNG Project SIA.

Figure 1.6.31 presents a similar stacked comparison between Hides and Hiri using 2013 SES data.

Figure 1.6.31. Hides versus Hiri 2013 Comparison

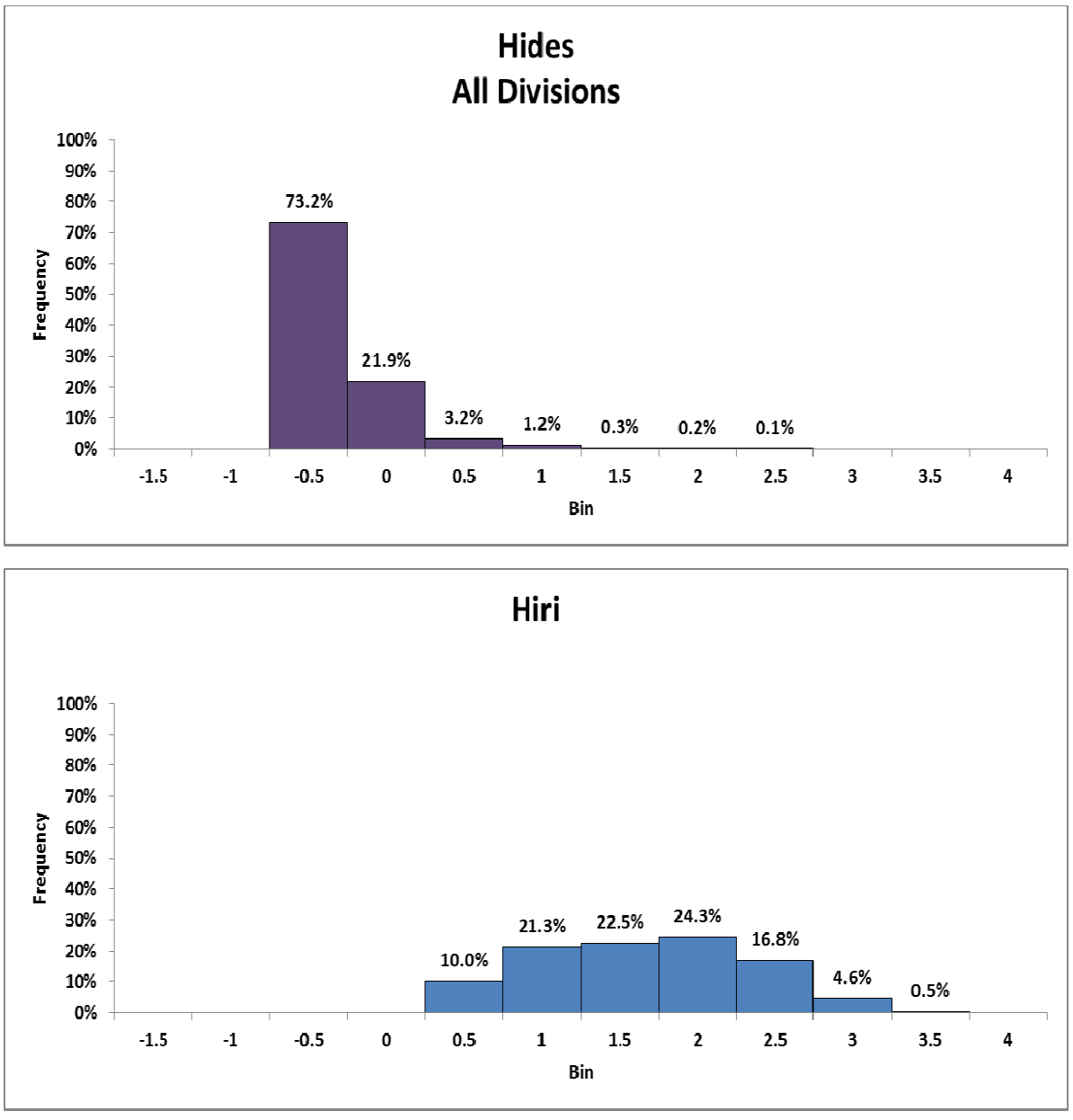
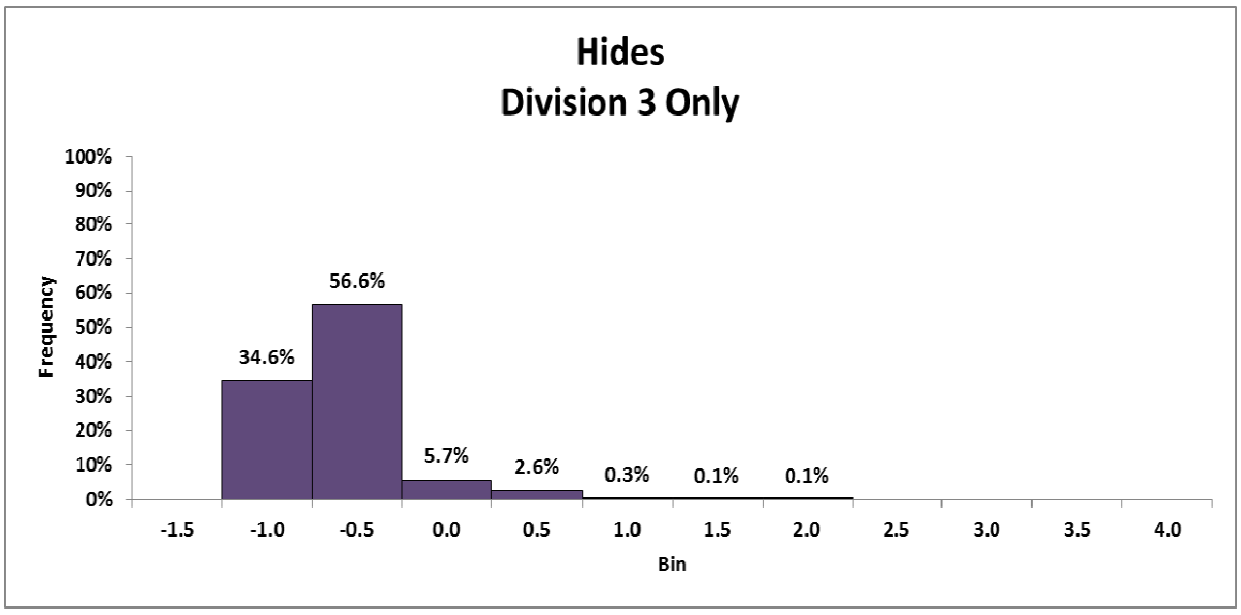
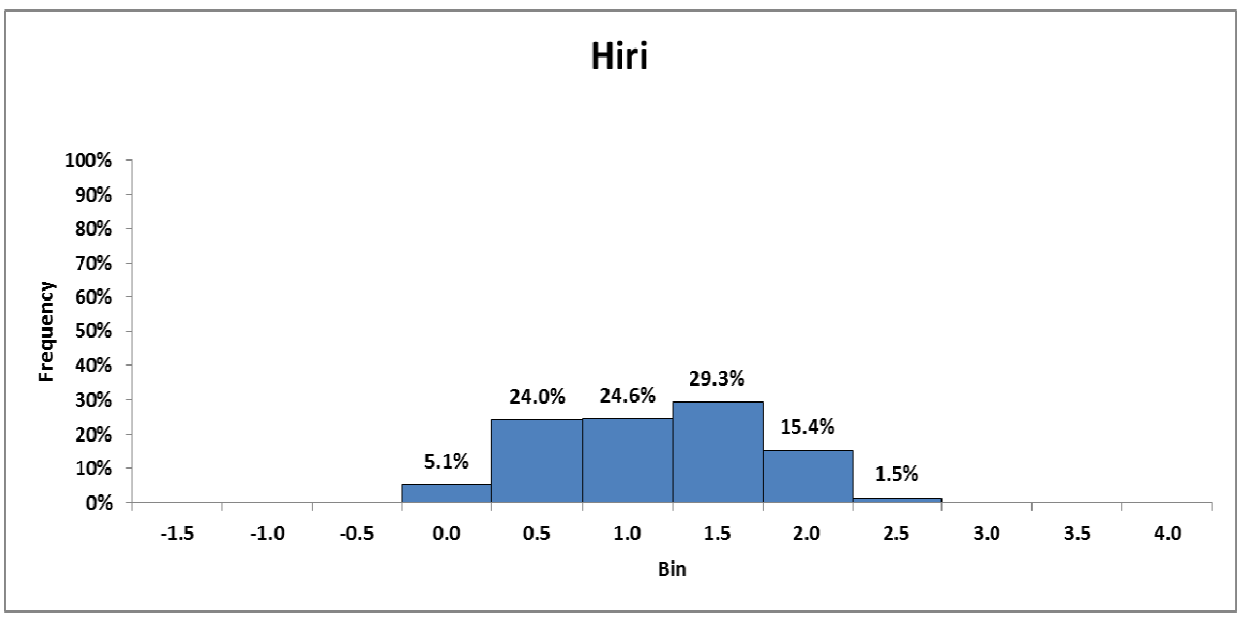


Figure 1.6.31 again confirms that Hiri is significantly outperforming Hides. There has been some marginal improvement but overall the relative positions of communities and households have not dramatically changed. In order to further explore the data, a separate analysis and comparison was made between Division 3 and Hiri. Figure 32 presents the stacked comparison.

Figure 1.6.32. Hides Division 3 versus Hiri 2013 Comparison





Hides Division 3 has a longer period of receiving oil/gas revenues unrelated to the current PNG LNG Project. The stacked comparison shows a somewhat better overlap versus Hiri. Nevertheless, 91% of Division 3 households perform worse than the lowest ranked Hiri household.

- **Comparison of Hides versus Hiri reveals the profound differences between the wealth status of the impact areas.**
- **Hiri significantly outperforms Hides across 90-95% of households.**
- **Hides has a consumable pattern of acquisition versus the durable pattern observed in Hiri.**
- **Potentially changing the pattern of consumable versus durable mentality in Hides is a complex and daunting task.**

While striking, these Hides versus Hiri comparisons are not unexpected. The Project SIA clearly predicted that Hides households would likely spend their money on consumables not durables. As soon as household consumables deteriorate or are consumed households are forced into a replacement cycle. Because there is no maintenance culture in Hides, deterioration in consumed assets – wear and tear, gift, loan, theft etc – means it drives replacement and when there are no more funds they revert back to baseline when they had no such assets.

Based on the current information, the pattern of consumables rather than durables is unfolding as foretold in the Project SIA. Whether the “Hides pattern” is distinct to Hela Province is unknown pending analysis of the Asaro SES survey and wealth analysis. Changing the “Hides pattern” is undoubtedly a daunting task and clearly requires a level of infrastructure and educational investment that can only be performed by government. As discussed in the SIA, “idiomatic changes” such as increased consumables (e.g., store bought food, cell phones, etc.) are not the same as “ideological transformation” an effort that is much harder and longer.

Summary

Overall the wealth analysis shows many positive trends, particularly for Hiri communities. Hides has shown marked improvement; however, the pattern of activity in Hides indicates that long-term sustainability is unlikely as PNG LNG Project moves towards operations. Hiri communities appear to have more diversified economic base and are far more likely to successfully weather the construction wind down and transition to Project operations.

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1.7. PROJECT INDUECED IN-MIGRATION (PIIM)

In-Migration

Project induced in-migration (PIIM) is a critical concern for any large development project. Given the size and magnitude of the PNG LNG Project, there is a natural focus on problems such as pressure on land, health and education infrastructure, housing and food inflation and disturbances in community social cohesion.

The iHDSS has an important, but not exclusive, role in providing objective for analyzing PIIM. iHDSS systematically and regularly collects important demographic and socio-economic data at a household level. In a developing country setting, the iHDSS is the internationally recognized system for gathering and reporting vital statistics.

In conjunction with other PNG LNG activities, the iHDSS data can be utilized to understand whether in-migration is occurring and at what level. The iHDSS data is an important information source that can be utilized to confirm or dispute other information streams such as individual community member interviews and observations made by third party observers.

Within the iHDSS system, in and out migration data is obtained by household surveys. Typically the in-migration data has greater reliability and salience than the out-migration data. This situation occurs because there is often an extremely high rate of "non-response" to the question of why an individual left a household, i.e., marriage, education, illness, personal reasons, etc. The non-response rate for in-migration tends to be far lower and the information is significantly easier to obtain. Household in and out-migration can be crossed checked by sequential comparisons to overall community population. In addition, the iHDSS also collects mortality and birth data. Hence, there is an ability to triangulate the in/out migration data with other objective sources of information. No survey system is perfect and there will always be a level of uncertainty with the data. Therefore, it is important to look at longitudinal trends not just a snapshot in time

The PNGIMR September 2013 report has utilized several data streams for PIIM analysis:

- Core demographic data collected at the household level- population including age and sex, births and deaths
- Formal in/out migration questions including reason(s) for entering or leaving a household/community, e.g., education, employment, marriage, etc.
- Sequential high resolution satellite imagery- structural counts and changes in land use

PNGIMR has established formal iHDSS activities in Hiri, Hides and two matched control sites. This report update is focused on the LNG villages (Hiri) and Hides areas. Data for the control site will be available in subsequent PNGIMR reports.

Hiri (LNG Villages)

The four LNG villages, Boera, Papa, Lealea and Porebada, have had population census surveys performed in 2011 and 2012 by IMR. In addition, a large socio-economic census style survey was completed in 2013.Local reporters follow up households in the HDSS every three months. During these visits the reporters record any in or out migrations, pregnancies, births and deaths. The current analysis includes data obtained from the end of May 2013 survey. The survey data are a snapshot and provide information since the last household survey and do not represent cumulative trend information.

According to the May 2013 survey, there were 145 out migrations and 46 in migrations recorded. The out migration data are shown below in Table 1.7.1.

Table 1.7.1. Out-migration Hiri Villages

Reason for migrating out	Number Females	Number of Males
Work	2	3
Marriage	2	1
Divorced/Separated	2	0
Moving with parents	1	4
Moving with husband/wife	6	2
Don’t know	56	66
Total	69	76

As illustrated by these data, almost 85% of the responses are “don't know;” hence, it is impossible to draw conclusions for out migration from these data. Unfortunately, high non-response rate for out migration is not unexpected.

In-migration data are shown in Figures 1.7.2-4. The non-response rate is significantly lower and these data, although the total numbers are small, still provide somewhat more insight in to the reasons why individuals are moving into the Hiri villages.

Table 1.7.2. In-migration Hiri Villages Male

Reason for migrating in/return	Boera	Porebada	Papa	Lealea	All
Work	1	0	0	0	1
Education	1	0	0	0	1
Marriage	1	0	0	1	2
Moving with parents	4	1	3	0	8
Moving with husband/wife	1	0	0	0	1
Others	0	0	1	0	1
Don’t know	1	0	0	0	1
Total	9	1	4	1	15

Table 1.7.3. In-migration Hiri Villages Female

Reason for migrating in/return	Boera	Porebada	Papa	Lealea	All
Education	0	1	0	0	1
Marriage	5	0	2	1	8
Death of spouse	1	0	0	0	1
Moving with parents	4	3	2	0	9
Moving with husband/wife	1	1	0	0	2
Others	5	0	1	0	6
Don’t know	1	0	1	2	4
Total	17	5	6	3	31

Table 1.7.4 In-migration by Village (all sexes combined)

Reason for migrating in/return	**Boera**	**Porebada**	**Papa**	**Lealea**	**All**
Work	1	1	0	0	2
Education	6	0	2	1	9
Marriage	2	0	0	1	3
Moving with parents	8	4	5	0	17
Moving with husband/wife	2	1	0	0	3
Others	5	0	2	0	7
Don’t know	2	0	1	2	5

Total	**26**	**6**	**10**	**4**	**46**
Pct Increase from 2012 Population	**1.5%**	**0.1%**	**0.6%**	**0.1%**	**0.4%**

As illustrated by these data, in-migration tends to be driven by family considerations, i.e., moving with parents and educational opportunities. The schools within the Hiri LNG villages have functional schools including secondary educational opportunities.

Overall the mid-May 2013 survey data do not demonstrate that significant in-migration is currently a major event. This does not mean that in-migration has not occurred; rather, at present, the flow of out versus in-migration is trending towards outward movement.

Yearly population data are also considered when evaluating longitudinal trends. Table 1.7.5 presents the 2011 to 2012 Hiri village census data. Census data was collected in 2011 and then one year later as part of the standard iHDSS protocol.

Table 1.7.5 Longitudinal Hiri Village Population Data

Village	2011 pop	2012 pop	Net change	2012 % Rate	2000-2011 % rate	2011-2012 % Difference
Boera	**1733**	**1781**	**48**	**2.7%**	**2.7%**	**0**
Papa	**1675**	**1728**	**53**	**3.1%**	**5.7%**	**(2.6%)**
Porebada	**5109**	**5530**	**421**	**8.2%**	**1.3%**	**6.9%**
Lealea	**3014**	**3109**	**95**	**3.1%**	**4.3%**	**(1.2%)**

The Table 1.7.5 data indicate that, with the exception of Porebada, population growth in the Hiri villages is clearly slowing. The cause of the upsurge in Porebada is unknown and could be do to a combination of factors: (i) survey underestimation—Porebada has dense housing and miscounting is possible, (ii) a true influx and (iii) a combination of factors including work related drivers. Porebada is the Hiri village farthest from the LNG construction site and historically has

the lowest LNG related employment levels. Porebada is geographically close to the Konebada Petroleum industrial area which may be impacting population movement.

The other LNG villages are clearly trending towards a more typical “natural PNG growth rate of 2.7%. As shown in Table 1.7.6, the decline in overall growth rate in Boera, Papa and Lealea is confirmed by analyzing the birth and death rates per thousand population across the four villages. The Porebada data shows a marked negative imbalance in births versus deaths implying that the 2012 absolute population growth is either true influx or influx plus historic underestimation errors. Table 1.7.6 data indicate a “birth boomlet” in Boera with an above-expected net rate in Lealea.

Table 1.7.6. Natural Rate of Increase 2012 Data (per 1000 people)

	All	Boera	Porebada	Papa	Lealea
Births/1000 population	12.3	42.7	2.0	4.6	17.7
Deaths/1000 population	9.6	10.1	10.7	5.8	12.5
Rate of natural increase from 2012 (per 1000 people)	2.7	32.6	-8.7	-1.2	5.1

	All	Boera	Porebada	Papa	Lealea
Births	150	76	11	8	55
Deaths	117	18	59	10	39
Total pop	12148	1781	5530	1728	3109

Overall the in-migration and population data paint a complex picture that is best analyzed at an individual village level rather than combining data across all villages. The overall Hiri natural rate of increase per thousand population is exactly as expected; however, this masks significant individual village differences.

Along with household level survey data, the PNG LNG Project has collected Hiri village sequential satellite imagery since 2008. The most current round of satellite imagery was in the second quarter of 2013. Imagery data have been longitudinally analyzed and are presented in the next section.

In-migration: Structure analysis

Additional remote sensing imagery for the Hiri region of PNG was obtained in May 2013. With the addition of these data, the change in the number and location of structures in the Hiri LNG villages can be sequentially analyzed over 5 years using imagery from three time periods: Q1 of 2008, Q1 2012 and Q2 2013. Figures 1-5 show the structures and their creation date for Kido, Lealea, Papa, Boera and Porebada. Kido is considered to be an “LNG village” for this analysis as it falls within 5 kilometers of the offshore pipeline. However, Kido is not part of the iHDSS. And is not connected by a land route to the other villages.

Figure 1.7.1 Kido Structures Over Time

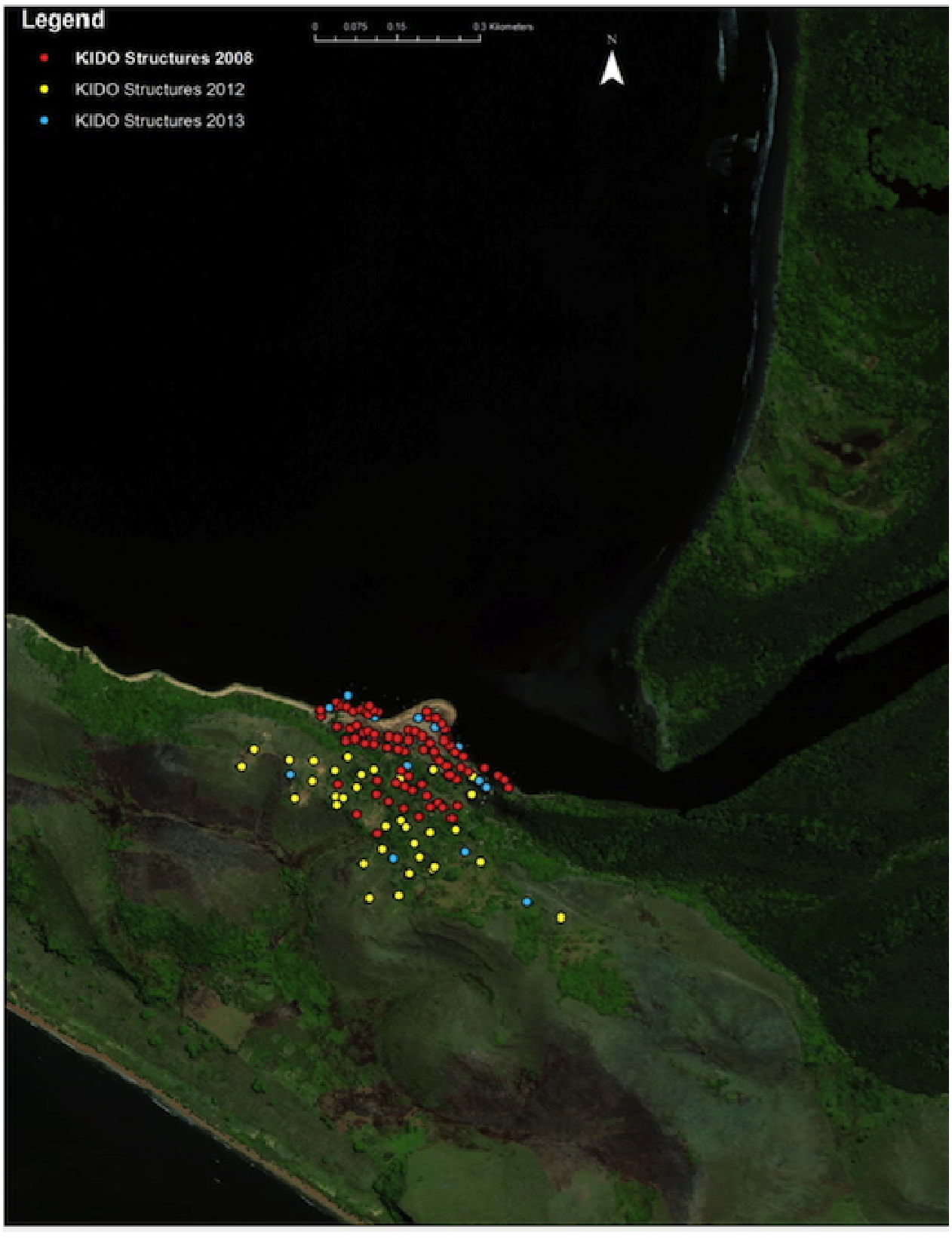


Figure 1.7.2. Lealea Structures Over Time

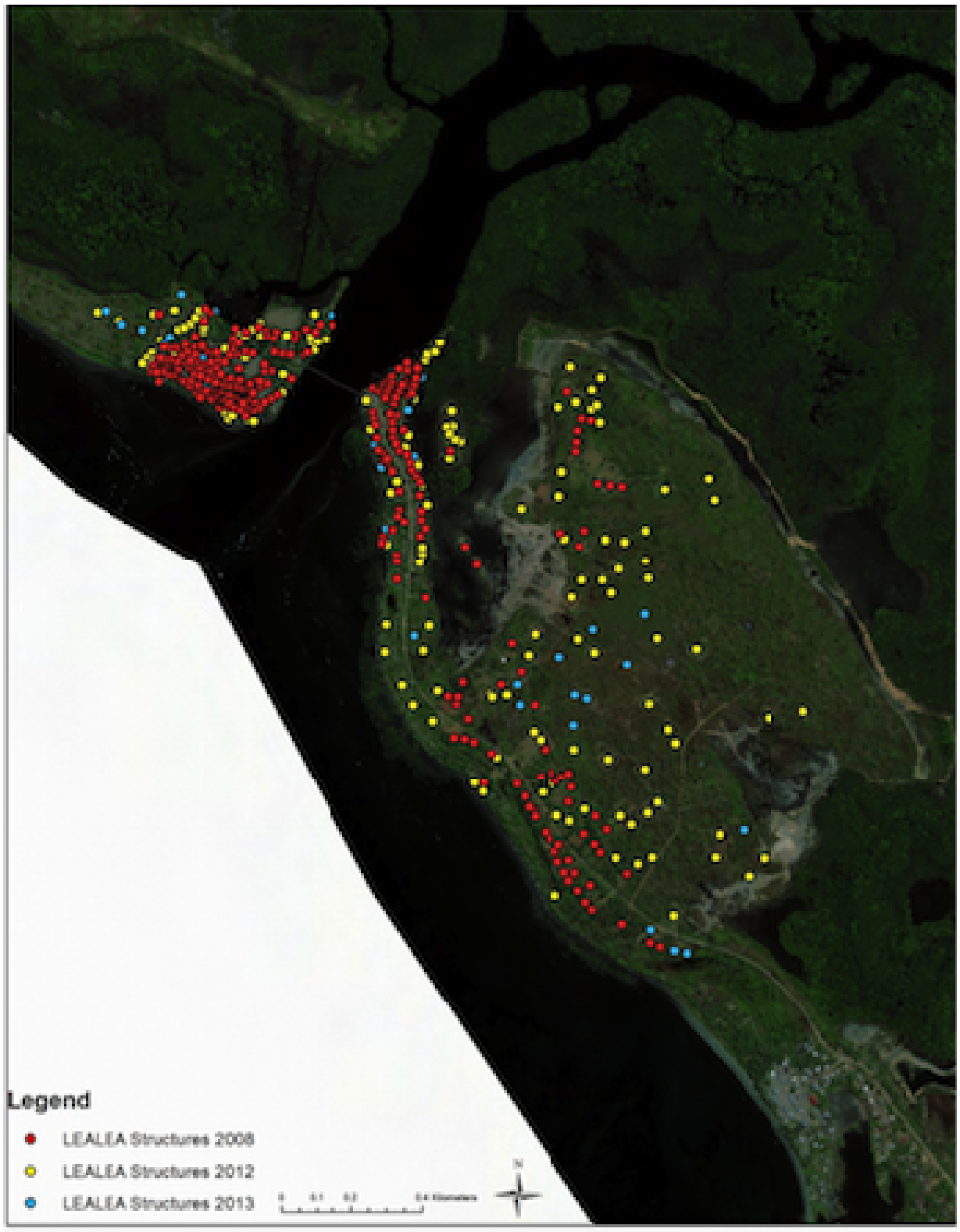


Figure 1.7.3. Papa Structures Over Time

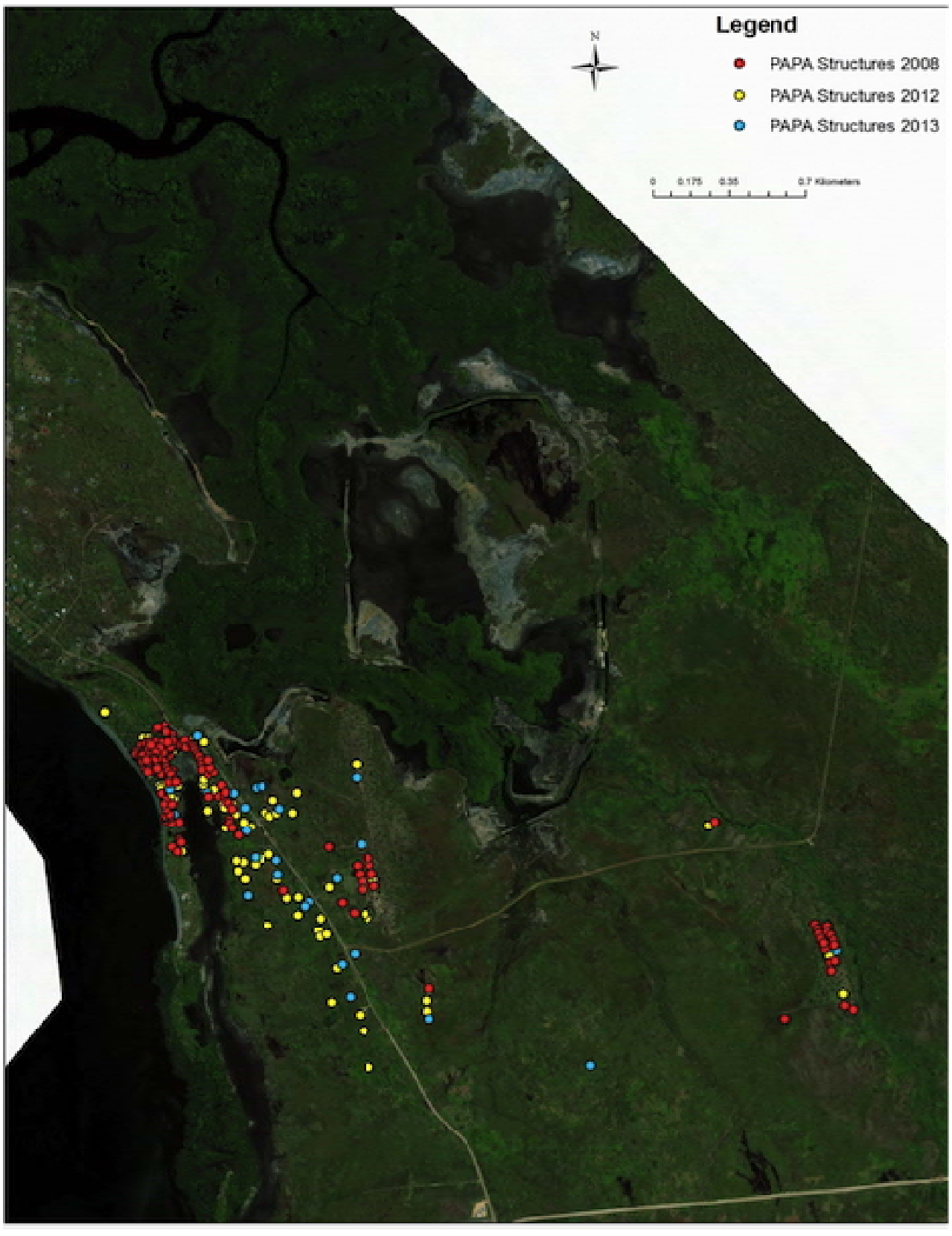


Figure 1.7.4. Boera Structures Over Time

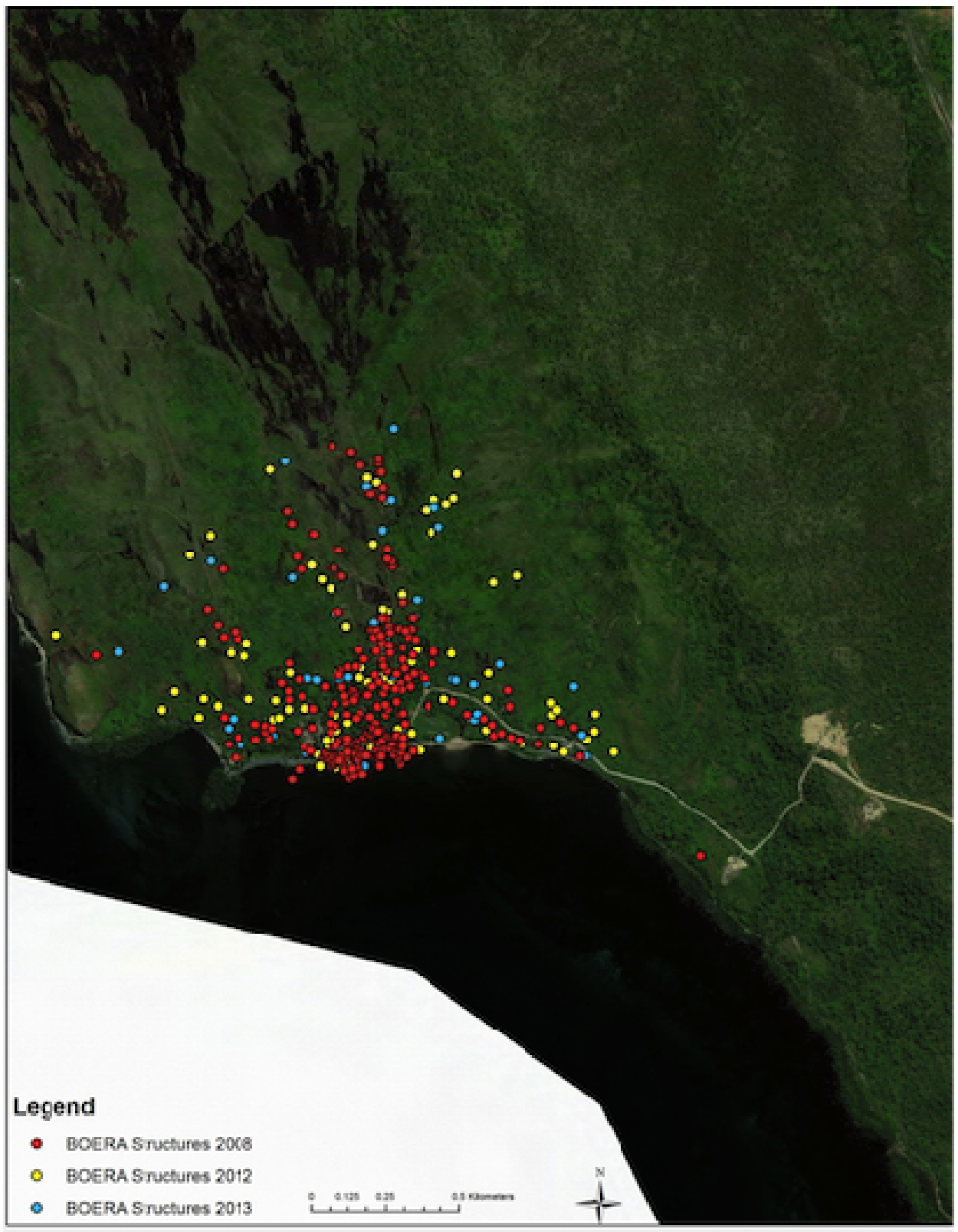
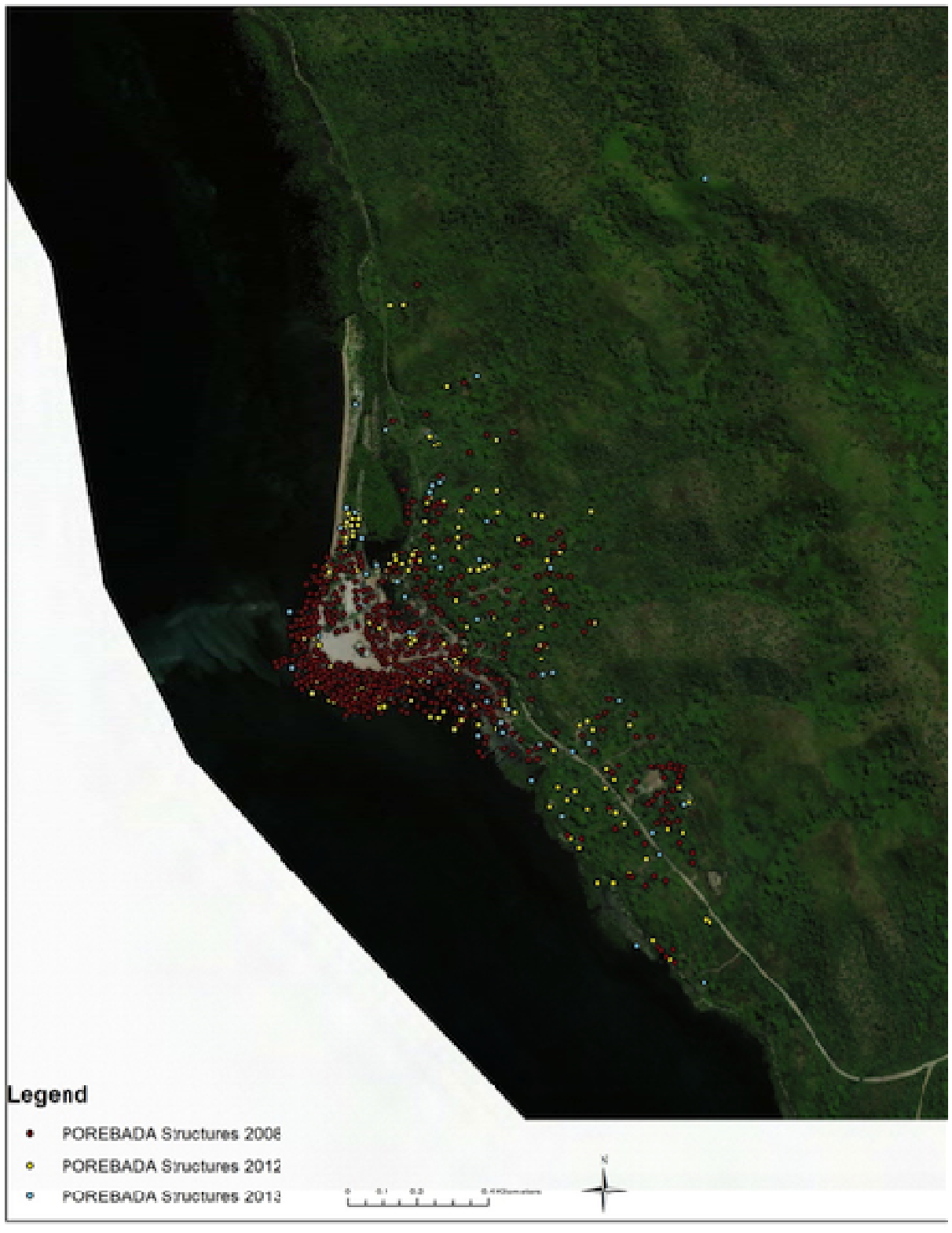


Figure 1.7.5. Porebada Structures Over Time



As the maps in Figures 1.7.1-5 show, there is increasing number of structures from 2008 to 2012 and from 2012 to 2013. The counts and percent change of structure by year identified are summarized in Table 1.7.7. Because these images were collected at different period of the year, the average quarterly change in structures is also included. Percent change is used to

normalize the data across villages. Without detailed ground truthing, “structures” cannot be further identified as habitable (households), small businesses, sheds, etc. A standard or “typical” housing growth rate for PNG is extremely difficult to define. Rural housing is typically constructed using “bush materials” while in an urban setting more complex construction using purchased materials would be anticipated. Housing growth rates over 2% exceed typical urban/peri-urban growth rates and potentially imply an accelerating organic expansion of population (increased fertility rate) and/or influx of new households.

Table 1.7.7. Count of Structures by Year

	Q1 2008	**Q1 2012**	**Q2 2013**	**2008-2012 Pct. Change**	**2012-2013 Pct. Change**	**2008-2012 Quarterly change**	**2012-2013 Quarterly change**
Kido	75	101	114	34.7%	12.9%	1.8%	2.0%
Lealea	279	411	443	47.3%	7.8%	2.3%	1.3%
Papa	135	204	231	51.1%	13.2%	2.5%	2.1%
Boera	222	289	327	30.2%	13.1%	1.6%	2.1%
Porebada	561	675	730	20.3%	8.1%	1.1%	1.3%

Table 1.7.7. demonstrates that structure growth has been uneven across the 5 villages. While Lealea experienced strong growth from 2008 to 2012, this rate has declined when comparing sequential 2012 to 2013 data. These data are consistent with the overall population growth rate observed from 2011 to 2012 and the in/out migration data. Porebada’s growth rate remains largely unchanged and is inconsistent with the apparent population jump observed from 2011 to 2012, implying undercounting as a potential explanation rather than a true growth surge. Interestingly, the growth rate of Boera has increased, while those of Papa and Kido have stayed at or above 2%. These relatively high growth rates may in part be explained by the fact that the initial counts of structures were low, i.e., the starting base denominator is small. For instance, Kido had an increase of nearly 35% from 2008 to 2012 in structures, yet this only

amounts to a total increase of 26 structures. Boera has also clearly experienced a birth boom as previously shown in Table 1.7.6.

Just as important as *how many* structures are being erected is *where* these structures are being built. An analysis of the location of the new structures may provide insight on the need for a local managed growth plan. For instance, an increase that occurs primarily in the already densely populated areas of the village of concern could mean that the burden on fragile water and sanitation services and supplies is critical. An increase in structures outside of the dense population areas may simply indicate an accelerating growth in areas where land is actually available. Land tenure in PNG is overwhelming based on customary rights; hence, land acquisition and housing expansion requires agreement by existing landowners, a prerogative that is zealously guarded and enforced. The development of uncontrolled squatter housing is virtually impossible. The imagery demonstrates *no evidence* of squatter settlement development.

Figures 1.7.6-10 show each village with red polygons delineating areas with a high density of structures. These polygons were based on the distribution of structures as detected by the 2008. While the polygons are arbitrarily defined, it represents an important first step in looking at the growth rate of developable land. A more focused study based on the work of Faith Karanja and Peter Lohmann's paper entitled "Using Developable Land Units as an Indicator of Rate of Growth of an Urban Area," would allow for a more accurate and refined estimate regarding the effects of an increasing growth rate on the village environment.

Figure 1.7.6. Kido 2008 Structures and Density Delineation

Figure 1.7.7. Lealea 2008 Structures and Density Delineation

Figure 1.7.8. Papa 2008 Structures and Density Delineation

Figure 1.7.9. Boera 2008 Structures and Density Delineation

Figure 1.7.10 Porebada 2008 Structures and Density Delineation

Using the delineations provided by the above figures, it is possible to determine whether a given structure is located within or outside a densely built area. Table 8 shows the results of this analysis.

Table 1.7.8. Structure Count by Density Delineation

	2008		2012		2013	
	Total Structures	*Pct. of Structures Not in Dense Region*	*Total Structures*	*Pct. of Structures Not in Dense Region*	*Total Structures*	*Pct. of Structures Not in Dense Region*
Kido	75	6.7%	101	31.7%	114	31.6%
Lealea	279	5.0%	411	23.4%	443	26.0%
Papa	135	11.1%	204	27.9%	231	33.8%
Boera	222	13.5%	289	20.4%	327	22.9%
Porebada	561	2.1%	675	4.1%	730	5.5%

With the exception of Porebada, the number of structures outside of the density polygons has dramatically increased since 2008. Both Kido and Papa have roughly one-third of their structures occurring outside of the developed zone, while Lealea and Boera have approximately one quarter of their structures outside the developed zones. While these numbers demonstrate a significant increase, Figures 1.7.6-10 illustrate that they still represent a small amount of the available land for each village. Additional research would be needed to determine what percent of developable land is being used and how it has changed over time.

Porebada's lack of structures outside of the density delineators is striking. Only a small fraction of the 169 new structures erected over the past 5 years have occurred outside of this zone. The density of housing coupled with the apparent population "surge" seen in 2012 is striking. Continued monitoring could be considered in order to document whether a growing population living in an increasingly dense area adversely impacts water and sanitation. Additional survey work in Porebada may be considered by the iHDSS in order to clarify population dynamics.

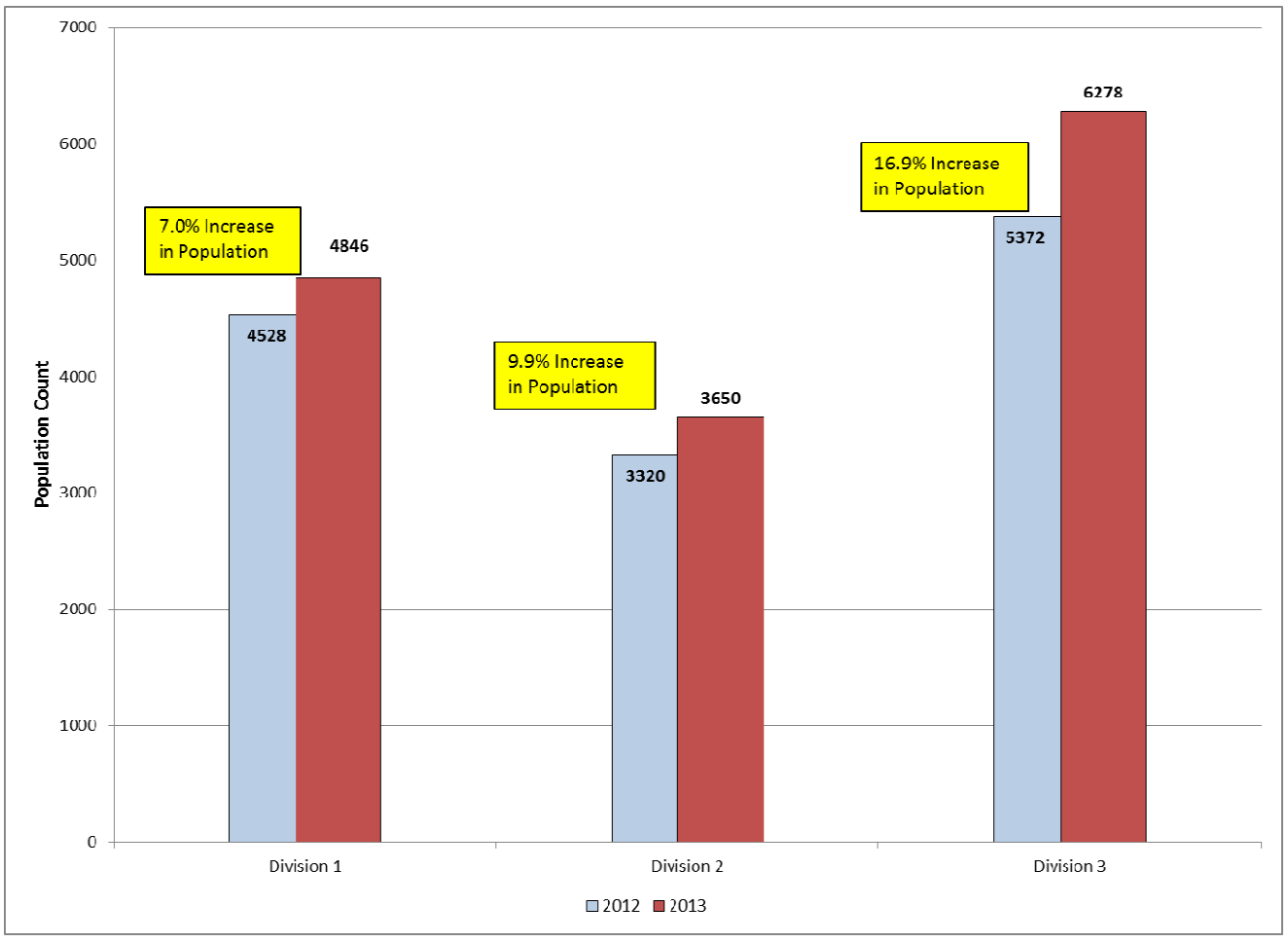
Summary Hiri

Overall, the different lines of data, e.g., surveys and satellite imagery, indicate that the four iHDSS villages are likely stabilizing in terms of population growth and land use trends. The impact of the PNG LNG project in Boera, Papa and Lealea is quite likely and is also confirmed by the wealth analysis data. The situation in Porebada is more complex. Structure and wealth analysis indicate low PNG LNG impacts. Historic population data also do not indicate significant in-migration in Porebada; however, the 2012 population data indicate a likely adult population influx. Further Porebada evaluation may be appropriate; however, it seems unlikely that the PNG LNG is the main driver of change in Porebada based on other lines of accumulated evidence, e.g., wealth and structure analysis, distance from LNG Project and LNG-related employment trends.

Hides/Komo (HGCP site)

The three divisions of Hides each have different makeups regarding population size and structure. Figure 1.7.11 shows the population distribution by division of Hides/Komo over two years: the 2012 initial data and the 2013 census update. There has been a substantial increase in the population count for each division, particularly for Division 3. This population increase is potentially related to the substantial economic activity associated with the PNG LNG.

Figure 1.7.11. Hides /Komo Population Count by Division over Time



Figures 1.7.12-14 show the population pyramids for each of the divisions the 2013 census. The large percentage of males age 25-29 in Division 3 may be an indicator of employment-induced in-migration, as work on the HGCP is likely the largest source of employment in the area. Komo airfield work has been completed and significant demobilization has occurred in 2013.

Figure 1.7.12. Hides Division 1 Population Pyramid

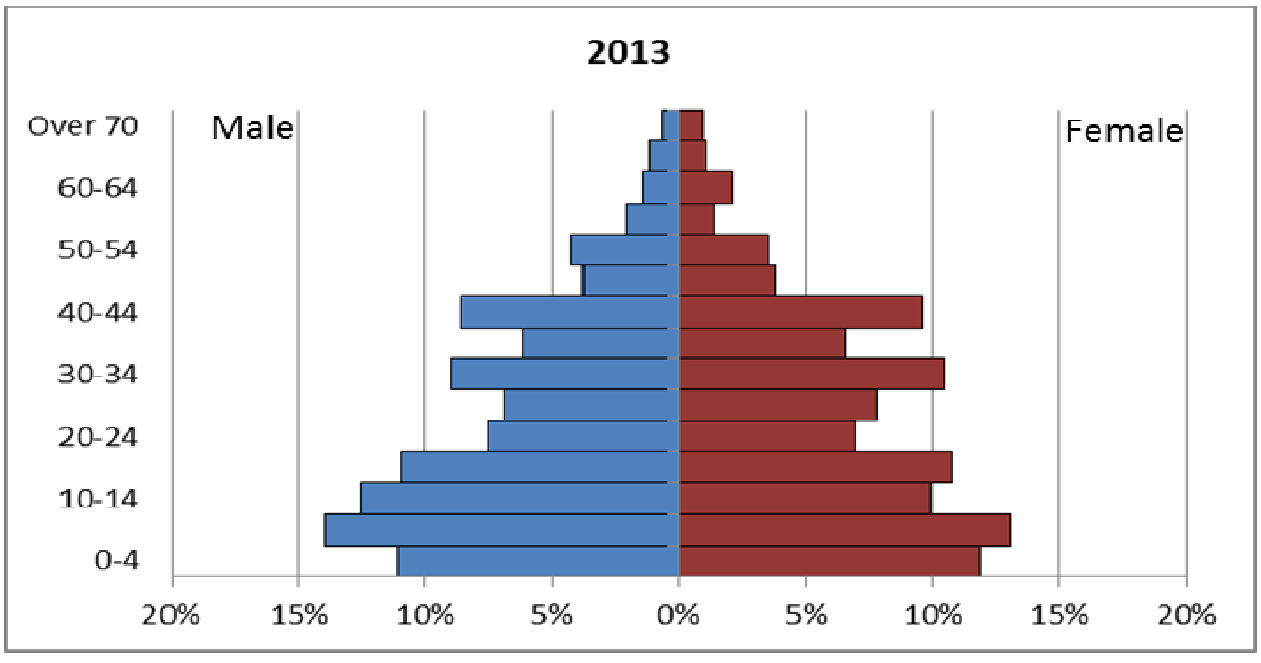


Figure 1.7.13. Hides Division 2 Population Pyramid

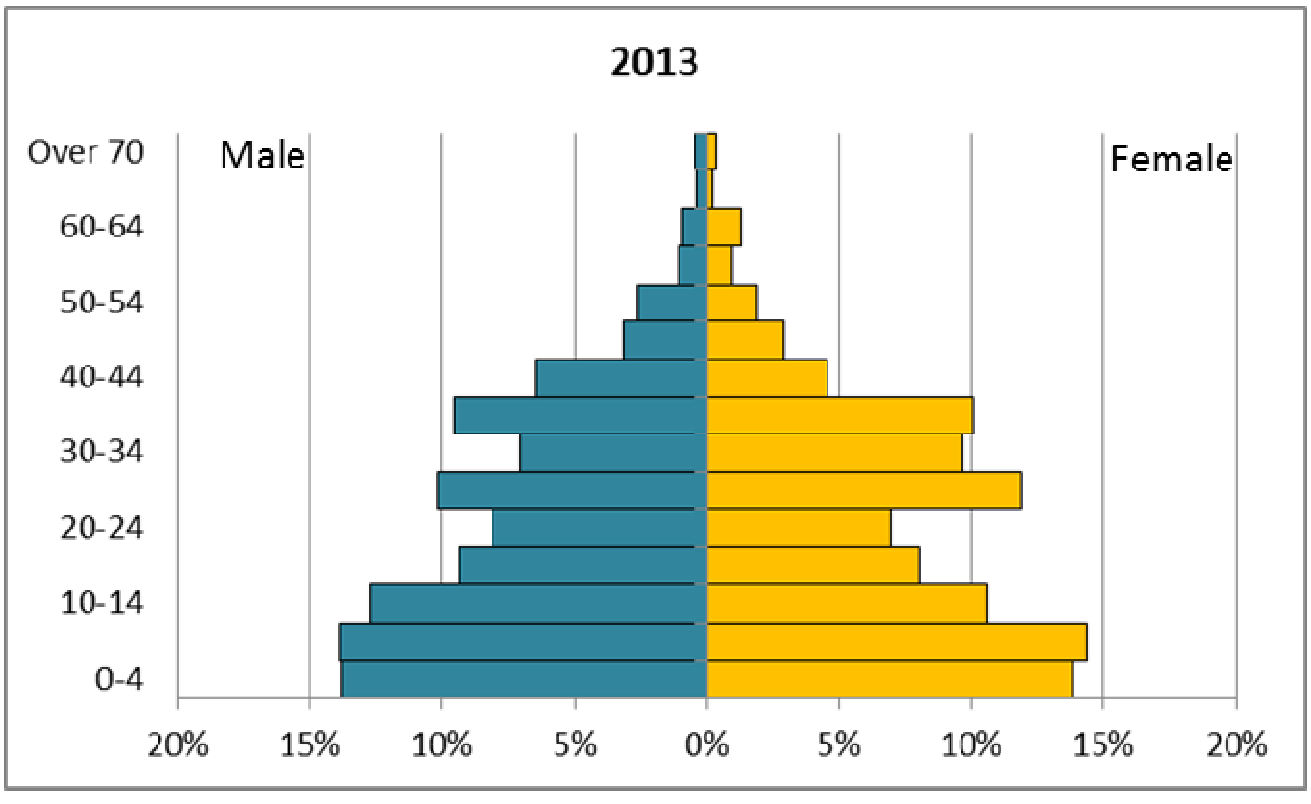
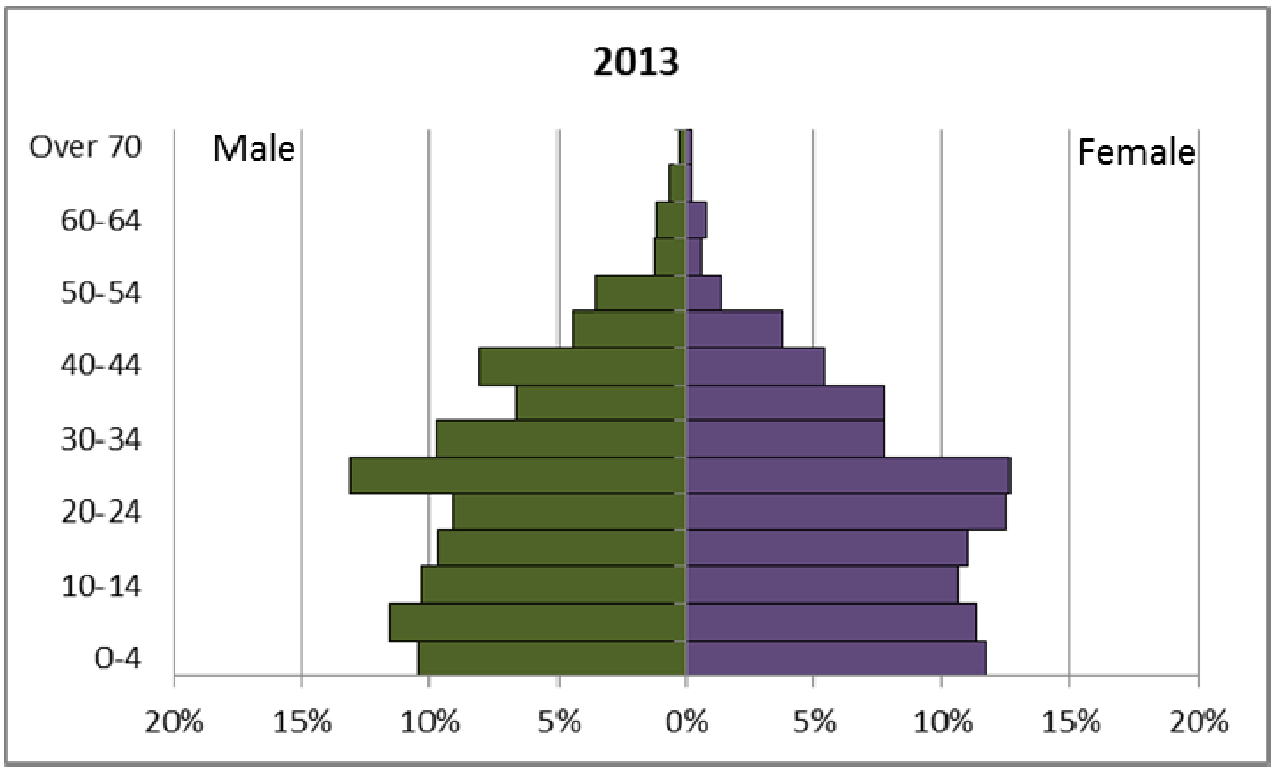


Figure 1.7.14. Hides Division 3 Population Pyramid



Each of the Hides Divisions has more males than females, a pattern also observed by the Hiri iHDSS. Table 1.7.9 shows the counts and sex ratios for all three divisions. Divisions 2 and 3 have high proportions of males. Division 1, which is not as close to the Komo Airfield or HGCP, has a sex ratio that is much closer to being even. The differences in sex ratios may reflect some level of PIIM.

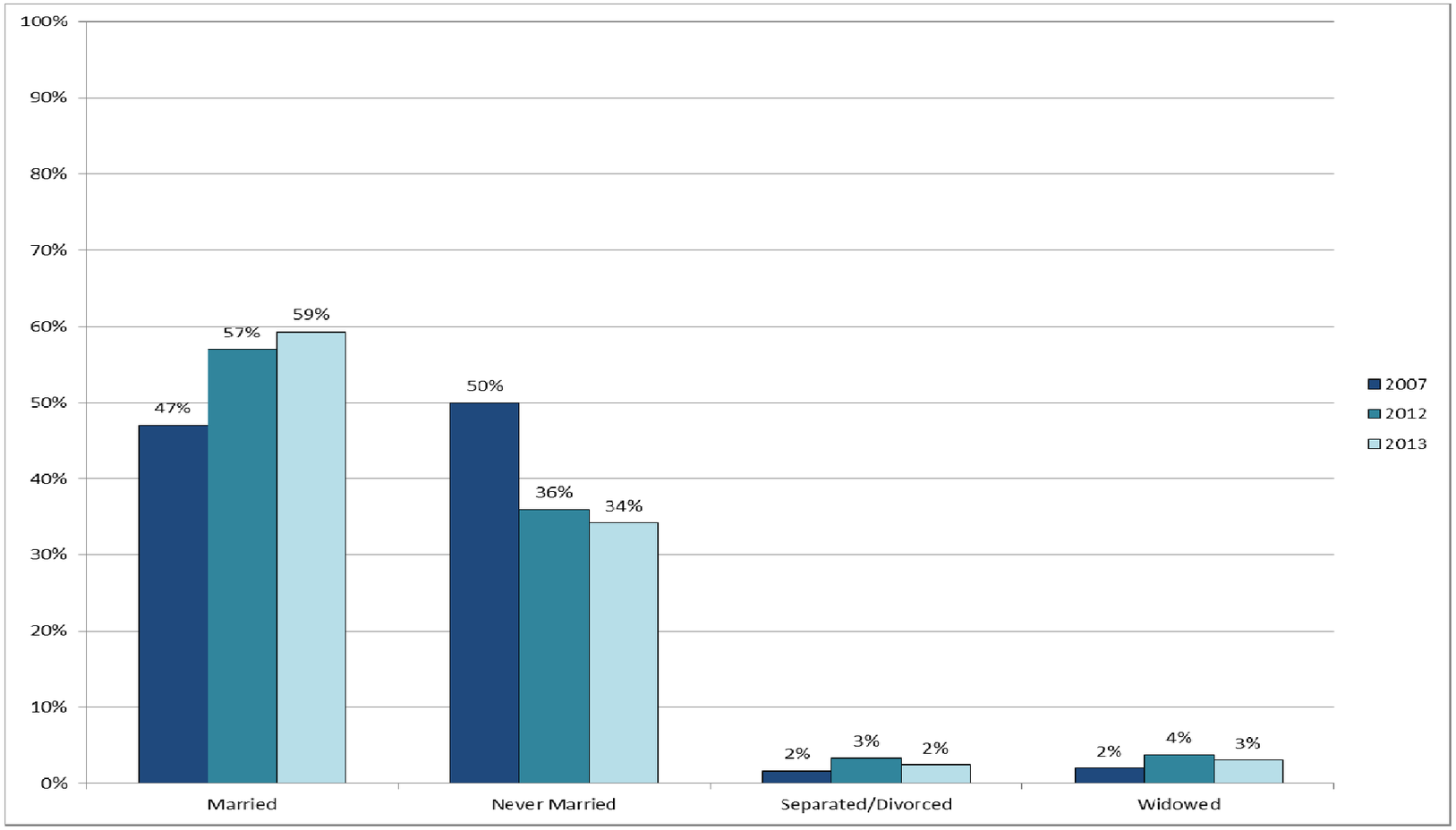
Table 1.7.9. 2013 Hides/Komo Population and Sex Ratio by Division*

	Male	Female	Sex Ratio (Male/Female)
Division 1	2440	2368	**103.0**
Division 2	1890	1735	**108.9**
Division 3	3290	2964	**111.0**

*Those records where gender has been omitted have been excluded from table

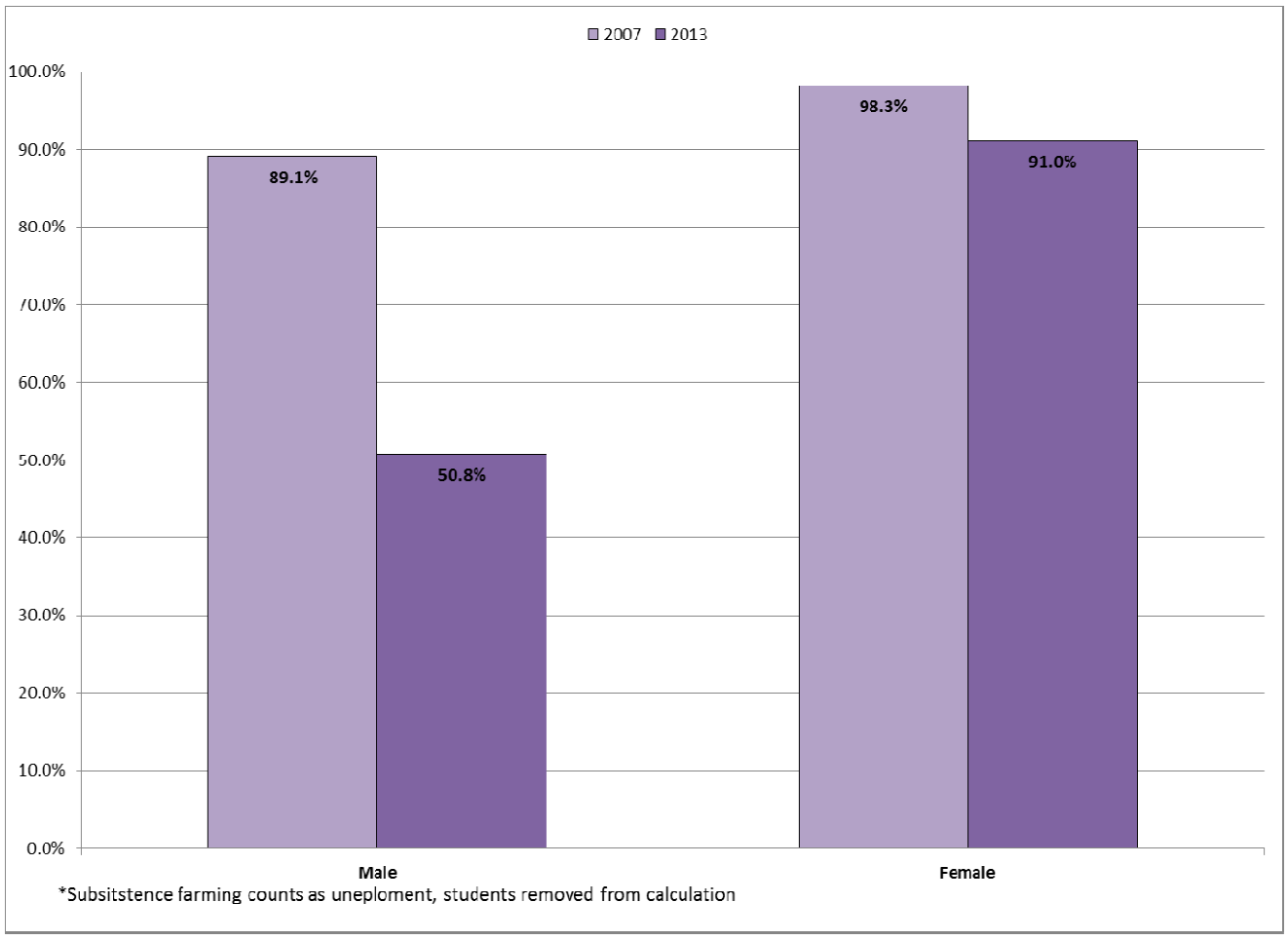
The distribution of marital status by time period is shown in Figure 1.2.6. All three divisions show similar rates of marriage. Marriage rates have increased substantially from 2007 to 2013; although the trend has appeared to slow significantly from 2012 to 2013. Many Huli practice polygamy and take on more wives as their wealth increases. Anecdotally, this observation has been frequently reported to 3rd party observers. Further survey work is needed to better evaluate this issue.

Figure 1.7.15. Hides/Komo Marital Status Over Time



Employment status by sex is examined in Figure 1.7.16. Those people in the cohort with these responses were considered unemployed: (i) unemployed, (ii) subsistence farming, and (iii) home duties. There was a nearly 40-percentage point drop in the male unemployment rate from the SIA conducted in 2007 to Census update in 2013. Over the same time period, there was over a 7-percentage point decrease among females. In Huli culture, employment is much more likely to be concentrated among men with women focused on domestic affairs and gardening.

Figure 1.7.16. Employment Status for Adults by Sex



Given the substantial decrease in male unemployment, Figure 1.7.17 compares the percentage of males by employment type (as asked by the census) and Division. The high percentage of workers that fall into “Labourer in mining, construction, and transport” category in Division 3 is likely because of its proximity to the HGCP construction activity. Similarly, the higher count of plant and machine operators and assemblers is likely due to the proximity of the Komo Airfield.

Figure 1.7.17. Male Employment by Type: 2012-2013 Comparisons

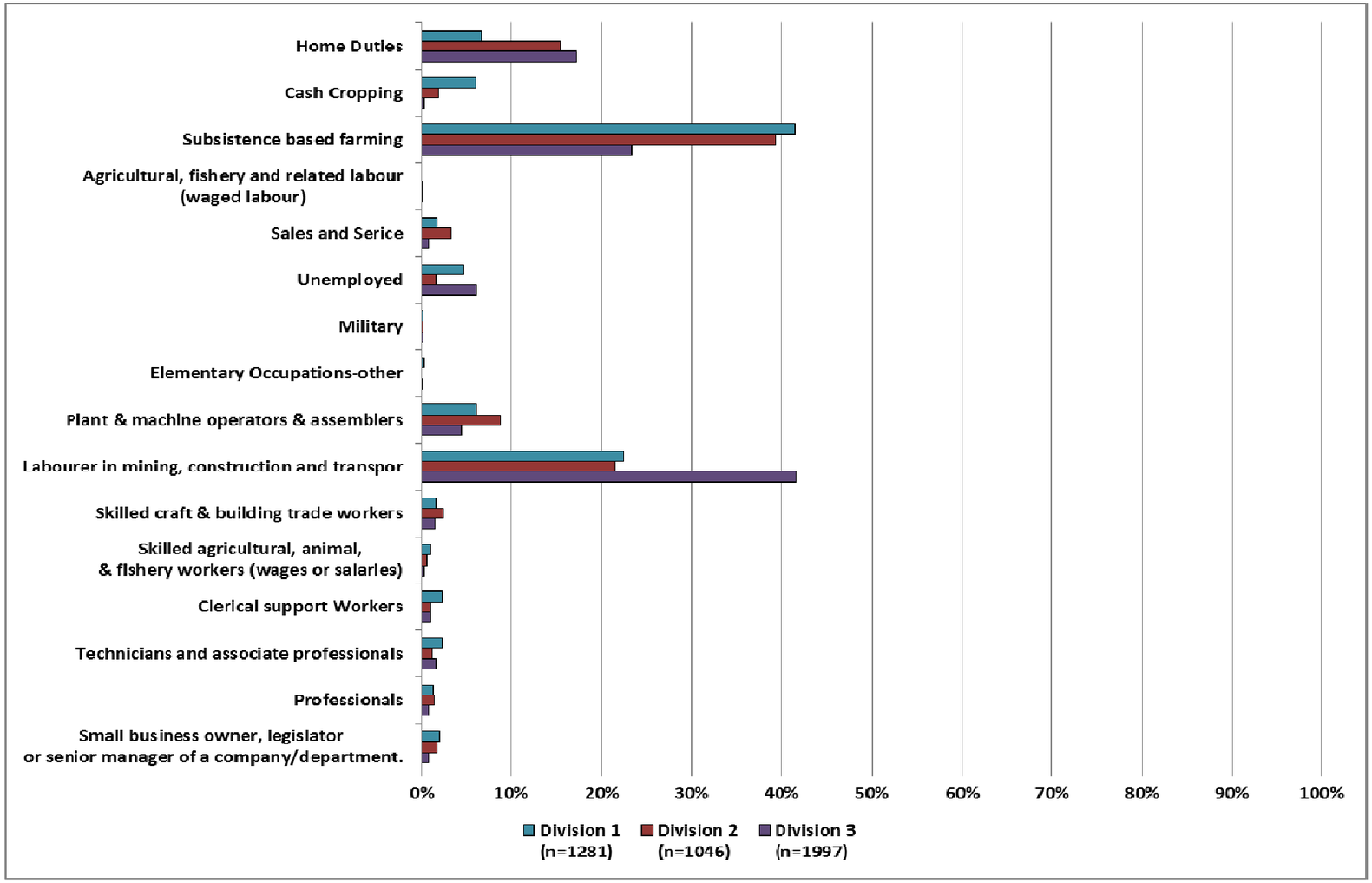
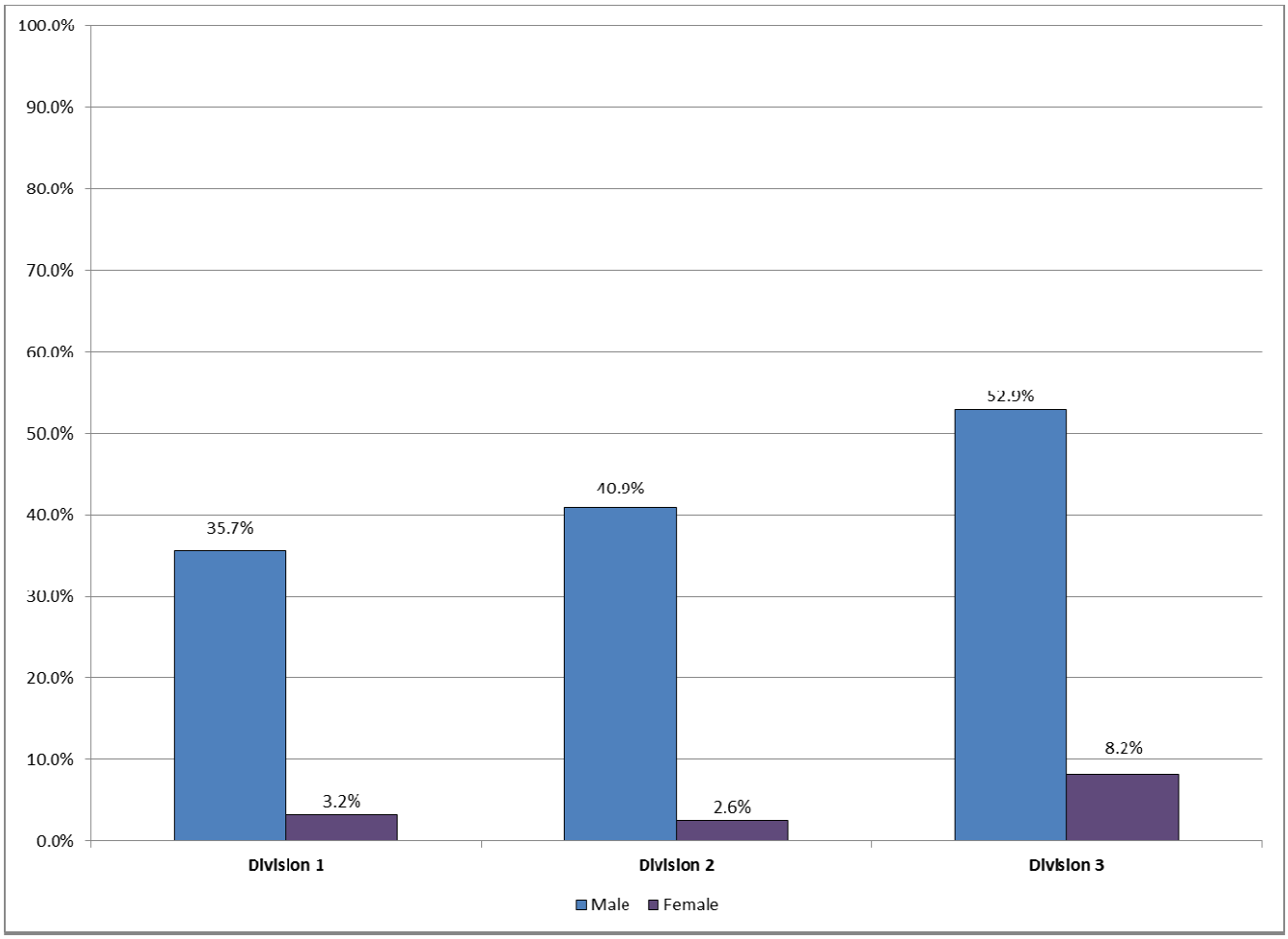


Figure 1.7.18 shows the percentages of residents employed by division and sex. Residents who responded either as student, not relevant, or don't know to the question regarding their occupation were excluded from the equation, as these residents are likely to be children under the age of 15. The two divisions closest to the LNG project (Divisions 2 and 3) have the highest percentage of workers employed by the project. Over 50% of males in Division 3, and 40% of males in Division 2, are employed by the LNG Project. Most women do not work for the LNG project; however, the largest female working cohort is in Division 3, and likely a result of its close proximity to HGCP construction.

Figure 1.7.18. Percentage of Residents Employed by LNG Project by Sex and Division

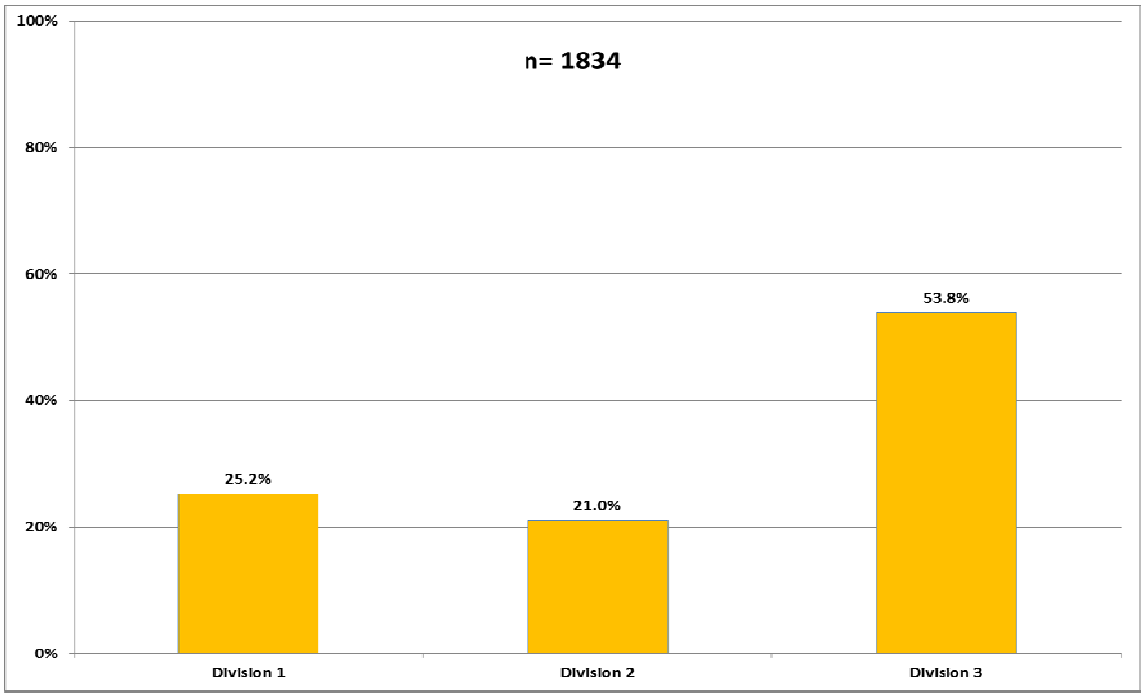


In-Migration Hides

Two surveys, the initial 2012 census data and the 2013 update were reviewed and compared. Within the surveys, each person is given a unique ID that is the same in both files. Using this ID, it is possible to determine who from the 2013 file is also in the 2012 file. It is assumed that if a person is in the 2013 file but not in the 2012 file, that they are a "new resident" of a specific surveyed Hides division. A new entrant can be through birth or via in-migration.

There were 1834 in-migrants in 2013. This represents 13.9 percent of the overall all combined 2012 divisional population. The 2012 population was 13,220. Figure 20 illustrates the distribution of these "entrants" by percentage across each division. Division 3 dominates the percent distribution with slightly over 50% of the total. The absolute numbers by division are shown below Figure 20. Absolute numbers are more meaningful than percentages as the local communities and households absorb a true number not a relative percent.

Figure 1.7.19. New Entrants by Division- Distribution of the Increased Total by Percent



Division 3 increase **972** people; Division 2 increase **385** people; Division 1 increase **457** people

The age and sex breakdown of “entrants” is presented in Figures 1.7.20 and 21. As illustrated in these figures, greater than age 16 year olds account for a significant percentage of the total, particularly for Division 2 and 3. However, as shown in Figure 1.7.21 new entrants are not simply young males as the percentages of males and females are extremely close.

Figure 1.7.20. New Entrants by Age Range and Division

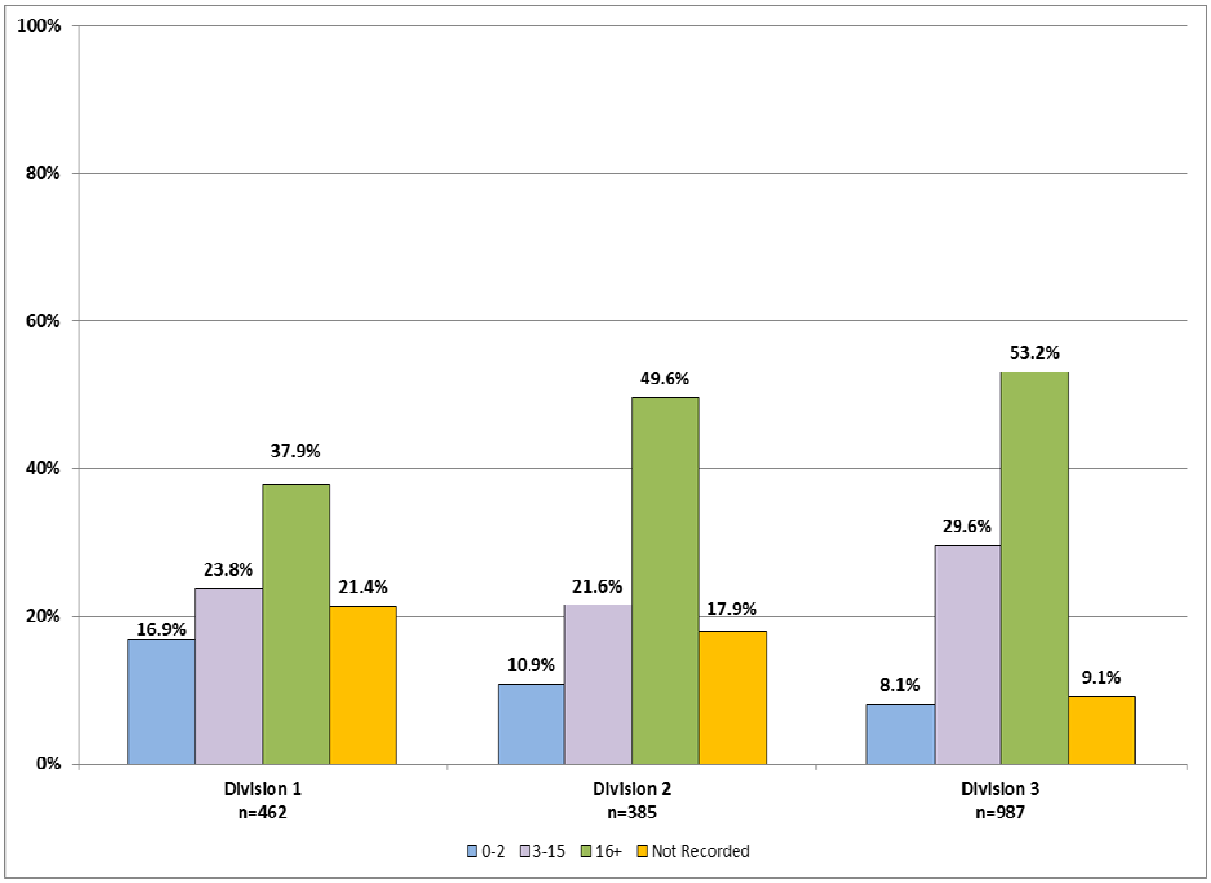


Figure 1.7.21. New Entrants by Sex and Division

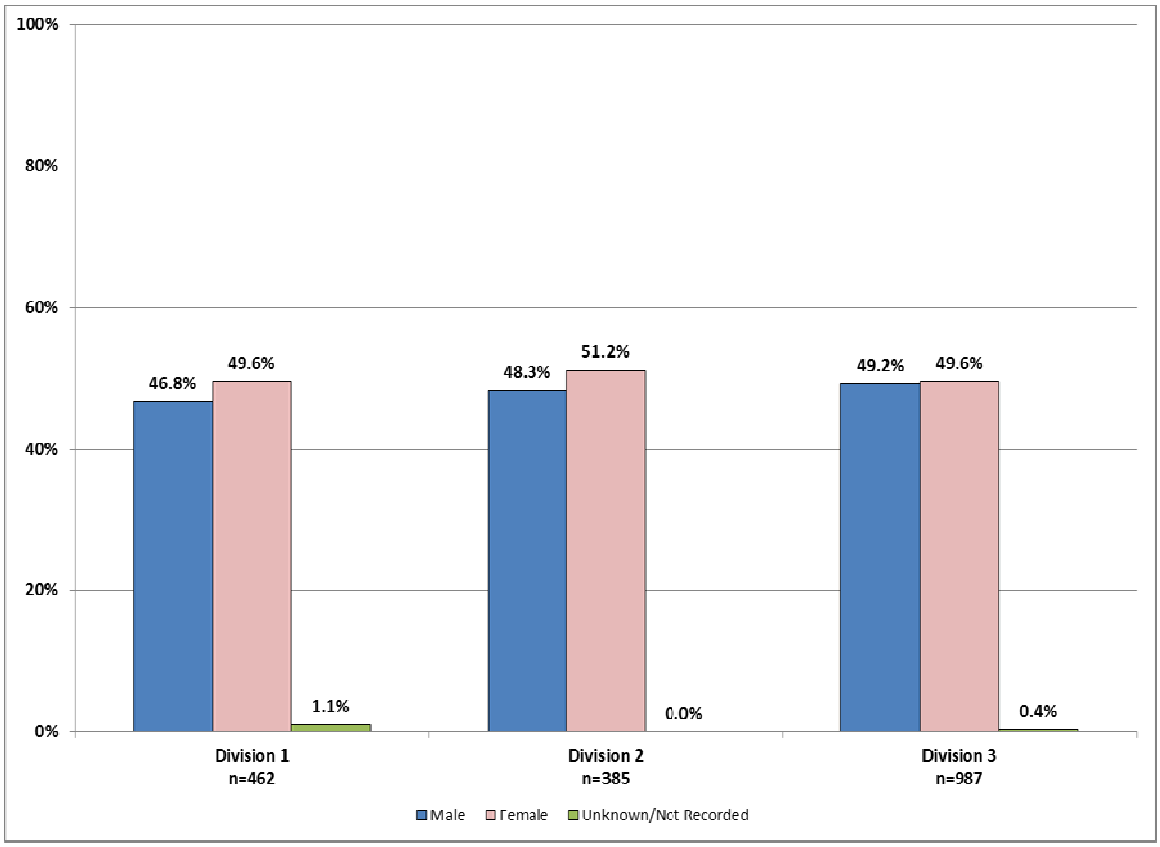
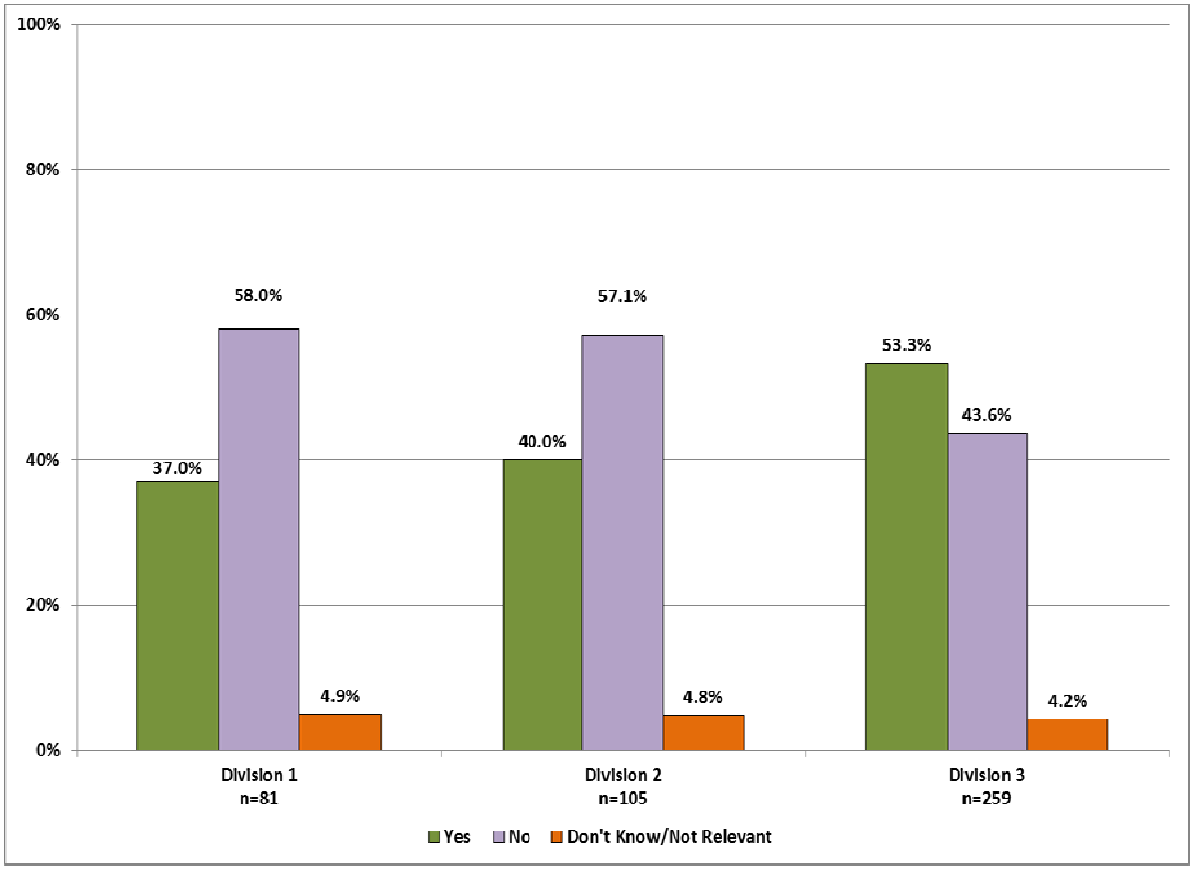


Figure 1.7.22. presents the entrants data sorted by LNG employment and per division. As show in Figure 1.7.22., the LNG employment varied by division. Division 3 had the highest LNG employment for new entrants at 53%. Not surprisingly, Divisions 2 and 3 had much lower levels of LNG employment.

Out-migration data are not shown as the non-response rate was 97%; therefore, theses data are not meaningful.

Figure 1.7.22. New Entrants by LNG Employment (for males age 16+ i.e, working age males)



Summary In-migration

Overall, the in-migration (new entrant) data are consistent with the observations made in the March 2013 PIIMs Report. As noted in this report, IFC estimates extractive industry in- migration often adds 10–15% over the annual national average 2–3%. Moreover, PIIMS survey/analysis per Dr. L Goldman established above that the pre-project rate of 'movement' was in the range 7–14%. As also noted by Dr. Goldman, in-migrants (or entrants) in Hides are often multi-local residents, i.e., they come and go as they have alternative residences outside the immediate survey area. In Hides, there is a constant shifting between locales in Huli geography but with greater 'velocity' of movement because of the project attractions.

CHAPTER 2. TUBERCULOSIS RESEARCH IN KIKORI

Dr. Gail Cross, a physician from Australia, recorded clinical information into the study form after examining a TB patient.

SUMMARY

The incidence and characteristics of tuberculosis (TB) in remote areas of Papua New Guinea (PNG) are largely unknown. The purpose of the PiHP sponsored study was to determine the incidence of TB in the Gulf Province of PNG and describe disease characteristics, co-morbidities and drug resistance profiles that could impact on disease outcomes and transmission. The Kikori location had been an active PNG LNG Project area early phases of construction. The PNG LNG Project 2008 Health Impact Assessment noted that Kikori Hospital had an unusually high burden of active TB cases. This observation was confirmed during construction, as there were a significant number of active TB cases during pre-employment screening and workforce monitoring. In addition, there is a well-known and active “trade-route” between Kikori area and the LNG (Hiri) village of Lealea. While active PNG LNG Project construction has been completed, there was continued concern by the Project that the Kikori area had a large and unmanaged TB problem that could significantly impact both long-term operations and present a critical threat to public health in PNG. Therefore, the PNG LNG Project requested that PNGIMR undertake a TB investigation and evaluation in Kikori Hospital.

Between March 2012 and June 2012, IMR and its Australian academic collaborators prospectively collected data on (i) 274 patients presenting to Kikori Hospital with a presumptive diagnosis of TB, and (ii) hospital inpatients and outpatients receiving TB treatment during the study period. Sputum was collected for microscopy, GeneXpert analysis, culture and genotyping of isolates. IMR estimated the incidence of TB in Kikori to be 1130 per 100,000 people (95% CI 1000 to 1300) in 2012. The proportion of TB patients co-infected with HIV was 1.9%. Three of 37 TB cases tested were rifampicin resistant. Typing of nine isolates demonstrated allelic diversity and most were related to Beijing strains.

The incidence of TB in Kikori is one of the highest in the world and it is not driven by HIV co-infection. The high incidence and the presence of rifampicin resistant warrant urgent attention to (i) mitigate substantial morbidity in the region and (ii) prevent an expanding and explosive outbreak of TB and MDR-TB in PNG.

INTRODUCTION

On a global scale, a substantial proportion of the morbidity and mortality caused by tuberculosis (TB) is attributed to HIV co-infection and the emergence of drug resistance [1]. These factors and their impact on TB incidence and outcomes have been well studied in many African countries [2-4]. The 2 incidence of TB in countries with geographically isolated communities such as Papua New Guinea (PNG) is largely unknown and there is very limited data on drug resistance and HIV co-infection in remote PNG communities. The World Health Organization (WHO) reported annual national incidence of TB in PNG is 346 per 100,000 population and the reported percentage of tested TB patients that are HIV positive is 11% [5]. Due to the geographical isolation of most rural areas and limited access to health care facilities in these areas, the national figure may not reflect true TB incidence in the many remote regions of PNG. It is important to quantify TB incidence in these areas as many resource development projects are opening access to these remote communities and modeling studies performed in the Western province of PNG (adjacent to the Gulf province) have indicated that areas with high disease burden can dominate the TB dynamics of an entire region [6]. The PNG LNG Project raised concerns that TB was rampant in the Kikori area. Therefore, with PNG LNG Project funding, IMR sought to determine the incidence of TB, the frequency of drug resistance and the incidence of concurrent HIV infection in Kikori.

MATERIAL AND METHODS

Setting

Kikori is a town located in the Kikori district of the Gulf province of Papua New Guinea. The district is divided into 4 rural local level governments (LLG): West Kikori LLG, East Kikori LLG, Baimaru LLG and Ihu LLG. Kikori district encompasses an area of 27000 km^2, only 2500 km^2 of which is inhabited by a network of villages scattered along a river delta system [7].

There are two hospitals in the Kikori district. Kikori hospital primarily services West Kikori and East Kikori LLGs and a few patients from Baimaru LLG attend the

hospital. Kikori hospital is a 90-bed hospital administered and operated by the Christian charity organization called Gulf Christian Services. There are 25 medical staff at Kikori hospital and volunteer expatriate physicians sporadically visit the hospital. Over the study period, two Australian physicians collaborators attended the hospital to assist with clinical care and data collection. Kikori hospital resident staff managed TB diagnosis, treatment and care. Standard care for TB patients at Kikori generally involved hospital admission, where possible, for the first 2-months of intensive phase treatment followed by 4 months of treatment at home. TB patients are provided with hospital appointments or are referred to nearby health facilities for treatment follow-up. DOTS (directly observed treatment, short-course) intervention had not been implemented at Kikori during the study period. The Kikori district health office TB control program was responsible for TB patient follow-up, but due to funding and manpower issues the program was not functioning. Accessibility to Kikori town and Kikori hospital is poor.

Study design

Between March 2012 and June 2012, we conducted an observational study to determine the incidence of TB and disease characteristics in Kikori. Patients self-presenting to Kikori District Hospital with TB symptoms and inpatients receiving TB treatment during the study period were invited to participate in the study. Written informed consent was obtained prior to study enrolment. The PNG Medical Research Advisory Committee approved the study (amendment to MRAC No. 10.17) and maintains records of all signed consent forms.

Diagnosis of TB

Three sputum samples were collected from patients with a productive cough. Ziehl-Neelsen (ZN) stains were performed on sputum and other clinical specimens by trained scientists. Aliquots of sputum specimens were frozen and stored at -20□C for later analysis as described below. Attempts were made to obtain other clinical specimens for ZN smears; this included aspirates from lymph nodes, swabs from discharging ears and aspirates from other collections of pus. The WHO recommended algorithm for the diagnosis of TB, incorporating the international standards for TB care, were used for the diagnosis of TB in this study [8].

Definition of TB cases and new and previously treated cases

The patients enrolled were classified as TB suspects or cases of TB in accordance with the WHO TB Treatment guidelines [9]. A **'TB** suspect' was defined as a patient with symptoms or signs of pulmonary or extra pulmonary TB and/or constitutional symptoms (loss of appetite, weight loss, fever and fatigue). A 'TB case' was defined as a patient with acid fast bacilli (AFB) detected in ZN stained sputum (or other) specimen, or in the absence of such laboratory confirmation, when a health worker or clinician diagnosed TB based on symptoms and signs and decided to treat the patient with a full course of TB therapy. Cases of TB were further classified as new or previously treated cases [9].

Estimation of population size and TB incidence

Detailed population figures for each province in PNG are available from the 2000 PNG National census. The population serviced by Kikori Hospital in 2000 was 17,779 people. This is the sum of the population in West Kikori rural ward (n=7579), East Kikori rural ward (n=8788) and people residing in Baimaru Station in Baimaru rural ward (n=1416). The annual population growth rate from the most recent census in 2011 is known to be 1.2%, however absolute population figures have not yet been made available. Therefore the population serviced by Kikori Hospital in 2012 is estimated to be 20,144 people.

HIV testing

HIV testing was performed using the Alere Determine HIV-1/2 Ag/Ab Combo Rapid test kit HIV 1/2 119 STAT-PAK, Chembio Diagnostic Systems (NY, USA), after patients received appropriate provider-initiated HIV counseling and testing (PICT).

GeneXpert testing, microscopy culture and genotyping

Each sputum sample was analysed by two trained microscopists for AFB at Kikori Hospital. Aliquots of all sputum samples obtained from cases were frozen and stored at -20□C for several months before being sent to the PNG Institute of Medical Research (Madang) or the Queensland Mycobacterial Reference Laboratory (QMLR) in Australia for GeneXpert assays.

Sputum samples were decontaminated according to Petroff's method[10] and GeneXpert assays utilizing the Xpert MTB/RIF kit (Cepheid, Sunnyvale California USA) were performed as described previously[11]. Additionally, Queensland MLR cultured all AFB smear positive sputa using BACTEC^{TM}MGIT^{TM} (Beckton Dickinson, USA) and performed drug susceptibility testing (DST) and genotyping analyses on all isolates that were recovered after culture. DST was performed by the proportion method [12] using BACTEC^{TM}MGIT^{TM} 960 [13].

DNA was purified from cultures using ethanol and heating to 95^{o}C and multilocus mycobacterial interspersed repetitive unit variable number of tandem repeats (MIRU-VNTR) was used for molecular analysis and to define strains as previously described using GenoScreen (Lille Cedex, France) MIRU-VNTR Typing Kit – *Mycobacterium tuberculosis* Complex 24-loci [14]. Amplified products were detected using the AB® 3130x1 genetic analyser with GeneScan^{TM} 1200 LIZ® size standard (Appliedbiosystems, Life Technologies, NY, USA). The results were analysed using GeneMapper® Solfware (Appliedbiosystems, Life Technologies, NY, USA).

The online MIRU-VNTRplus tool (http://www.miru-vntrplus.org) was used to calculate a neighbor-joining tree using categorical distance measures based on 24 loci MIRU-VNTR, and to represent strains and lineage similarities as previously described [15, 16]. The loci (and corresponding aliases) used in our studies were: 154 MIRU02, 424 Mtub04, 577 ETRC, 580 MIRU04 ETRD, 802 MIRU40, 960 MIRU10, 1644 MIRU16, 1955 Mtub21, 2059 MIRU20, 2163b QUB11b, 2165 ETRA, 2347 Mtub29, 2401 Mtub30, 2461 ETRB, 2531 MIRU23, 2687 MIRU24, 2996 MIRU26, 3007 MIRU27 QUB5, 3171 Mtub34, 3192 MIRU31 ETRE, 3690 Mtub 39, 4052 QUB26, 4156 QUB4156 and 4348 MIRU39. It is noted that the laboratory work has taken at least 10 months to get a complete data on the genotyping, and TB drug resistance testing (DST) is still on going at the QMRL.

Data collection and data entry

Data were collected through patient interview for all TB cases, and stored in a dedicated database. Data entry was done using FileMaker pro 11 (Filemaker Inc, Santa Clara, CA) database.

Demographic variables

The following demographic variables were recorded for each patient: age, gender, body mass index (BMI), occupation, level of education, access to mobile phone, distance from hospital, smoking status, alcohol consumption, exposure to in-house smoke and chewing of betel nut. BMI for children and teenagers was calculated using the Centers for Disease Control and Prevention BMI online calculator tool (http://apps.nccd.cdc.gov/dnpabmi/). Exposure to smoke from cooking fires has been associated with an increased risk of TB [17], and spitting associated with betel nut chewing may facilitate transmission of infection in crowded housing [18]. Another variable captured was ethnicity (Papuans and Highlanders), to ascertain the ethic representation amongst TB cases.

Risk factors for TB

The following potential risk factors for TB were recorded for each patient: contact with a TB case, history of previous TB treatment, crowding (number of people in cohabitation), and absence of a BCG vaccination scar.

Distribution of TB cases

Global Positioning System (GPS) coordinates for the homes and villages of 143 TB cases were 7 ascertained by visiting the villages and using a Garmin eTrex 10 GPS device. GPS coordinates were plotted using Epi Info 7 software (Center for Disease Control USA).

Time trends in TB incidence in Kikori

Hospital records of the National TB Register from 2004 to 2012 were reviewed to obtain the number of patients commenced on TB therapy every year.

Statistical analysis

Statistical analysis was performed with STATA software version 12 (STATA Corp, College Station, TX). Confidence intervals for TB incidence were calculated using both the Wilson score interval and Agresti-Coull adjusted Wald interval methods.

RESULTS

Patient characteristics

Two hundred and eighty seven people were approached for informed consent. Thirteen declined consent and 274 were enrolled into the study. Of the 274 patients enrolled; 146 were determined to be TB cases and 128 were TB suspects (Fig. 2.1). Seventy-four of the 146 cases had sputum or other clinical specimens collected. In the remaining 72 cases we were unable to collect adequate specimens for analysis. Sputum and clinical specimens from 44 of the 74 cases were AFB positive or had MTB DNA detected by GeneXpert (Table 2.1). The demographic characteristics of TB cases are detailed in Table 2.2.

Table 2.1. Specimen results for 146 patients

Test and result	Number
ZN stain for AFB	
Clinical specimen not available	71
Sputum available for ZN stain	70
Negative	36
Positive	34
Scanty (1-9 AFB /100 fields)	3
1+ (10-99 AFB/100 fields)	2
2+ (1-10 AFB/ field)	13
3+ (> 10 AFB / field)	16
Other clinical specimens	5
Negative (ear swab)	1
Positive	4

Lymph node aspirates	*2 (both scanty)
Ear swab	1 (3+)
Aspirate from abscess	1 (1+)
Xpert MTB/RIF	
Sputum available for GeneXpert	67** (33 AFB+ve, 34 AFB -ve)
MTB not detected	30 (3 AFB +ve, 27 AFB -ve)
MTB detected	37 (30 AFB +ve, 7 AFB -ve*)
High	14 (all AFB +ve)
Medium	8 (all AFB +ve)
Low	(10 6 AFB +ve, 4 AFB -ve)
Very Low	5 (2 AFB +ve, 3 AFB -ve)
rpOb mutation (rifampicin resistance) detected	3 (all AFB +ve)

*One patient had a ZN negative but GeneXpert positive sputum along with a ZN positive lymph node aspirate

** Three sputum specimens were lost and not available for GeneXpert testing

The median age of TB cases was 22 years and 36% of all TB cases were under the age of 16 years. Fifty eight percent of cases had had no formal education or had only completed primary school education. Of note, 62% of cases had access to functional mobile phones. Twenty percent of patients had to travel for more than one day to get to the hospital. Most patients were non-smokers but 71% had exposure to in-house smoke from cooking fires. Potential risk factors for TB in cases are detailed in Table 2.3. Seventy three percent of cases reported having had had contact, usually through co-habitation, with at least one other person that was diagnosed with TB. Many households consisted of more than 10 occupants in a single dwelling.

Table 2.2. Demographic characteristics of 146 TB cases

Characteristics	N = 146 (%)
Median age	22 (range: 8 months to 76 years)
Age	
< 5 years old	25 (17%)
5 – 15 years old	27 (18%)
16 – 59 years old	90 (62%)
≥ 60 years old	4 (3%)
Sex	
Male	66 (45%)
Female	80 (55%)
Ethnicity	
Papuan	141 (97%)
Highlanders	5 (3%)
Occupation	
Subsistence Farmers	65 (44%)
Students	41 (28%)
Mining Industry	15 (10%)
Health Workers	3 (2%)
Children/ Unknown	40 (27%)
Level of education	
University education	1 (0.7%)

Diploma	2 (1.4%)
Trade School	2 (1.4%)
High School education	23 (15.8%)
Primary school education	51 (34.9%)
No formal education	33 (22.6%)
Unknown/ Children under school age	34 (23.2%)
Mobile phone access	
NO access to mobile phone/ no coverage	55 (37.7%)
Access to own mobile phone	51 (34.9%)
Access to family members mobile phone	40 (27.4%)
Distance from hospital	
Walk ≤ 1 hour	46 (31.5%)
Boat Road trip ≤ 1 hour	29 (20%)
Walk > 1 hour < 1 day	0
Boat Road trip > 1 hour < 1 day	44 (30%)
Walk ≥ 1 day	5 (3.4%)
Boat/ Road trip ≥ 1 day	22 (15.1%)
Smoking status*	
Non smokers	104 (71.2%)
Smokers	41 (28.1%)
Unknown	1 (0.7%)
Exposure to in-house smoke**	
Exposed	104 (71.2%)
No Exposure	32 (21.9%)

Unknown	10 (6.9%)
Alcohol consumption	
Drink Alcohol	30 (20.5%)
Never Drink Alcohol	115 (78.8%)
Unknown	1 (0.7%)
Betel nut chewing	
Does not chew betel nut	92 (63%)
Chews betel nut	53 (36.3%)
Unknown	1 (0.7%)

*Actively smoking any quantity of cigarettes prior to and leading up to illness

** Any exposure to wood smoke from in-house fire prior to and leading up to illness

Table 2.3. Potential risk factors for TB in 146 TB patients

Risk factors	Frequency (%)
Contact with TB case	107 (73.3%)
No contact with TB	34 (23.3%)
Unknown	5 (3.4%)
Number of people in a household	
≤ 5	35 (24.0%)
6 – 10	71 (48.6%)
> 10	40 (27.4%)
History of TB illness	
No history of TB	99 (67.8%)
Unknown	1 (0.7%)
History of previously treated TB	46 (31.5%)
Relapsed case	11/46 (23.9%)
Treatment failure	6/46 (13.1%)
Defaulted on therapy	18/46 (39.1%)
Completed treatment but uncertain if symptoms resolved	11/46 (23.9%)
BCG scar	
BCG scar present	99 (67.8%)
No BCG scar	41 (28.1%)
Unknown	6 (4.1%)

Microbiology

All sputum and clinical specimens, obtained from cases, were ZN-stained and the number of AFB was quantified (Table 1). Eighty five percent of AFB positive sputa (29/34) had a heavy burden of bacilli (2+ or 3+). IMR analyzed 67 out of 70 sputum samples (3 were lost) with GeneXpert for the presence of *Mycobaterium tuberculsosis* (MTB) DNA and rifampicin resistance (rpoB gene mutation) [10, 11]. Thirty of the 34 smear positive sputa had MTB DNA detected by GeneXpert and three of these had rifampicin resistance detected. MTB DNA was also detected in 7 out of 36 AFB smear negative specimens obtained from TB cases, and none of these were rifampicin resistant on GeneXpert analysis (Table 2.1).

There was a wide geographical distribution of TB cases (Figure 2.1) and rifampicin resistant isolates across the region. One out of the three patients with rifampicin resistance had previously been treated for TB and had defaulted on therapy. The other 2 patients had no history of TB treatment. MTB DNA was detected by GeneXpert in 7 of the 34 AFB smear negative sputum specimens obtained from TB cases and available for testing (Table 2.1). All sputum specimens that were AFB positive were cultured and 10 specimens yielded isolates. DST confirmed that all of the cultured isolates were sensitive to first line drugs. Genotypic profiling was performed on these isolates using MIRU-VNTR. A complete pattern was only available for 9 isolates from cases distributed across the Kikori region. Most isolates resembled Beijing strains and allelic diversity was noted at two loci (Figure 2.2).

Figure 2.1. Distribution of TB patients in this study

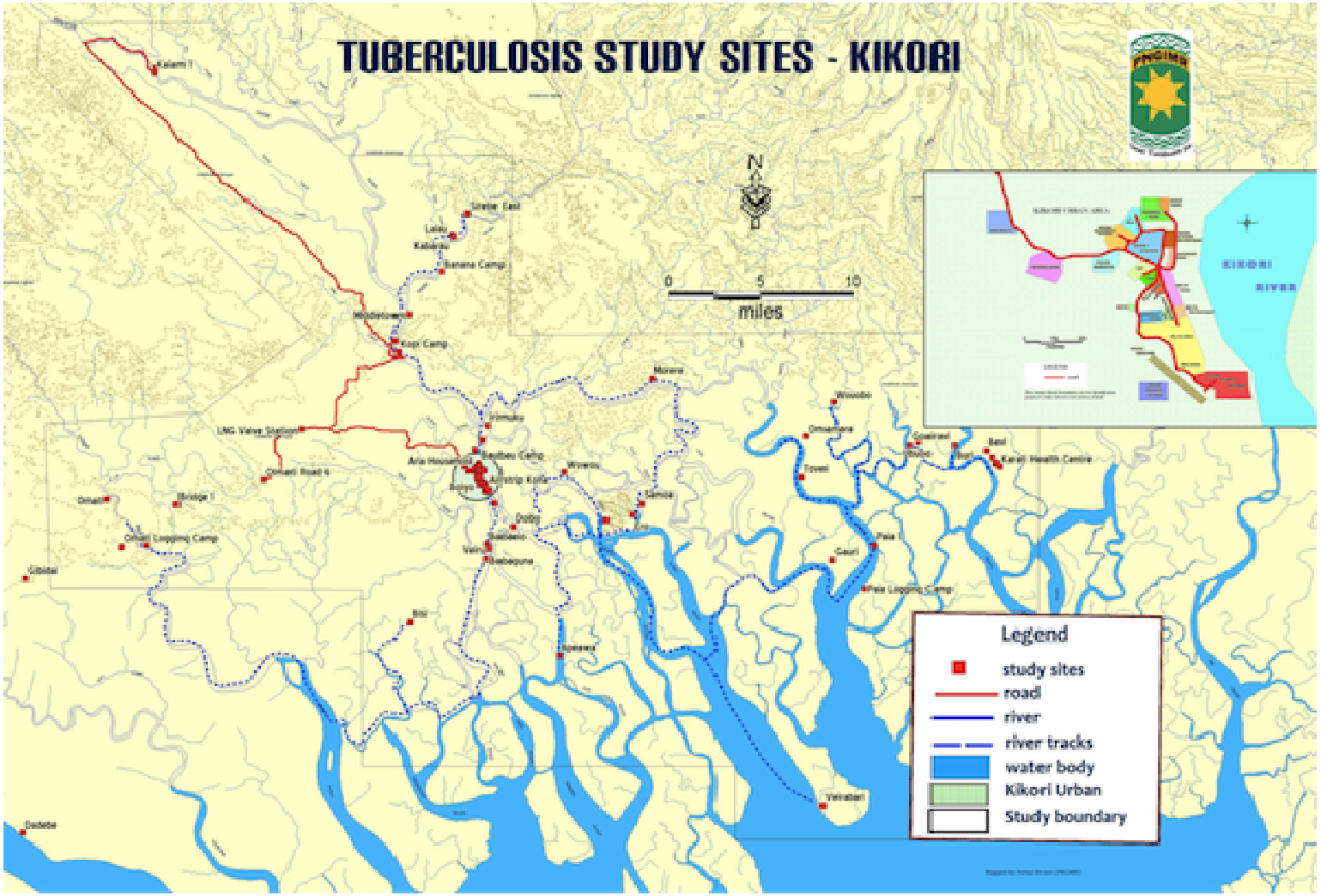
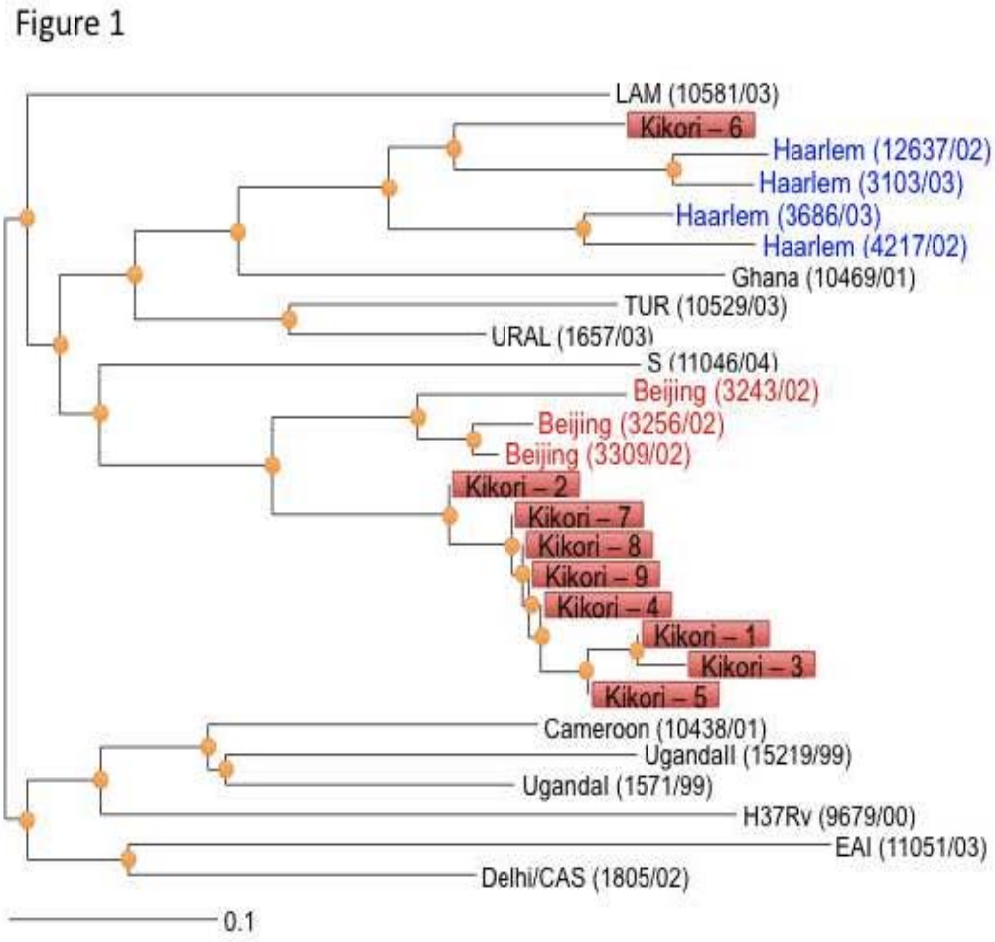


Figure 2.2. Phylogentic tree of 9 cultured isolates from Kikori. Numbers in parentheses represent MIRU-VNTRplus database strain ID numbers.



TB clinical manifestations and treatment follow-up

A complete summary of clinical symptoms and signs for TB cases is shown in Table 2.1. Thirty four percent of children were severely underweight with BMIs falling below the 1st percentile. The clinical focus or site of TB in cases is shown in Table 2.4.

Table 2.4. TB in 146 cases by site

TB site	N of patients	Positive ZN smear	Median age (age range)
Disseminated TB	14 (9.6%)	1 sputum 1 ear swab 1 lymph node aspirate	7 (1 – 35)
Pulmonary TB	72 (49.3%)	34 sputa (+ 7 AFB –ve but GeneXpert +ve)	30 (< 1 – 76)
TB Lymphadenitis	28 (19.2%)	1 aspirate	10 (< 1 – 40)
TB Abdomen/ Pelvis	11 (7.5%)		19 (2 – 45)
Cerebral TB/ TB Meningitis	6 (4.1%)		4 (2 – 5)
TB Malnutrition	6 (4.1%)		3.5 (< 1 – 5)
TB Spine	3 (2.1%)	1 aspirate	25 (8 – 47)
TB in Joint	1 (0.7%)		6
Sites Unknown	5 (3.4%)		28 (24 – 56)

IMR next assessed factors that may be contributing to the development of TB and its management. HIV screening was performed on 105 TB cases. IMR identified 2 TB cases that were co-infected with HIV (1.9%). IMR collected data on patient management, discharge and follow-up. By the end of the study, 37 of 146 cases (25%) were inpatients, 17 (12%) were being managed as outpatients and 7 (5%) were transferred to another hospital closer to their home village or to mining camp clinics if employed by the mining sector. Sixteen cases (11%) defaulted on their therapy during the course of the study with the most common reason being a lack of food provision at the hospital (7/16). The remaining cases (46%) were discharged to their home with a supply of TB medication because of hospital bed shortages. Two cases (1.4%) died during the study period but formal mortality rates could not be calculated, as many cases were lost to follow-up after hospital discharge. Only 24 of 83 cases (29%) that were discharged from hospital, with TB therapy, attended any follow-up appointment.

Incidence of TB in Kikori

Over the course of the study period, the number of TB cases enrolled per month remained consistent, ranging from 20 to 33 per month. To estimate TB incidence IMR only included cases that were diagnosed and commenced on treatment during the study period (n=97). Based on the number of new, relapse and re-infection cases (Fig. 2.3) over 16 weeks, IMR extrapolated the TB incidence to be 1,130 cases per 100,000 people, per year (95% CI: 1000 to 1300 per 100,000) in the Kikori region (West and East Kikori LLGs and Baimaru Station in the Baimaru LLG). IMR next assessed if the large number of TB cases was a recent or more chronic problem. IMR reviewed hospital records to track the number of registered TB cases at Kikori Hospital between 2004–2011. The number of expected 10 cases for 2012 based on extrapolated figures from our 16-week study is 315, and this is consistent with figures over the preceding 8 years. Table 2.5 showed the Global incidence rate of TB, and the rate in Kikori is much higher than the estimated rate for PNG.

Figure 2.3. Flow chart for calculating incidence of TB in Kikori

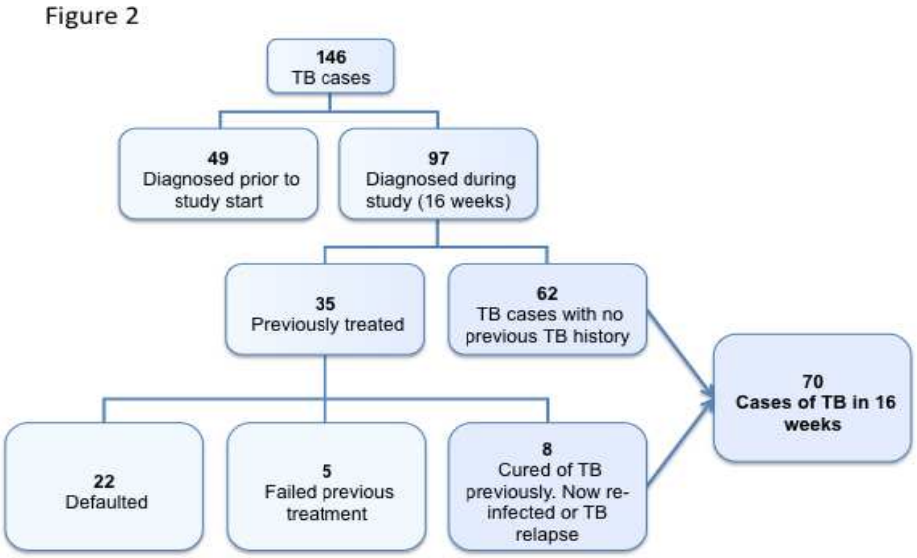


Table 2.5. Global Incidence of TB

Country	Per 100, 000 pop
Swaziland	1287
South Africa	981
Timor-Leste	498
D. Republic of Congo	327
Papua New Guinea	303
Kikori	**1130**
Indonesia	189
India	185
Russian federation	106
China	80
Australia	6.3

Source: WHO, Global Tuberculosis Report, 2011

DISCUSSION

IMR has confirmed the concerns raised by the PNG LNG Project and have identified ***one of the highest TB incidence rates in the world***, [5] much higher than the WHO figure reported in 2011 [19]. IMR used the same case definitions in our study that are used by the PNG government in reporting National incidence to WHO. The IMR incidence figure may be an underestimate of the true incidence, as only patients presenting to the hospital were included in the study and we did not perform active case finding in the community villages. This incidence IMR reports is not a temporally isolated event coincident with our study, as a review of Kikori Hospital TB registries indicates that TB has been problematic in the area since at least 2004. In contrast to the high TB incidence rates reported in African countries [20], the rate in Kikori is unusual as it is not associated with a high frequency of HIV co-infection. Several factors are probably contributing to the high incidence of TB in Kikori including: delayed presentation, difficulties in managing patient follow-up, infectious burden, and the interplay between local environmental factors and immunity. The IMR analysis of case demographics, disease characteristics and microbial genetics sheds some light on the likely factors that contributes to the Kikori TB incidence.

Delayed presentation is evident in the IMR study as illustrated by the number of complicated presentations including disseminated TB, and the duration of symptoms. IMR found literacy to be poor and in the absence of education, cultural beliefs and folklore can delay the seeking of early treatment for TB [21]. Additionally the remoteness of some villages precluded early access to medical care and compromised treatment and follow-up. Access to medical care and follow-up could potentially be improved by contacting patients that return home using mobile phone. The remoteness of the hospital from major drug distribution centers also complicated supply of both loose and fixed combination anti-TB drugs. The late presentation of cases and the inefficiencies in treatment access and delivery may contribute to prolonged transmission risk and very high infectious burdens of MTB. The IMR study highlights that overcrowding, spitting as a cultural phenomenon, and the heavy AFB density in most cases, could translate to a high infectious load which results in a cycle of infection, repeated exposure, onset of clinical disease, and further transmission of disease. Drivers of clinical disease in Kikori might include

malnutrition and exposure to household smoke [22, 23].

IMR's ability to culture specimens and obtain isolates for genotyping and other analyses was compromised by difficulties in maintaining a cold chain during storage and transport. Culture recovery rates in the Australian reference laboratory were low, although the Xpert MTB/RIF assay performed well on smear positive samples despite the loss of viability. Of the ten isolates grown and drug susceptibility completed, all were pan susceptible to the five first line agents, including pyrazinamide. IMR were not able to recover culture isolates form the three sputa that were found to harbour *rpoB* mutations. While rifampicin resistance is considered a strong predictor of multidrug resistant phenotype [24, 25], the association is not invariable [26] and cannot necessarily be inferred in Kikori where no prior knowledge of drug resistance patterns exists. Although sample size is small, the finding of three rifampicin resistant isolates amongst 37 strains tested (8%) is of concern and a systematic study of patterns of drug resistance to anti-tuberculous agents is urgently required in this patient cohort.

Whilst the exact factors driving TB in Kikori are unclear, ***it would appear that circumstances could easily conspire to create an environment for the generation and spread of MDR/TB.*** This is a major concern for a region that has limited access to, and ability to deliver and monitor second line therapies. In the absence of substantial improvements in infrastructure and supports, ad hoc administration of 12 second line therapy could result in the development of extensively drug resistant TB [27]. The high TB incidence in Kikori could rapidly promote the dominance of resistant TB strains unless a reliable TB control program is implemented that can detect cases, support microbiological diagnosis including rapid detection methods such as Xpert MTB/RIF and ensure treatment adherence and follow-up. The more immediate consequences of the high incidence of TB in Kikori and its impact on morbidity and mortality need to be urgently addressed. The IMR study shows that, in at least one remote region in PNG, there is an extremely high incidence of TB, with the potential to promote the emergence and expansion of MDR/TB.

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CHAPTER 3. HEALTHY PREGNANCY STUDY

The Epidemiology of Sexually Transmitted Infections, including Human Papillomavirus, among pregnant women attending Antenatal clinics at four sites in Papua New Guinea.

SUMMARY

The 2008 PNG LNG Project Health Impact Assessment identified changes in the rates of sexually transmitted infections at project-affected areas as a significant concern. In order to investigate and monitor possible project related impacts, a major STI study was developed as part of the PiHP. In addition to providing objective evidence whether the PNG LNG impacted STI rates, the study effort also has the opportunity to provide significant public health benefits to PNG policy makes and public health officials.

The aim of this study is to investigate the epidemiology of HIV, human papillomavirus (HPV) and other sexually transmitted infections (STIs) among pregnant women attending antenatal clinics (ANCs) at four sites in Papua New Guinea (PNG). The four sites included the project-affected areas of Hiri and Hides along with the comparison sites at Karkar and Asaro. The study has these Research Objectives:

1. To provide the first robust estimates of *C. trachomatis, N. gonorrhoeae, T. vaginalis*and*Herpes simplex* type-2 (HSV-2) prevalence among pregnant women in PNG;
2. To provide the first general population estimates of human papillomavirus (HPV) prevalence among women in PNG in order to inform national policy on HPV vaccination;
3. To validate estimates of antenatal HIV and syphilis prevalence obtained through national antenatal surveillance;
4. To investigate the demographic and sexual behavioural correlates of HIV, HPV and STI risk among women attending antenatal clinics at these sites.

INTRODUCTION

Sexually transmitted infections (STIs) are associated with significant adverse reproductive health outcomes, particularly among women[1-3]. In pregnant women with untreated early syphilis, 25% of pregnancies result in stillbirth and 14% in neonatal death[3-4]. Up to 35% of pregnancies among women with untreated gonococcal infection are estimated to result in spontaneous abortion and premature deliveries, and up to 10% in perinatal death[3-4]. In the absence of prophylaxis, 30 - 50% of infants born to mothers with untreated gonorrhoea and up to 30% of infants born to mothers with untreated chlamydia will develop *ophthalmia neonatorum*, which can lead to blindness if not diagnosed and treated promptly[3]. Untreated chlamydia or gonorrhoea can result in chronic salpingitis leading to infertility or ectopic pregnancy. Infection with certain high-risk sub-types of human papillomavirus (HR-HPV) is associated with cervical epithelia dysplasia and cancer of the cervix, particularly types 16 and 18 whilst HPV-6 and HPV-11 cause genital warts[5]. In addition to their direct effects on reproductive health, many STIs have been shown to biologically enhance the transmission and acquisition of HIV[6-13], so that their effective management may play an important role in HIV prevention, particularly in resource-limited settings[14-18].

As is the case with many developing countries, PNG could benefit from better information on the extent of STIs to inform national prevention and control strategies. This study will provide (i) objective evidence whether PNG LNG project impact sites (Hiri and Hides) are adversely affected by changes in STI rates and (ii) valuable epidemiological data on STI prevalences among pregnant women, including the first prevalence estimates of HPV and HSV-2 infection.

Sexually transmitted infections in the Asia-Pacific region

In a recent six country study among 1678 pregnant women attending urban and rural antenatal clinics in Fiji, Kiribati, Samoa, Solomon Islands, Tonga and Vanuatu, the prevalence of chlamydia was 6.4-29.0% (mean 18.0%); gonorrhoea, 0.0-2.5% (mean 1.7%); and syphilis, 0.0–10.0% (mean 3.0%) in the period 2004-2005[19]. None of the 1618/1678 clinic attenders who underwent voluntary counselling and confidential HIV testing (VCT) were HIV sero-positive[19-20]. Chlamydia was the most prevalent STI, particularly in Fiji (29.0%) and Samoa (26.8%). As in PNG, chlamydia was more prevalent in younger women in all locations[21]. For example, in Tonga, prevalence among women <25y was 27.5%, compared to 8.3% among women >25y; in Samoa prevalences of 40.7% and 17.5% were observed in these age-groups respectively[20]. Only 1.5% of the 1678 antenatal clinic attenders reported transactional or commercial sex in the previous 12-months, but these women were six times more likely to have chlamydia infection[20]. High rates of STIs among pregnant women, including chlamydia (21.5%), gonorrhoea (5.9%), HSV-2 (30.0%), syphilis (2.4%) and trichomonas (27.5%), have also been reported previously in Vanuatu[22-24] and similar rates observed in Fiji[25] and Samoa[26].

Among 451 antenatal clinic attenders in Cambodia, the prevalence of chlamydia was 2.8%; gonorrhoea, 0.0%; syphilis, 1.3%; and trichomonas 2.7%[27]. In a general population survey among 2550 women and 1350 men in the Philippines, the prevalence of chlamydia was 5.7%, gonorrhoea 0.8%, and syphilis 0.2% among women; and 4.4%, 1.1% and 0.2% among men, respectively[28].

Sexually transmitted infections in Papua New Guinea

High prevalences of HIV, STIs and genital infections have been reported among men and women in PNG in comparison to other countries in the Asia-Pacific region[29-55]. A recent systematic review and meta-analysis of HIV/STI prevalences in community and clinic-based settings in PNG[21] however, identified only 3 epidemiological studies conducted to date among pregnant women; a combined total

of 206 antenatal clinic attenders[37] and 736 women presenting in labour[40, 47] (Table 3.1).

Table 3.1. Summary of published data on antenatal HIV/STI prevalences among pregnant women in PNG

Author	Klufio *et al*., 1995[37]	Mgone *et al*., 1997[40]	Suarkia *et al*., 1999[47]
Study population	206 pregnant women attending first antenatal clinic visit at Port Moresby General Hospital	155 women presenting in labour to Goroka Base Hospital	581 women presenting in labour to Goroka Base Hospital
Bacterial vaginosis	23.3 (17.7, 29.7)	-	-
C. trachomatis	17.7 (12.4, 24.0)	36.8 (29.2, 44.9)	34.1 (30.2, 38.1)
N. gonorrhoeae	-	-	-
Syphilis	-	-	-
T. vaginalis	18.9 (13.8, 25.0)	-	-
HIV	-	-	-
HSV-2	-	-	-

Periodic syphilis and HIV sero-surveys are conducted by the National Department of Health (NDoH) in PNG to support routine antenatal surveillance. In 2009, estimated antenatal syphilis prevalence was 6.9%, and HIV prevalence 0.7% in urban areas (N=4623) and 4.2% and 0.5% respectively in rural areas (N=3180) (NDoH 2009, personal communication). No prevalence estimates of HSV-2 or HPV have previously been reported among pregnant women in PNG[21].

The reasons for the differences in the epidemiology of HIV and STIs in PNG compared to other countries in the Asia-Pacific region are unclear, but felt likely to be the result of locally-specific interactions between the behavioural determinants, socio-cultural dimensions and structural contexts that frame sexual agency, sexuality and sexual health in PNG compared to other settings[56-65]. These include gender power disparities, sexual violence and the societal roles of men and women[56-59, 62, 64-66]; low levels of male and female condom use[43, 51, 67], and of male circumcision[57, 66, 68-69]; limited access to STI treatment services due to poor transport and health systems infrastructure[70-71]; and limited success in the design and implementation of culturally-relevant behaviour change interventions among both general population and at-risk groups, such as truck drivers, male and female sex workers and their clients[57, 69, 72]. These factors may also explain the high HIV/STI prevalences observed in Tanah Papua Province in Eastern Indonesia, which is experiencing a generalised HIV epidemic that has many parallels to that of neighbouring PNG[73].

HPV and cervical cancer in PNG

Papua New Guinea has one of the highest rates of cervical cancer in the world with an estimated age-standardized incidence of 23.7/100,000 compared to 5.0/100,000 in Australia and New Zealand[74]. Cervical cancer is the most common cancer among women in PNG and a leading cause of premature death[5, 75]. An estimated 1500 women die every year in PNG due to cervical cancer.

Despite the burden of cervical cancer in PNG, no large-scale surveys have been conducted to establish the prevalence of HPV among general or at-risk populations of women. The only survey published to date was conducted among 114 women in Eastern Highlands Province, which reported a 33% prevalence of HPV-16/18[76]. More recently, cervical biopsies obtained over the period 2006-09 from 70 women in PNG with cervical cancer were analysed for HPV infection[77]. HPV-DNA was found in all cases with HPV-16, 18, 33 and 31 the most prevalent HR types (57%, 26%, 10% and 4% respectively). These findings suggest that the currently available and highly effective vaccines against HPV types 16 and 18 have the potential to

significantly reduce the burden of HPV-related cervical cancer in PNG, if distribution and cost issues can be resolved.

The Healthy Pregnancy Study is part of a broader program of research being undertaken by the PNGIMR collaborative research group in sexual and reproductive health, and is designed to provide policy-relevant data on the epidemiology of HPV and cervical cancer in PNG. Complimentary research among 1,400 women attending well woman and sexual health clinics in Eastern and Western Highlands Provinces is also being carried out by our group under a separate funding mechanism, and will provide data on HPV genotype prevalence among women at different levels of sexual risk. These studies will together provide the necessary policy-relevant evidence required to inform locally appropriate and effective interventions for the prevention of cervical cancer in PNG.

MATERIAL AND METHODS

Study design

Cross-sectional bio-behavioural survey among 1000 women attending antenatal clinics (ANCs) in Central, Madang, Eastern Highlands and Hela Provinces (CP, MP, EHP, HP). A total of 250 women per site will be recruited in order to enable the study to estimate STI prevalences with adequate precision at site-level in addition to providing robust estimates of prevalence across all sites. For example, this sample size will enable a chlamydia prevalence of 18% across all sites combined to be estimated with around 2.4% precision (i.e. 95% CI: 15.6, 20.4), and a prevalence of 18% at a single site to be estimated with around 4.8% precision (i.e. 95% CI: 13.2, 22.8).

Eligibility Criteria

- Pregnant women aged over 18 years at the time of first ANC visit.
- Pregnancy confirmed by a positive urinary pregnancy test (UPT) if presenting in first trimester or by clinical examination if presenting in second or third trimester.

- Willing and able to provide an effective mechanism for future tracing in the community (e.g. house and village location) in order for clinic staff to provide feedback on laboratory results and additional treatment for STIs and HR-HPV as indicated.
- Able to understand why the study is being carried out, the potential benefits and inconveniences associated with study participation and to complete study informed consent procedures.

Exclusion Criteria

- HIV status will not be used as an exclusion criterion so that clients who are HIV positive, HIV negative and those who decline to undergo provider initiated counselling and confidential HIV testing (PICT) at the ANC will all be eligible to participate.
- Where staff feel for whatever reason it would not be in a client's best interests to participate in the study, that client will be excluded from enrolment.

Recruitment of study participants

Women will be invited to participate in the study by trained clinic staff and provided with information about the research whilst they wait to be attended at ANC. Information about the study will also be provided at local community meetings, community health announcements (*tok save*) and via other relevant channels e.g. announcements at the end of church services.

Ethical Considerations and Informed Consent

Ethics approval for the study has been provided by the Medical Research Advisory Committee (MRAC) of the National Department of Health (NDoH) in Papua New Guinea; and from the Health Research Ethics Committees of the University of New South Wales (UNSW) and the Alfred Hospital in Australia.

Study informed consent procedures are consistent with internationally-agreed Good Clinical Practice (GCP) guidelines[78] and follow written study-specific Standard Operating Procedures (SOPs). All volunteers are provided with a written Participant Information Sheet and given an opportunity to ask questions about the study by a trained member of the clinic team. During the consent process, researchers check each individual understands the study objectives and procedures using a study-specific Comprehension Checklist. Participants then sign (or to provide a witnessed thumbprint) on the study Informed Consent Form. Participants are provided with K10.00 in cash to recognize their valuable contribution to this research and to reimburse them for any costs incurred as a result of study participation e.g. PMV bus fares; loss of earnings from selling market produce etc.

Study Procedures

Following completion of informed consent procedures, a trained clinic staff member (newly recruited for this study at each site) assigns each participant a unique alphanumeric Study ID number from a pre-printed Study Register. Study ID numbers contain a site-specific identifier to facilitate data analysis by site but do not include any names, locator or other information that could compromise client confidentiality (e.g. HID0023T would be assigned to the 23rd woman enrolled at the Hides site; HIR0009F to the 9th woman enrolled at the Hiri site).

Participants are then asked to take part in a face-to-face interview, conducted using study-specific case record forms (CRFs) to capture key socio-demographic, sexual behavioural and clinical information, including obstetric history (e.g. date of last menstrual period, parity, gravidity, past obstetric complications, gynecological and relevant general medical history); and sexual risk factors (e.g. early age of sexual debut, multiple sexual partnerships, sexual concurrency, commercial and transactional sex work).

Participants undergo a general medical examination (including temperature, pulse, blood pressure, weight) and an antenatal assessment (including fundal height

measurement, foetal position and foetal heart auscultation) with key findings recorded in each participant's patient record card and in study-specific CRFs.

All participants are offered confidential counselling and HIV testing as per routine clinic operating procedures and in accordance with approved NDoH national guidelines. HIV tests are performed on a finger-prick specimen using the Determine and Stat-Pak HIV simple rapid tests.

Participants are also asked to provide the following laboratory specimens:

- A fingerpick specimen for clinic-based syphilis testing (SD Bioline anti-TP rapid test);
- A 10mL venous blood specimen for confirmatory laboratory-based syphilis serology (RPR); and HSV-2 serology (Kalon ELISA), conducted at the PNG IMR STI/HIV Research Laboratory in Goroka;
- A self-collected mid-cavity vaginal swab that is placed in a transport tube then stored at -20^{o}C in the clinic prior to transport in batches to PNG IMR STI/HIV Research Laboratory in Goroka. HPV typing is being carried out using the Roche Linear Array kit and STI diagnostics conducted using real-time multiplex polymerase chain reaction (PCR) testing for *N. gonorrhoea, C. trachomatis* and *T. vaginalis*.

Participants with clinical features suggestive of an STI are managed according to national syndromic management guidelines and advised to return in 2-3 weeks for clinical review. During clinical follow-up, clinic staff review the notes of those participants with positive laboratory test results to determine whether additional treatment and/or follow-up is necessary e.g. a woman given treatment for a syndromic diagnosis of vaginal discharge syndrome (VDS) may not require additional treatment if found to have a positive result for *T. vaginalis* on PCR but may need additional treatment if she also has positive syphilis serology.

Women found to be positive for HSV-2 are advised of their results; the importance of consistent condom use to minimize the risk of herpes transmission to sexual partners; and the association between HSV-2 infection and the risk of HIV acquisition / transmission. Women with high-risk type HPV infection are advised to attend local cervical cancer screening services at 8-10 weeks post-delivery. Participants found to have reactive HIV tests in the clinic are managed according to national guidelines on the prevention of parent to child HIV transmission.

Data management

A study-specific MS Access database has been developed by the collaborative research team for this study and will be similar in design to those previously developed by our group. Information collected in CRFs is data entered at clinical sites and following data query resolution and other quality checks, data analysis conducted in SAS v9.2 (SAS Institute Inc, NC, USA) by a dedicated study statistician.

RESULTS

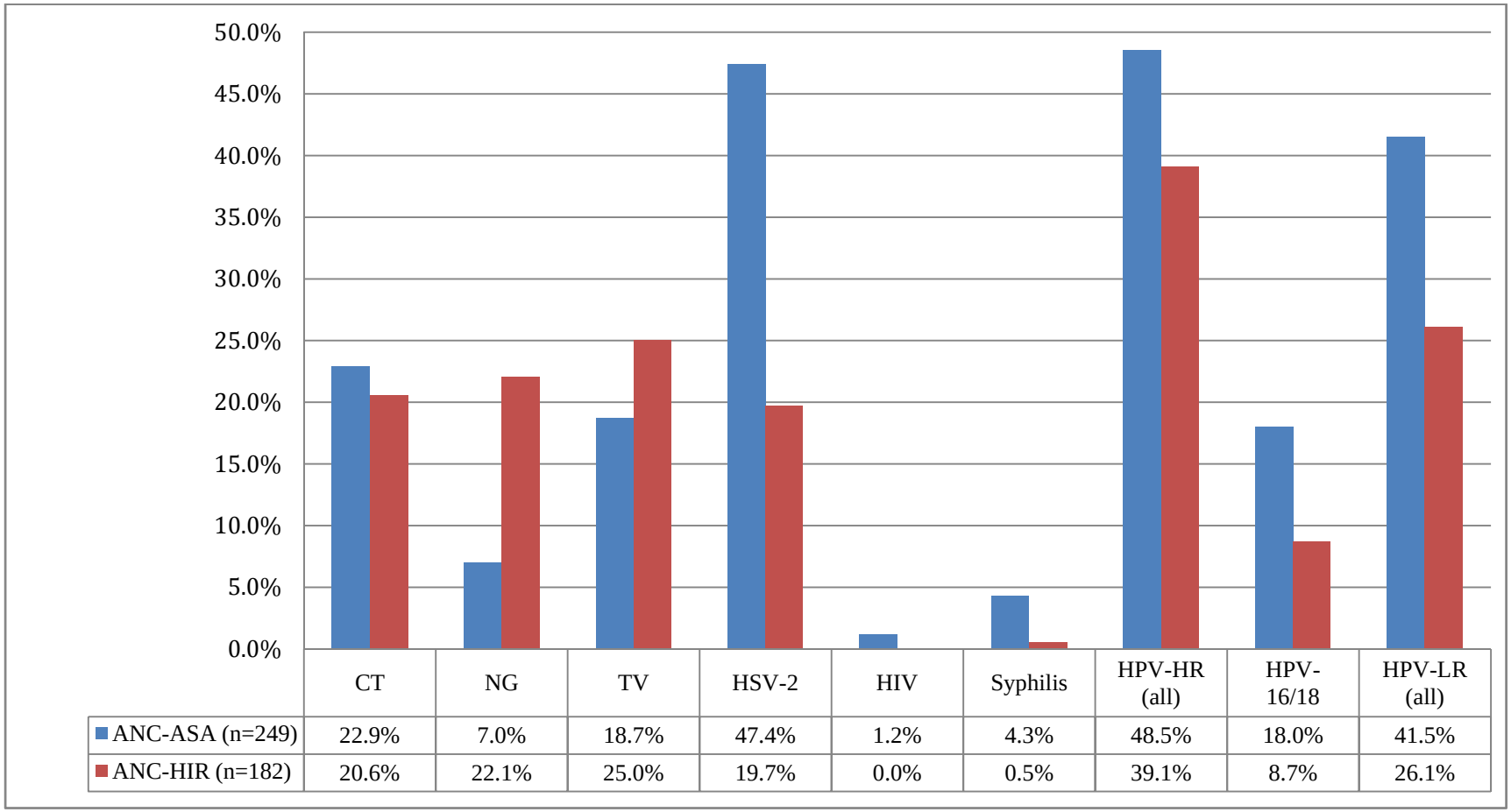
At end-August 2013, a total of 553 women had been recruited into the study (EHP: 258 (Asaro ANC); CP: 203 (Papa, Porebada, Boera ANCs); HP: 92 (Malanda, Para ANCs)). Preliminary laboratory findings (Asaro and Hiri ANCs, July 2013) indicate a high burden of HIV, HPV and other STIs among pregnant women in these settings (Table 3.2, Figure 3.1). The most prevalent high-risk HPV types identified in this population were HPV-16, 52 and 33 (Figure 3.2). Laboratory data from ANCs at Malanda and Para Health Centres in Hides will be available in late 2013, and from Gaubin Hospital ANC in Karkar in early 2014.

Table 3.2. Prevalences of HIV, HPV and other STIs among pregnant women attending antenatal clinics in Asaro, EHP and Hiri, CP

	HPS-Asaro			HPS-Hiri		
	n	N	%	n	N	%
C. trachomatis	49	214	22.9%	14	68	20.6%
N. gonorrhoea	15	214	7.0%	15	68	22.1%
T. vaginalis	40	214	18.7%	17	68	25.0%
HSV-2	118	249	47.4%	26	132	19.7%
HIV	2	171	1.2%	0	182	0.0%
Active syphilis[1]	9	209	4.3%	1	182	0.5%
HPV-HR (all types)	97	200	48.5%	18	46	39.1%
HPV-16/18	36	200	18.0%	4	46	8.7%
HPV-LR (all)	83	200	41.5%	12	46	26.1%

[1]Defined as both anti-TP and RPR positive (any titre)

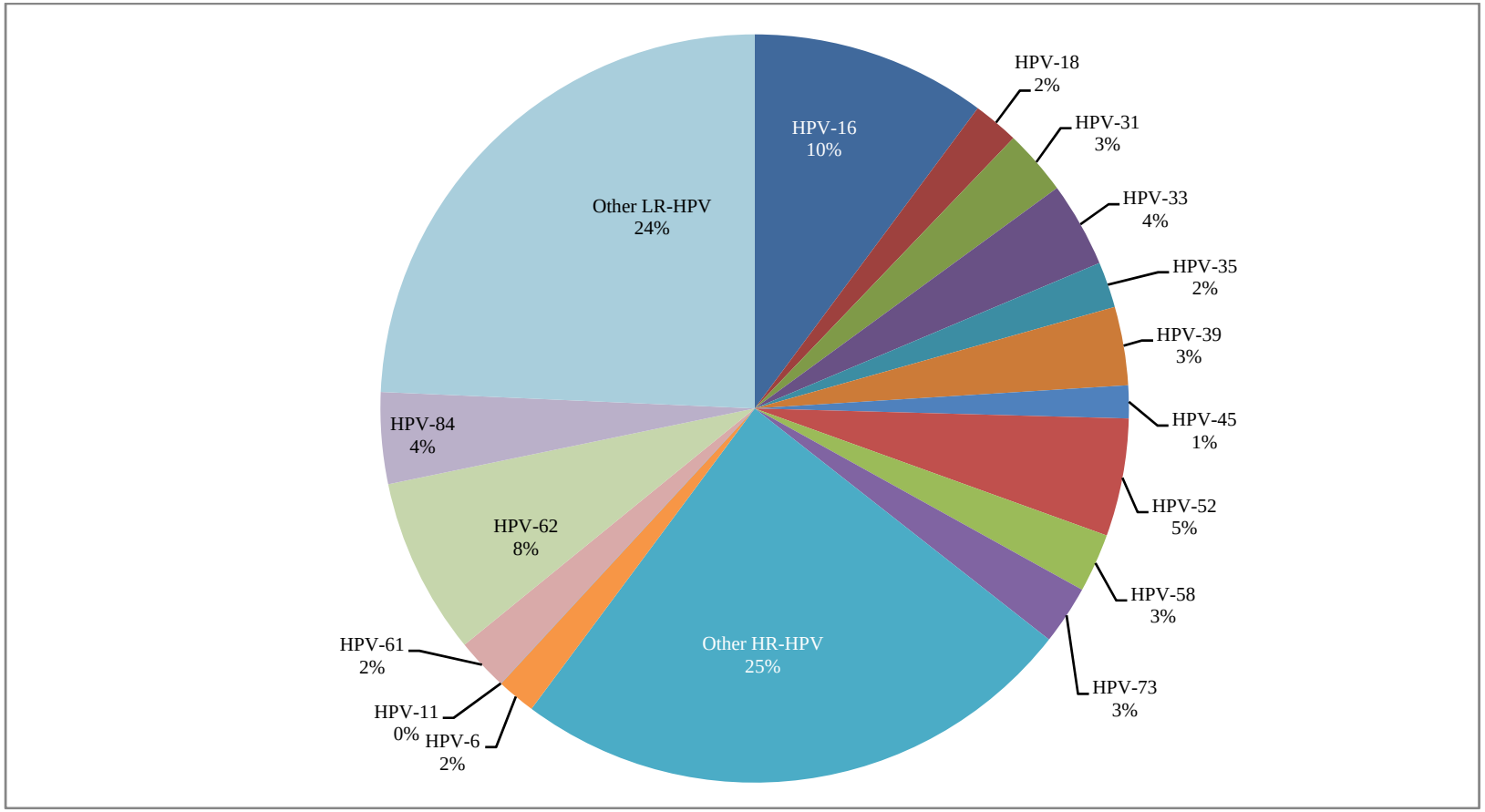
Figure 3.1.Prevalences of HIV, HPV and other STIs among 431 women attending ANCs in Asaro and Hiri



	CT	NG	TV	HSV-2	HIV	Syphilis	HPV-HR (all)	HPV-16/18	HPV-LR (all)
ANC-ASA (n=249)	22.9%	7.0%	18.7%	47.4%	1.2%	4.3%	48.5%	18.0%	41.5%
ANC-HIR (n=182)	20.6%	22.1%	25.0%	19.7%	0.0%	0.5%	39.1%	8.7%	26.1%

CT: *C. trachomatis;* NG: *N. gonorrhoea;* TV: *T. vaginalis*

Figure 3.2. HPV-type prevalence among 246 women who tested HPV positive at Asaro and Hiri ANCs (total of 354 infections among 246 women)



CONCLUSION

This research is providing the first geographical, age and type-specific prevalence data on HPV infection in Papua New Guinea. Initial HIV findings in Hiri do not indicate an upsurge in HIV as all tests are negative to date. Preliminary data from Hides (not shown in this report) are also negative for new HIAV cases. Therefore, initial (and still preliminary) findings do not demonstrate a surge in HIV cases at Hiri and Hides iHDSS locations. Preliminary HPV findings are consistent with the ongoing mortality study across iHDSS locations, which demonstrate a significant burden of cervical conacer, particularly in Hiri.

Study findings will inform evidence-based public health policy on HPV and cervical cancer control in PNG, including the introduction of polyvalent HPV vaccines for primary cervical cancer prevention. This work is also expected to inform national policy on the elimination of mother to child transmission of HIV and syphilis, and new public health approaches to the control of STIs in pregnancy.

PUBLICATIONS/PRESENTATION

Vallely A et al. Achieving control of cervical cancer in Papua New Guinea: What are the research and program priorities? PNG Medical Journal, 2012 [In press]

Vallely A et al. Human papillomavirus and cervical cancer in Papua New Guinea. Invited oral presentation, *The International Union against Sexually Transmitted Infections (IUSTI) World Congress 2012*. Melbourne, Australia, October 2012.

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CHAPTER 4. SENTINEL SURVEILLANCE STUDY

Investigation into Febrile, Diarrhoeal and Acute Lower Respiratory Illnesses in Papua New Guinea

SUMMARY

The PNG LNG Project is extremely interested in establishing objective, laboratory-based clinical diagnoses. The Project recognizes that the lack of laboratory testing is a major impediment to understanding the true nature and extent of the underlying burden of disease across the iHDSS locations. In order to jump-start the process of accurately diagnosing a suite of critical infectious diseases, the PNG LNG in partnership with PNGIMR and the PNG School of Medicine, developed and built a state of the art Class 2+ infectious disease research laboratory in Port Moresby (POM). This laboratory is staffed and managed by PNGIMR in conjunction with scientists at the School of Medicine. The POM lab mirrors and further extends research capability developed by IMR in Goroka. In addition to providing critical diagnostic research, the laboratory provides an extended educational and training platform for PNG scientists and students.

IMR have adopted and evaluated >60 real-time PCR assays for the detection of the most important pathogens associated with diarrhoeal, febrile and respiratory illnesses in our region. The assays have been optimised and evaluated using stored clinical material that was collected as part of pre-existing studies. The development of this capacity is the first time that such a comprehensive range of assays has been adopted in PNG. In addition to evaluating the assays using stored clinical samples we were able to assist the PNG National Department of Health in confirming that chikungunya virus was the aetiological agent of an outbreak of febrile illness in Vanimo, Sandaun Province. The outbreak subsequently spread throughout the country and we were able to confirm new outbreaks using the assays we had previously adopted.

The collection and analysis of samples from the Asaro iHDSS sites has progressed steadily throughout 2012 and 2013. Collection of samples from other sites, Hiri and Hides, has begun in September and initial febrile and diarrheal sample results are under evaluation. IMR anticipates a significant level of results will become available over the next few months and will be included in the March 2014 report. However, due to the criticality of these investigations, IMR is providing weekly updates to the PNG LNG Project on Hides and Hiri samples.

The October 2013 provides an extensive scientific background into the study and detailed results from the Asao iHDSS site provided by the Goroka laboratory. These results will be compared to the upcoming findings from Hiri, Hides and Karkar.

INTRODUCTION

Diarrhoeal illness

Sanitation and hygiene standards are generally lower in developing countries. Related risk factors are also an important source of outbreak potential - such as interaction with faecally contaminated environmental sources such as local drinking supply, swimming and washing in rivers and the ingestion of faecal-contaminated fresh produce. Diseases related to unsafe water, poor sanitation, and lack of hygiene are some of the most common causes of disease outbreaks, and the resulting death amongst the poor of developing countries. In Papua New Guinea, only approximately 40% of people have access to a safe water supply and adequate sanitation [1], one of the lowest rates in the world. These factors mean that PNG is at an increased risk of disease epidemics.

Enteric infectious diseases remain a serious health concern in Papua New Guinea (PNG). Diarrhoea, primarily caused by enteric infections, remains as one of major causes of death in PNG, and less severe diarrhoeal disease outbreaks cause considerable morbidity and cost to the economy. Despite this, little is known about the aetiology of diarrhoea in PNG, due largely to the lack of necessary facilities and human resources. As such, currently little effort is made to determine the cause of

diarrhea in PNG. However, identification of the pathogens is essential for the selection of appropriate types of antibiotics for treatment and for effective prevention strategies. Currently, there are only a small number of laboratories with the equipment and skilled personnel required to conduct culture for bacterial pathogens. Moreover, culture needs to be conducted quickly after specimen collection, limiting the capacity to collect samples from rural and remote areas.

Febrile illness

Febrile illness is a common clinical presentation at hospitals and health clinics in tropical developing countries. The large range of possible aetiological agents means that clinicians face a difficult decision when deciding upon treatment options. Due to the potential severity of malaria (particularly in children), healthcare providers in endemic regions routinely test for the disease using either microscopy or rapid diagnostic tests. However, a negative result often creates a dilemma as to how to treat a malaria-negative fever, with studies demonstrating gross overtreatment of laboratory confirmed malaria-negative patients with anti-malarial drugs [2-3]. However, the overtreatment of malaria is unlikely to be addressed until we can also better diagnose other major causes of febrile illness in low-income settings.

Febrile illnesses are a major cause of morbidity in Papua New Guinea (PNG). However, an accurate diagnosis of illness is beyond the capacity of the vast majority of diagnostic laboratories in low-income countries, and as such little is known about the aetiology of febrile illness in this setting.

Respiratory illness

Acute lower respiratory infections (ALRI) are the leading cause of morbidity and mortality in children worldwide, resulting in an estimated 4 million deaths annually [4]. This equates to approximately 20% of all childhood deaths, the majority of which occur in developing countries [5]. In Papua New Guinea ALRI is the most common cause of hospitalization for children under the age of 1 years and the second most common cause of hospitalization for children 1-4 years of age [6].

ALRI can be caused by many different aetiologies, including numerous species of bacteria, virus, protozoa and fungi. Although bacterial pathogens, in particular

Haemophilus influenzae and *Streptococcus pneumoniae*, are identified as the major cause of ALRI - viral agents are also considered important agents in the disease process. Various studies have identified viral species as the aetiological agent of ALRI in 20–48% of cases examined [7-10]. In addition to causing primary pneumonia, viruses also damage the mucosal layer of the respiratory tract and therefore predispose the onset of secondary bacterial pneumonia. Numerous studies have shown that co-infections with bacterial and viral respiratory pathogens cause more severe disease. De Roux *et al*. [11] found that people with a mixed infection (viral and bacterial) were at increased risk of sepsis or septic shock.

Although ALRIs result in a high degree of morbidity and mortality the aetiological agent is often unidentified. Conventional culture and serological methods are time consuming and often suffer from poor sensitivity. Some viral agents are unable to be grown in culture due to the unavailability of a suitable cell line to support their growth. Molecular diagnostics such as PCR offer the potential for improved diagnosis of respiratory viruses.

MATERIAL AND METHODS

Evaluation of assays through retrospective analysis of stored clinical samples

Throughout the early phases of this study we have adopted and evaluated an extensive panel of real-time PCR assays for the sensitive and rapid detection of the major pathogens in our region. We now have at our disposal assays for the detection of ~20 of the most important causes of diarrhoea, ~20 of the most important causes of febrile illness (in our region), ~15 of the most important respiratory viruses and 6 important vaccine preventable pathogens (Table 4.1) Initially these assays have been evaluated on stored clinical material which was collected using funding from other sources. These initial studies have been important because they have allowed us to evaluate the sensitivity of the assays and replace assays that were sub-optimal. The development of this capacity is the first time that such a comprehensive range of assays has been adopted in PNG and even allowed us to assist the PNG National Department of Health to confirm the chikungunya outbreak only hours after receiving the initial blood samples from Vanimo. These capabilities have not

previously been possible in PNG. Although the retrospective analysis was conducted on samples that were collected in areas that were not within the iHDSS sites (as PNGMIR had not previously worked in any of these areas except Asaro) the results generated from these studies will provide important comparative analysis when results are compiled from the iHDSS sites.

Causes of acute watery diarrhoea in children

Retrospective analysis was conducted on 199 stool samples collected from Goroka General Hospital from children admitted with acute watery diarrhoea. The inclusion criteria for this study were children < 5 years of age, > 3 loose bowel movementsin the last 24 hours, no blood in the faeces, and collection of thesample within 48 hours of hospitalisation. The samples were collected during routine rotavirus surveillance as part of the Western Pacific RegionRotavirus Surveillance Network (World Health Organization).

The samples were screened for a large range of enteric pathogens using individual Taqman real-time PCR assays. RNA viruses (rotavirus, norovirus G1 and norovirus G2) were detected using the QuantiTect Multiplex RT-PCR Master Mix (Qiagen, Hilden, Germany); DNA viruses (adenovirus type 40/41) and bacteria (*Salmonella* spp., *Shigella* spp., *Vibrio cholerae* and *Campylobacter* spp.) were detected using the QuantiTect Multiplex PCR Master Mix (Qiagen, Hilden, Germany). All reactions and cycling conditions were conducted according to the mastermix manufacturer's instructions. Viral and bacterial positive controls, and negative controls of nuclease-free water, were included with each assay to ensure consistency of the assays.

Evaluation of LAMP for the detection of enteric infections

Loop-mediated isothermal amplification (LAMP) is a nucleic acid amplification test that uses a strand displacement polymerase to synthesise large amounts of DNA during a single temperature step of 60-65°C for less than 60 minutes [12]. The assay uses four primers which are specifically designed to target 6 distinct regions of the DNA template; a further two loop primers can be used to accelerate the LAMP reaction [13]. A variety of methods for detecting nucleic acid amplification in LAMP assays has been described including turbidity, fluorescence, intercalating dyes, gel electrophoresis and pH indicators [14-16]. However, few studies have compared the

relative sensitivity of these methods across a range of assays. LAMP assays show great promise in developing countries as single-temperature amplification and colorimetric detection methods greatly reduce the system complexity of PCR-based methods, while maintaining many of the advantages of nucleic acid amplification methods.

We evaluated the sensitivity of LAMP colorimetric detection methods for *Salmonella*, *Shigella*, and *Vibrio cholerae*. Previously published LAMP assays were utilised with different end-point detection methods, namely visual turbidity, hydroxynaphthol blue (HNB), SYBR Green I, and readings from the Loopamp Endpoint Turbidimeter (Teramecs). The assays were also compared to real-time PCR assays using previously published primers.

Causes of febrile illness in Wipim, Western Province

We investigated the aetiological agents of febrile illnesses for 136 people presenting to Wipim Health Centre in Western Province, Papua New Guinea. Samples were collected as a component of active malaria surveillance of the National Malaria Control Program by the Papua New Guinea Institute of Medical Research covering a period of 37 working-days, between April and June 2009. Arboviral and rickettsial real-time PCR assays, malaria blood smears and a malaria PCR test were used to identify pathogens associated with a history of fever.

Investigation of a febrile disease outbreak in Vanimo

In late June 2012, an increase in cases of prolongedfever for ≥3 days was reported from the Vanimo GeneralHospital in Vanimo, Sandaun Province. The illness wascharacterized by high fever (temperature >40°C), arthralgia,emesis, and severe nausea. In most patients, feversubsided within 24–72 hours and patients were dischargedafter abatement of initial signs and symptoms. However,many patients returned within a few days reporting lingeringarthralgia and severe pruritus. On the basis of clinicalcharacteristics, several arboviruses were immediately suspectedas causes of the illness.

Serum samples were collected from 86 patients withacute fever during September–October 2012. Sampleswere screened for CHIKV, DENV and RRVusing previously

reported real-timereverse transcription PCRs [17-19]. The epidemic subsequently spread throughout much of the country and our laboratory was responsible for the confirmation of cases in new outbreak areas.

Causes of influenza-like-illness

Retrospective analysis was conducted on 300 samples collected in 2010 from two major hospitals in Papua New Guinea during routine influenza surveillance as part of the Global Influenza Surveillance and Research System (World Health Organization). The two hospitals where influenza-like-illness surveillance was conducted were Goroka General Hospital in the highland region of the country and Vanimo General Hospital on the north-west coast. Patients with influenza-like-illness were identified according to the WHO case definition: sudden onset of fever (>38°C), with cough and/or sore throat, in the absence of other diagnoses [20]. Nasopharyngeal swabs and detailed patient data were collected from enrolled participants according to standard methods and stored at -80°C until required for testing.

The samples were screened for a large range of respiratory viruses which have previously been associated with influenza-like-illness. All viruses were detected using individual Taqman real-time PCR assays. RNA viruses (influenza A virus, influenza B virus, respiratory syncytial virus, parainfluenza virus 1-3, coronaviruses (229E, OC43, NL63 and HKU1), metapneumovirus and rhinovirus) were detected using the QuantiTect Multiplex RT-PCR Master Mix (Qiagen, Hilden, Germany) and the DNA viruses (adenovirus) were detected using the QuantiTect Multiplex PCR Master Mix (Qiagen, Hilden, Germany). All reactions and cycling conditions were conducted according to the mastermix manufacturer's instructions. Viral positive controls, and negative controls of nuclease-free water, were included with each assay to ensure consistency of the assays.

Collection of samples from iHDSS sites

Samples were collected from health clinics participating in the PiHP iHDSS. Patients presenting to the clinics with febrile illness over 38°C were tested for malaria using a

commercial rapid test. Regardless of the result, a blood sample was taken for further analysis. If the febrile patient was also showing respiratory symptoms a nasal swab sample was taken for respiratory pathogen screening. Patients presenting to the health clinics with a diarrhoeal illness were asked to provide a faecal sample. If a patient presented with a combination of symptoms (e.g. febrile illness with diarrhoeal and respiratory symptoms) then multiple samples were requested. All of the required sampling materials were provided by PNGIMR including detailed information sheets for the health-care practitioners to complete.

Collection and transport of stool samples

Case definition of diarrhoea - the passing of three or more loose stools, which take the shape of the container, in a 24 hour period.

Self-collected stool specimens were obtained from patients presenting to participating iHDSS clinics with acute diarrhoea meeting the case definition. Specimens were labelled appropriately and linked to the iHDSS Morbidity Case Forms for identification of clinical history. Samples were stored at 4C and transported to the PNGIMR laboratories for further analysis.

Bacterial stool culture and microscopic examination for parasitic pathogens were conducted according to standard procedures. Nucleic acids were extracted from the stool samples using the Qiagen Stool kit and molecular analysis using real-time PCR was conducted for the enteric pathogens listed in Table 4.1.

Collection and transport of blood samples

Case definition of a febrile illness - a current fever of ≥38°C, OR reports a fever over the past 2 days (but not more than 2 weeks).

Blood samples (8-10ml for adults; 1-5ml for children) and blood culture bottles were collected from patients presenting to participating iHDSS clinics who met the case definition of a febrile illness. Specimens were labeled appropriately and linked to the iHDSS Morbidity Case Forms for identification of clinical history. Samples were stored at 4C and transported to the PNGIMR laboratories for further analysis.

Blood culture samples were analysed using standard procedures in the Bactec system. Serum was removed from blood samples and nucleic acids were extracted using the Qiagen DNeasy Blood and Tissue kit. Molecular analysis using real-time PCR was conducted for the febrile pathogens listed in Table 4.1.

Collection and transport of respiratory samples

Case definition of an acute lower respiratory illness - a history of fever OR measured fever of ≥38°C, ANDcough, ANDshortness of breath or difficulty breathing

Nasopharyngeal swabs were collected from patients presenting at participating iHDSS clinics meeting the case definition of an acute lower respiratory illness. Specimens were labelled appropriately and linked to the iHDSS Morbidity Case Forms for identification of clinical history. Samples were stored at 4C and transported to the PNGIMR laboratories for further analysis.

Nucleic acids were extracted from the nasopharyngeal samples using the QIAamp Viral RNA Minikit and tested by real-time PCR for the respiratory pathogens listed in Table 4.1.

Table 4.1 Real-time PCR assays that have been adopted and evaluated in our laboratory for the detection of diarrhoeal, febrile and respiratory illnesses

Disease	**Pathogens**	**Sample type**
Enteric illnesses		
Cholera	*Vibrio cholerae*	Stool sample
Shigellosis	*Shigella* spp	Stool sample
Salmonellosis	*Salmonella* spp	Stool sample
Campylobacteriosis	*Campylobacter* spp	Stool sample
Travellers diarrhoea	Pathogenic *E. coli* (EPEC/ETEC)	Stool sample

Rotavirus	Rotavirus	Stool sample
Other enteric viruses	Adenovirus, Norovirus (GI and GII), Astrovirus, Sapovirus	Stool sample
Febrile illnesses		
Dengue fever	Dengue viruses (DENV1-4)	Blood sample
Murray Valley encephalitis	Murray Valley encephalitis virus	Blood sample, CSF
Japanese encephalitis	Japanese encephalitis virus	Blood sample, CSF
Chikungunya fever	Chikungunya virus	Blood sample
Ross River fever	Ross River virus	Blood sample
Typhoid fever	*Salmonella typhi*	Blood sample
Leptospirosis	*Leptospira* spp	Blood sample
Scrub typhus	*Orientia tsutsugamushi*	Blood sample
Influenza	Influenzavirus A and Influenzavirus B	NP swab
Other viral respiratory pathogens	Respiratory syncytial virus, parainfluenza virus, metapneumovirus, coronavirus, adenovirus, rhinovirus	NP swab
Vaccine preventable diseases		
Measles	Measles virus	Blood sample
Mumps	Mumps virus	Blood sample

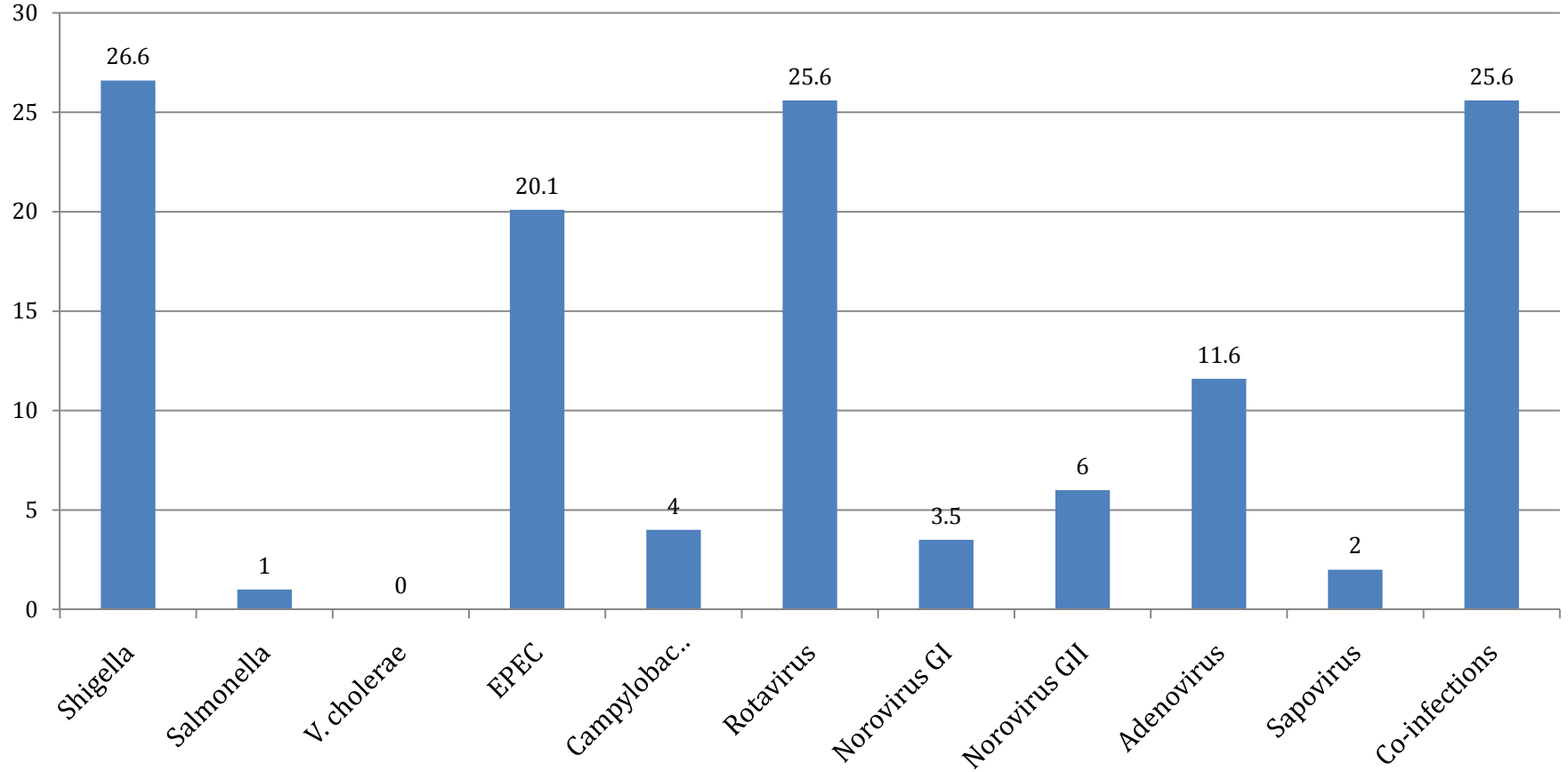
Rubella	Rubella virus	Blood sample
Chicken pox	Varicella zoster virus	Blood sample
Diphtheria	*Corynebacterium diphtheriae*	Throat swab
Whooping cough	*Bordetella pertussis*	NP swab

RESULTS

The aetiology of paediatric acute watery diarrhoea at Goroka General Hospital

The aetiological agent of acute watery diarrhoea was investigated for 199 children admitted to Goroka General Hospital. An enteric pathogen was detected in 67.8% (n=135) of the samples tested. *Shigella* spp. (26.6%), Rotavirus (25.6%), enteropathogenic *Escherichia coli* (20.1%) and enteric adenovirus (11.6%) were the pathogens most commonly detected. All other pathogens were detected at varying rates below 10% (Figure 4.1). Mixed infections were detected in 25.6% diarrhoeal cases, with rotavirus (n=26) and *Shigella* spp. (n=25) the most commonly detected in co-infections.

Figure 4.1 The aetiology of paediatric acute water diarrhoea at Goroka General Hospital (% positive; n=199)



Evaluation of LAMP colorimetric dyes for the detection of enteric pathogens

The detection sensitivities of HNB and SYBR Green I were identical across all three LAMP assays used in this study (Table 2). The colorimetric dyes detected <48 colony forming units (CFU), <9.6 CFU and <3.2 CFU for the *Salmonella*, *Shigella*, and *V. cholerae* assays, respectively. Comparatively, the real-time PCR assays were between 1-2 logs more sensitive than the LAMP colorimetric assays, which are comparable to other studies that have directly compared real-time PCR and LAMP [21,22]. However, bacteria are usually excreted in very high numbers in patients with enteric infections such as salmonellosis, shigellosis and cholera [23-25] and therefore the LAMP reactions may have sufficient sensitivity for clinical use.

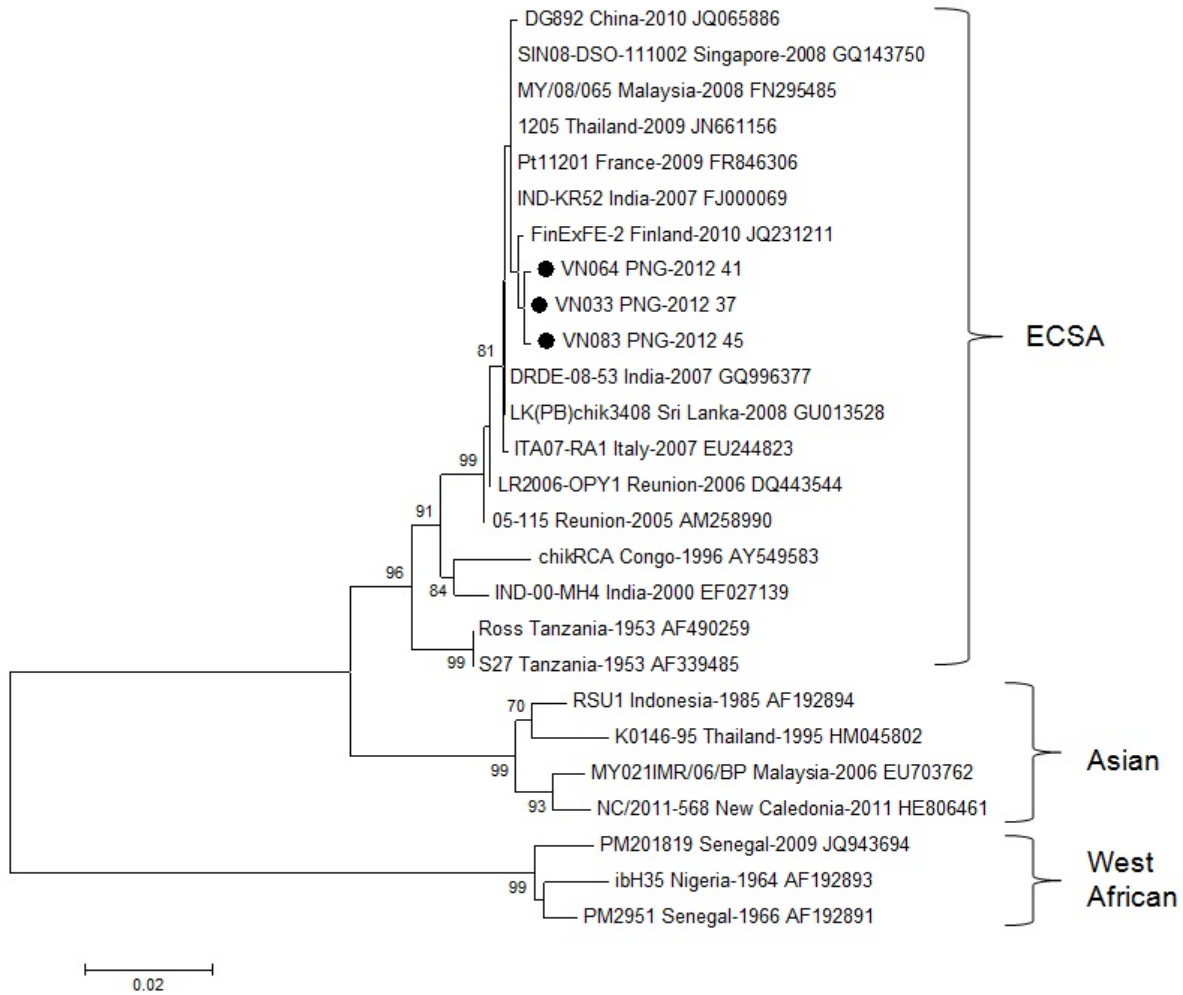
The aetiology of febrile illnesses in Wipim, Western Province

All of the clinical samples were tested for regionally important arboviruses and rickettsials (Table 1) to detect the aetiological agents of fever in the area. Dengue virus 1 (DENV-1) was detected in 11.0% (n=15) of the samples. Malaria was detected in three patients by both light microscopy and PCR. No other dengue type and none of the other pathogens of interest were detected in any of the samples.

Investigation into an outbreak of chikungunya in Vanimo, Sandaun Province

During June 25–November 25, a total of 1,590 suspected cases of chikungunya were recorded at Vanimo General Hospital (Figure 2). Real-time RT-PCR was used to confirm that the outbreak was caused by chikungunya virus. Partial E1 genes for 3 CHIKV strains from PapuaNew Guinea (VN033–KC524770, VN064–KC524771,and VN083–KC524772) were sequenced [17]. The PapuaNew Guinea strains had high levels of nucleotide (99.9%)and amino acid (100%) identity; only 2 synonymous sequencepolymorphisms were observed between the 3strains. Sequence alignment and phylogenetic analysis ofE1 sequences showed that the Papua New Guinea outbreakwas caused by CHIKV from the ECSA genotype (Figure 4.2). All 3 CHIKV strains had the E1:A226V mutation which enhances the transmissibility of CHIKV in *Aedes albopictus* mosquitoes.

Figure 4.2 Chikungunya phylogenetic tree showing that the PNG strains belong to the ECSA genotype.



The aetiology of Influenzae like illness (ILI) in Goroka

Table 4.2 The frequency of viral detection in ILI patients

Characteristics	Number of cases (%)		*p* value[a]
	<5 yr (n=167)	> 5yr (n=133)	
Tested positive for a virus	132 (79.0)	67 (50.4)	**0.0001**
Multiple viral agents	25 (15.0)	5 (3.8)	**0.0015**
Influenza A	26 (15.6)	24 (18.0)	0.6405
Influenza B	29 (17.4)	9 (6.8)	**0.0081**
Rhinovirus	33 (19.8)	18 (13.5)	0.1667
Respiratory syncytial virus	22 (13.2)	4 (3.0)	**0.0017**
Adenovirus	19 (11.4)	1 (0.8)	**0.0001**
Parainfluenza virus 1	4 (2.4)	4 (3.0)	0.7363
Parainfluenza virus 2	4 (2.4)	0 (0)	0.1321
Parainfluenza virus 3	13 (7.8)	6 (4.5)	0.3408
Metapneumovirus	0 (0)	3 (2.3)	0.0860
Coronavirus 229E	0 (0)	2 (1.5)	0.1957
Coronavirus OC43	5 (3.0)	3 (2.3)	0.7363
Coronavirus NL63	0 (0)	2 (1.5)	0.1957
Coronavirus HKU1	2 (1.2)	0 (0)	0.5048

[a]*p* value - Fischer's Exact Test (significant values in bold)

Among the 300 patients presenting with an influenza-like-illness at Goroka and Vanimo Hospitals, a viral respiratory pathogen was detected in 66.3% (n=199) of samples. HRV (17.0%, n=51), influenza A (16.7%, n=50) and influenza B (12.7%, n=38) were the viruses most commonly detected in the nasopharyngeal swabs (Table 4.2). All other viruses targeted during this study were detected at varying rates below 10%. Mixed infections were detected in 10.0% of patients, and influenza A and HRV were most commonly associated with co-infections with other viruses.

The rates of virus detection for most of the viruses included in this study were not significantly different between the two age groups analysed (<5 years and >5 years). However, influenza B (p=0.0081), HAdV (p=0.0001) and HRSV (p=0.0017) were all detected at significantly higher rates in patients <5 years of age with an influenza-like-illness (Table 4.2). There was also a significant difference in the two age groups for the detection of at least one viral pathogen in a patient (p=0.0001) and the detection of viral co-infections (p=0.0015).

Collection and analysis of samples from iHDSS clinics

Asaro

Sample collection at Asaro Clinic commenced in early 2012 following the recruitment of a nursing officer to work full-time at the clinic. During this period we have collected 34 stool samples from patients presenting with diarrhoea and 69 serum samples from patients presenting with a febrile illness.

Standard bacterial culture of stool samples has revealed a high prevalence (44.1%) of *E. coli* in the stool samples. Real-time PCR results are pending to determine if the pathogenic strains of *E. coli* are present in the samples. *Shigella* sp. was isolated from 8.8% (n=3) of the faecal samples which again confirms that this organism is an important cause of disease in PNG. Molecular testing of the samples is pending following the optimisation of assays using retrospective analysis of stored samples.

Hiri

We have now achieved full functionality in the Port Moresby laboratory following the recent installation of a real-time PCR machine and the transfer of most molecular assays to this laboratory. The collection of serum samples from febrile patients has recently commenced and results from molecular assays are pending. We have received six serum samples (and further samples were recently received) from ExxonMobil to test for *Salmonella typhi* following a suspected typhoid outbreak. All of the samples were negative for *S. typhi*, however one sample was positive for *Shigella flexneri* and another for Norovirus G2.

Hides

Senior project staff (Dr Paul Horwood and Dr Kevin Soli) travelled to Hides (Papa and Malanda Clinics) to evaluate the readiness of the site for sample collection. To date 12 stool samples have been collected from patients presenting with diarrhoeal illnesses. No pathogens could be cultured from any of the samples.

Karkar

Senior project staff (Dr Kevin Soli and Dr Yazid Abdad) are scheduled to visit Karkar on the 2nd to the 4th of October. The site will be evaluated for readiness to commence sample collection.

Progress in the Port Moresby laboratory

The Port Moresby laboratory has been completed and our group has relocated two staff to work on the PiH study. A senior staff member (Dr Kevin Soli) has relocated to the Port Moresby laboratory to ensure that sample collection and analysis commences smoothly. All molecular assays have been successfully introduced to the new laboratory.

DISCUSSION

As a tropical, developing country PNG is at great risk from infectious disease outbreaks. This has been highlighted by the recent maiden-outbreaks of cholera and chikungunya in this country. There is currently a low capacity for outbreak investigation and confirmation of aetiology in PNG.Over the past 2 years the EEDU group has been making efforts to adopt a wide range of diagnostic tests so that we are able to detect many of the outbreak-prone pathogens in our region. This capacity development allowed us to rapidly confirm the outbreak of chikungunya only hours after receiving the first samples from Vanimo. Rapid confirmation of outbreak aetiology has been greatly lacking in this country for many years, and previous outbreaks have required samples to be sent to overseas reference laboratories for confirmation of clinical diagnoses. The capacity we have built could potentially be passed on to CPHL and other national laboratories with the necessary capacity.

Notwithstanding the need for increased capacity for the rapid confirmation of the aetiology of outbreaks, there is also a distinct lack of data about the causes of 'every-day' illnesses in PNG. Febrile, diarrhoeal and respiratory illnesses can all be caused by a large range of viral, bacterial and protozoan infections – with limited clinical characteristics able to determine the likely aetiology. Nonetheless, it remains unattractive to most funding agencies despite a survey conducted more than 10 years ago identifying 'modified molecular technologies for affordable, simple diagnosis of infectious diseases' as the most important application of biotechnology for improving health in low-income countries; ranking it above vaccines and medicines [26]. In this study we aim to determine the major causes of disease in the four iHDSS areas so that clinicians can be guided on appropriate treatments for these illnesses.

Diarrhoeal illnesses

Diarrhoeal illness is a major health issue in developing countries, particularly in children under the age of 5 years. Morbidity and mortality remains high in this age group with more than 2.5 million deaths per year occurring in developing countries. This equates to more than 13% of child deaths per year worldwide [27]. The most comprehensive investigation into the aetiology of diarrhoeal illness in PNG was

published by Howard et al. [28]. This study investigated 1,526 children admitted to Goroka hospital over a 5-year period between 1985 and 1990. The most commonly isolated pathogens were rotavirus (23%), *Shigella* spp. (13%), *Campylobacter* spp. (12%), *Cryptosporidium parvum* (10%) and enteropathogenic *Escherichia coli* (8%). However, a recognised pathogen was identified in only 39% of cases. The results we have generated in the present study from paediatric cases of acute watery diarrhoea at Goroka General Hospital are comparable to the main aetiological agents identified by Howard et al. [28], with *Shigella* spp. (26.6%), rotavirus (25.6%), enteropathogenic *Escherichia coli* (20.1%) and enteric adenovirus (11.6%) the main pathogens detected.

The collection of stool samples from Asaro (and limited collection from Hides) has confirmed that *Shigella* spp. is an underappreciated cause of enteric illness in PNG. The frequent identification of enteric parasites such as *Entamoeba* sp., *Giardia* sp., and *Cryptosporidium* sp. highlights the need for improved data on the prevalence of these pathogens across the four iHDSS sites. We are currently adopting and evaluating real-time PCR assays for the detection of these important pathogens.

Rapid diagnostic methods that are sensitive, specific and inexpensive are needed for routine diagnostic purposes and for disease outbreak investigations in resource-poor settings [29]. LAMP assays are particularly attractive for resource-limited settings as they do not require costly equipment (compared to expensive thermocyclers needed for real-time PCR) and are highly specific and sensitive. We have shown that the application of colorimetric dyes, as indicators for a positive reaction, can improve the simplicity of the interpretation of results, without adversely impacting on sensitivity of the assay. Indeed, the sensitivity of the LAMP assay is such that it could be used for case control studies to detect carriage as well as disease. We are conducting further evaluation of LAMP technologies to develop field-based assays that can be operated in a rural setting without power. Initial trials in our laboratory suggest that these applications are feasible and can have comparable sensitivity and specificity to conventional PCR.

Febrile illnesses

The recent (perhaps ongoing) outbreak of chikungunya in PNG has highlighted the fragility of outbreak response capabilities in this country and the difficulties in implementing appropriate outbreak mitigation strategies. The disease has now spread from the original outbreak site of Vanimo (Sandaun Province) to impact 10 additional Provinces (confirmed by our laboratory); and suspected outbreaks in a further 3 Provinces (Figure 4.3). The introduction of chikungunya into Papua New Guinea has coincidedwith the appearance of a variant strain of CHIKVthat has a mutation from alanine to valine at amino acidposition 226 in the envelope 1 (E1) glycoprotein gene. Sequence analysis of the PNG strains has confirmed that this strain is responsible for the present outbreak (Figure 4.2). This mutation enables CHIKV strains to more efficientlyreplicate in the salivary gland of *Ae. albopictus* mosquitoes,thus enhancing the role of this vector in transmissionof virus to susceptible human hosts [30]. Further studies conducted by PNGIMR have confirmed that *Ae. Albopictus* is the primary *Aedes* sp. along the north coast of PNG and the likely vector of the chikungunya outbreak [31]. Interestingly, the outbreak extended to the HighlandsRegion of PNG, which is the first confirmedarboviral outbreak recorded in this region of the country.Although no entomologic surveys have been conductedin the Highlands Region for many years, it has beenshown that *Aedes* mosquitoes are present in abundantnumbers. This may have important implications as morethan 50% of the PNG population live inthe Highlands Region.

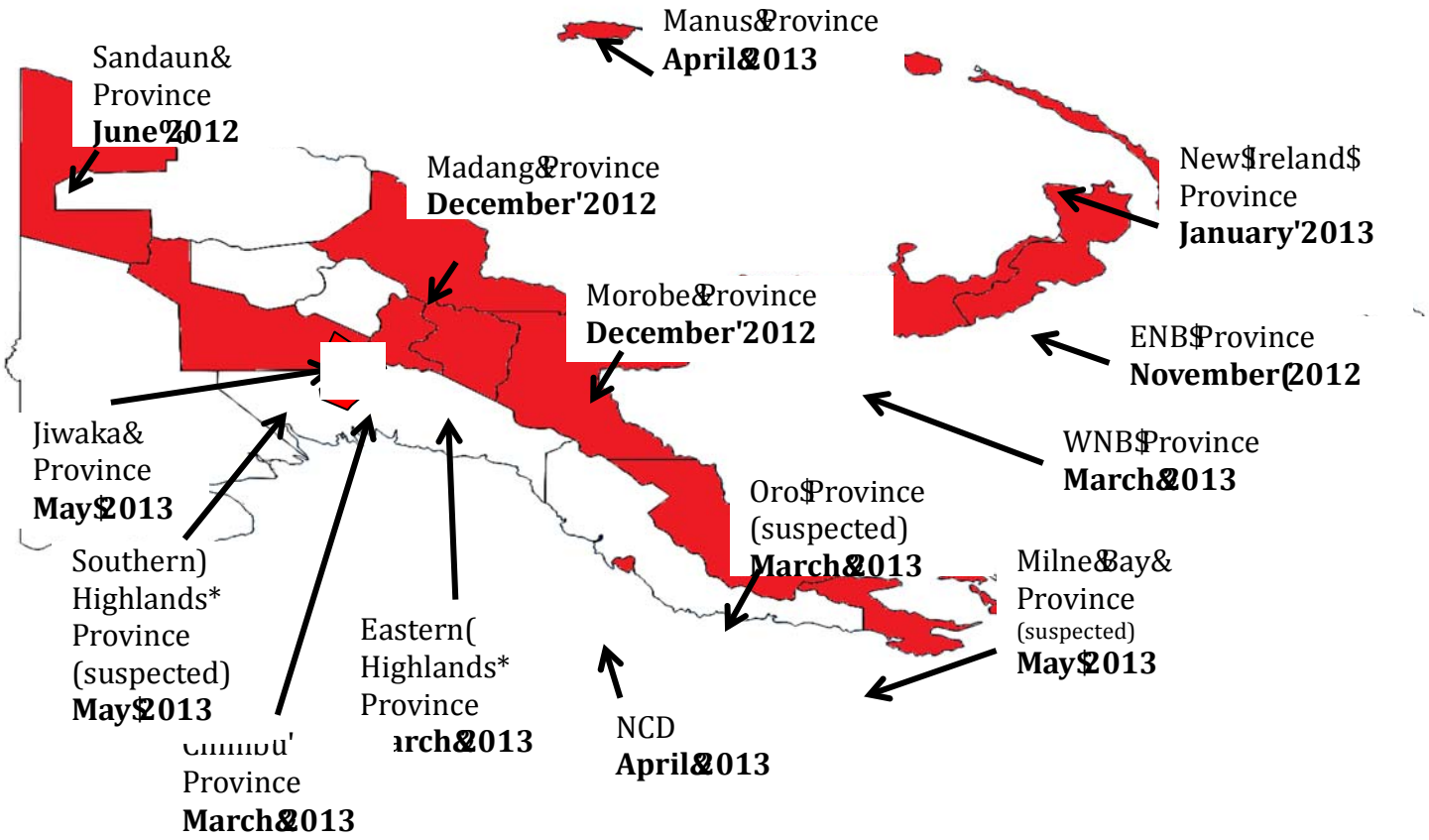
During the investigations into the causes of febrile illnesses at Wipim Health Centre (South Fly district, Western Province), DENV-1 was the most important pathogen detected in febrile patients. Although it is generally accepted that dengue is endemic and an important cause of febrile illnesses throughout the lowlands of PNG, very few studies have been conducted to investigate the prevalence and distribution of this important pathogen. Dengue outbreaks have been reported in PNG in the past [32,33], and a recent study at Yagaum rural hospital and Jumba town clinic, Madang Province detected DENV in 8% of febrile cases enrolled into the study [34]. Dengue fever has been widely reported in other neighbouring countries such as Fiji, French Polynesia and New Caledonia, where it has become a major concern among health

authorities [33]. The prevalence and distribution of DENV in PNG is currently unknown, and further research into this area is clearly needed.

Respiratory illnesses

This study demonstrated that multiple respiratory viruses are circulating in Papua New Guinea that may contribute to the high burden of acute respiratory infections in this population. The comparison between children <5 years of age and other patients highlights the differing aetiologies of respiratory disease in young children and provides important information for clinicians when treating patients presenting with an acute respiratory illness. The results from this study were consistent with the previous report from Chidlow et al [35] which found that influenza A, RSV and adenovirus were the most important causes of acute lower respiratory infections in PNG children.

Figure 4.3. Progression of the chikungunya outbreak in Papua New Guinea



PROGRESS AND CHALLENGES

We have completed the evaluation of a large range of assays using stored clinical samples. These studies have provided important information about the importance of specific pathogens in the presentation of diarrhoeal, febrile and respiratory illnesses. The development of the capacity to detect such a wide range of pathogens has also meant that we are now able to assist the PNG National Department of Health in disease outbreak investigations.

The commencement of sample collection at all of the iHDSS locations is ongoing and sample collection are now expected to proceed rapidly and results are already becoming available.

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CHAPTER 5. MATERNAL AND CHILD HEALTH STUDY

Vaccination Coverage among Children in iHDSS

INTRODUCTION

The PNG LNG Project has a strong interest in understanding the underlying health systems performance at key potentially impacted areas. Evaluating vaccination coverage is an appropriate and useful way to (i) ascertain of standard vaccination services are being provided at international levels and (ii) understand the potential for vaccine-preventable infectious disease outbreaks in key communities. Therefore, the PNG LNG Project through the PiHP sponsored a major vaccination coverage exercise across key iHDSS locations. This chapter presents the results of this investigation.

Vaccination is the process whereby a person is made immune or resistant to an infectious disease, typically by the administration of a vaccine. Vaccines stimulate the body's own immune system to protect the person against subsequent infection or disease. Childhood diseases (Hib diseases, pertussis, measles, neonatal tetanus, pneumococcal diseases and rotavirus) that are preventable by vaccines are still high in many developing countries globally. About 17% of deaths in children under-five years of age are attributed to these diseases [1]. The WHO aims for a 90% coverage of the Expanded Program on Immunization (EPI) by12 months of age. WHO launched the Expanded Program on Immunization (EPI) in 1974, to provide vaccine against polio, DTP (diphtheria, tetanus, and pertussis), tuberculosis, and measles to all children. Immunization currently averts an estimated 2 to 3 million deaths every year but an estimated 22 million infants worldwide are still missing out on basic vaccines in 2011 [1]. In most low-income countries the core vaccines in the EPI are BCG and oral polio vaccine (OPV) at birth, diphtheria- tetanus-pertussis vaccine (DTP) and OPV at 6, 10 and 14 weeks and measles vaccine at 9 months of age though new vaccines are now being added. Immunisation is the most cost-effective and highest-impact health intervention, reducing hospitalisation and treatment costs through prevention.Priority needs to be given to strengthening routine vaccination, especially in the areas that are of high number of unvaccinated children.

Current EPI vaccines in Papua New Guinea

Bacille Calmette–Guérin (BCG) vaccine prevents tuberculosis, caused by *mycobacterium tuberculosis* bacteria.

Haemophilus influenzae type b (Hib) vaccine prevents meningitis and pneumonia.

Hepatitis B (HepB) vaccine prevents a viral infection from Hepatitis B virus that attacks the liver can lead to cirrhosis and hepatocellular carcinoma.

Measles vaccine prevents a highly contagious disease caused by a virus specifically a paramyxovirus, which usually results in a high fever and rash, and can lead to blindness, encephalitis or death.

DTP prevents Diphtheria, a contagious disease caused by *Corynebacterium diphtheriae*, bacterium spread by direct physical contact or breathing the aerosolized secretions of infected individuals. Symptoms of diphtheria include fever, chills, sore throat, hoarseness, difficulty swallowing, painful swallowing, difficulty breathing, foul-smelling bloodstained nasal discharge and lymphadenopathy.

DTP prevents Pertussis or whooping cough, is a highly contagious bacterial disease caused by *Bordetella pertussis*.Symptoms are initially mild, and then develop into severe coughing fits, can cause subconjunctival hemorrhages, rib fractures, urinary incontinence, hernias, post-cough fainting, and vertebral artery dissection.

DTP prevents Tetanus, caused by a bacterium *Clostridium tetani* which grows in the absence of oxygen, e.g. in dirty wounds or in the umbilical cord if it is not kept clean. It produces a toxin, which can cause serious complications or death from spasms affecting muscles that help with breathing, which can lead to breathing problems.

Oral polio Vaccine (OPV) prevents Polio, caused by Poliovirus a highly infectious viral disease that can cause irreversible paralysis.

Source: WHO 2013.

Schedules of the Expanded Programme on Immunization (EPI) in PNG

At Birth: BCG, HepB

At 1 month: DTP/Hib/HepB, OPV

At 2 month: DTP/Hib/HepB, OPV

At 3 month: DTP/Hib/HepB, OPV

At 6 month: Measles

At 9 month: Measles

At 12 month: Vitamin A

BACKGROUND

About 17% of deaths in children under-five years of age are attributed to vaccine preventable childhood diseases (ie Hib, pertussis, measles, neonatal tetanus, pneumococcal diseases and rotavirus) [1]. The Expanded Programme on Immunization (EPI) provides necessary vaccines for disease prevention to population. Vaccination coverage is one of the most important indicators to evaluate the performance of health care delivery. The current Maternal and child health (MCH) study was conducted as a sub-study under PiH project. There are two components of MCH in population-based surveys, one evaluates the child's health (e.g., vaccination coverage or nutrition status) and another is focused on maternal health (e.g., birth outcome, morbidity during pregnancy and family planning). This survey on vaccination coverage is part of the MCH study. Hiri West in Central Province and Hides/Komo, Southern Highland Province are sites experiencing major and rapid economic development inducing population migration, which adds burden on existing health care facilities. This report presents results of vaccination coverage adherence to vaccination schedules in Hiri Health and integrated Health Demography Surveillance sites (iHDSS) and Hides/Komo iHDSS.

MATERIAL AND METHODS

A cross-sectional household survey was conducted in the first quarter of 2013 in the Hiri iHDSS, Hides/Komo iHDSS and Asaro iHDSS (from February to April 2013). A list of all children aged 1 to 5 years old was obtained from the iHDSS database. A specific questionnaire was developed to obtain records of vaccination dates from the children's health books and to assess the condition of health books.

Figure 5.1. The example of the vaccination record in health book

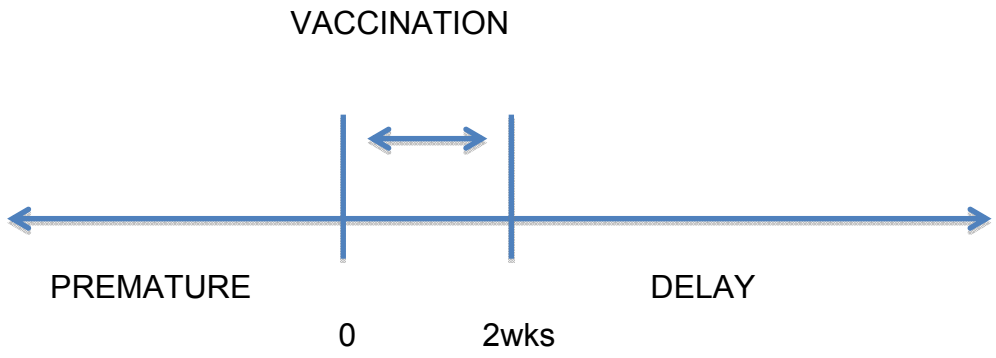
	1ST date	2nd date	3rd date	4th date
BCG				
Hep B				
Sabin/OPV				
TA				
DTP/Hib				
MEASLES				
Vitamin A				

After consent was obtained from the parents or guardians of children, DSS reporters collected and recordedinformation from the children's health book. The forms were returned weekly and the scientific officers performed quality checks by repeating the survey with 25% of all health books to validate the data. The records were entered into a Microsoft Access database and linking to iHDSS database to obtain the relevant demographic information. Statistical analysis was performed with STATA software version 12 (STATA Corp, College Station, TX) to determine vaccination status, coverage and the delay of vaccination. Chi-square (χ^2) tests were used to determine difference in vaccination coverage among doses of each vaccine. Probability values were considered to be statistically significant when the calculated P-value was ≤ 0.05.

A vaccination was considered delayed if the vaccine was given 2 weeks and more after the due date. For example, BCG is to be given from at birth up to 2 weeks old

while the 1st DTP/Hib/HepB would be at 1 month up to 1 month and 2 weeks (see Figure 5.2).

Figure 5.2. Calculating the delay and premature of vaccination



5.1 HIRI iHDSS

RESULTS

There are 398 children aged from 1 to 5 years old in the Hiri iHDSS census list (conducted in Nov 2011- May 2012). There was a slightly higher number of male than female children (52.3% vs 47.7%). At the time of the survey, 20 children were not present due to migration out of the area. 378 children were available to check for their health books. Of these, 314 children had health books, and 64 children did not have health books (16.9%). Those who had no health book, most of them (63 of 64) lost their health books, and one health book was badly damaged.

Table 5.1. Gender of study participants in Hiri iHDSS and health book ownership

Total	398
Female	190 (47.7%)
Male	208 (52.3%)
Migrated out	20 (5%)
Did not have health book	64 (16.9%*)
Had Health book	314 (82.8%*)

* % of 379 (from total of 398 -20 who migrated out)

Table 5.2. Conditions of health books in Hiri iHDSS

Condition of health books (N=314)		**%**
Good	213	67.8
Moderate	84	26.8
Bad	17	5.4

Of the 314 children who had health books, nearly 70% of health books were kept in good condition. Although 5.4% were in bad conditions, we were able to record the dates of vaccination.

Vaccination Coverage Rates

The vaccination coverage rates for 1st vaccines were 84.7% for BCG, 74.2% for HepB, 85% for OPV, 78% for DTP/Hib/HepB and 79.9% for Measles. As lower coverage rate was found for the 2nd and 3rd doses of all vaccines.

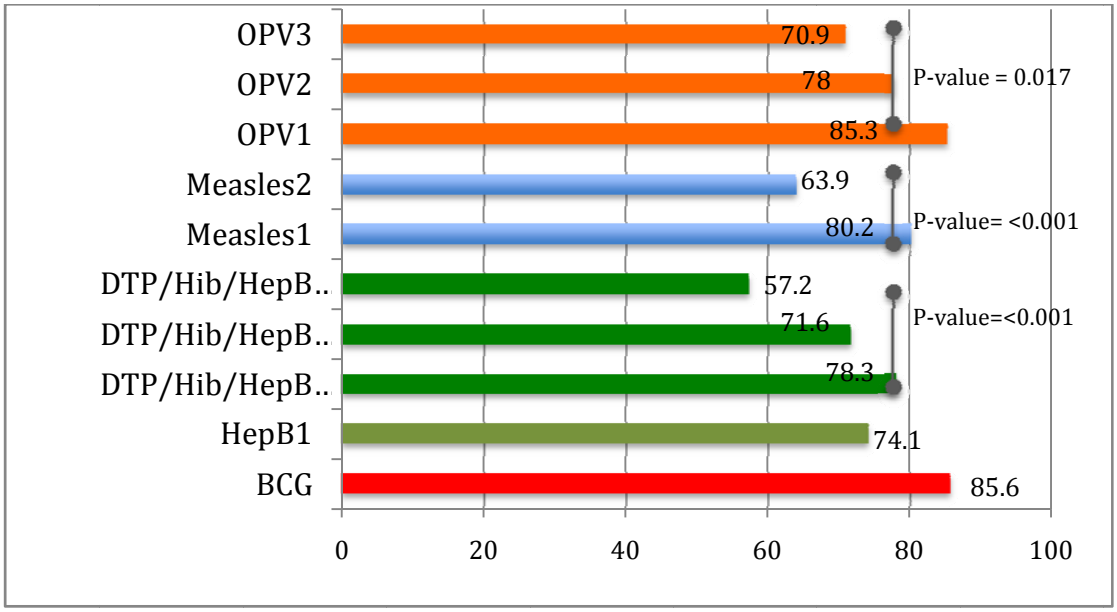
The Figure 5.3 shows decreasing coverage rates in the later vaccine doses. DTP/Hib/HepB coverage rates decreased from 78.3% at the 1st dose to 57.2% at the final dose (p <0.001), Measles (1st: 80.2% vs 2nd: 63.9%, p <0.001) and OPV (1st OPV 85.3%, 2nd OPV 78%, 3rd OPV 70.9%, p=0.017) coverage rates decreased similarly.

Table 5.3. Vaccination coverage rates in Hiri iHDSS

Vaccines	**N=314**	**%**
BCG	266	84.7
HepB1	233	74.2
DTP/Hib/HepB dose1	245	78.0
DTP/Hib/HepB dose2	224	71.3
DTP/Hib/HepB dose3	179	57.0
Measles1	251	79.9

Measles2	200	63.7
OPV1	267	85.0
OPV2	248	79.0
OPV3	218	70.1

Figure 5.3. The coverage rates among vaccine doses in Hiri iHDSS



Vaccine Dose Completion

The rates of completion of all vaccination doses were between 57-70% in the study areas. Sixteen percent of the participants received only one dose of Measles vaccine. Around 7% and 6% of participants received only one dose of DTP/Hib/HebB, and OPV, respectively.

Table 5.4. Dose completion of vaccination in Hiri iHDSS

Vaccine	Hiri iHDSS Coverage with Vaccine Doses (N=314)	%	Global Coverage with Vaccine Doses (%)*
DTP/Hib/HepB	179	57.2 %	83 %
OPV	218	69.4 %	84 %
Measles	200	63.7 %	N/A
Measles 1 dose at 2 years old	249	79.3 %	84%

* WHO & UNICEF, 2013

Table 5.4 shows a comparison the vaccine dose completion rate with the Global Immunization coverage figures, dose completion rates of all three vaccine-types in this study were lower than the Global rates, with DTP/Hib/HepB was as low as 57%.

Vaccination at Correct Time Schedule

For vaccination to offer optimal protection against the respective diseases, vaccines should be given at the right time. Adherence to the EPI schedule is thus and important component of EPI.

Table 5.5. Receiving vaccination at correct time schedule in Hiri iHDSS

Vaccines	N=314	%
BCG	186	59.2
HepB1	174	55.4
DTP/Hib/HepB dose1	132	42.0
DTP/Hib/HepB dose2	83	26.4
DTP/Hib/HepB dose3	50	15.9
Measles1	97	30.9
Measles2	50	15.9
OPV1	119	37.9
OPV2	69	22.0
OPV3	52	16.6

Approximately 60% of participants received BCG and HepB between at birth up to 2 weeks old. The vaccination rates at the correct time for the 1st doses of other vaccines were low and ranged from 42% for DTP/Hib/HepB, 30.9% for Measles and 30.3% for OPV. The adherence to vaccination schedule was even lower for final doses of vaccines and only 15.9% of DTP/Hib/HepB, 15.9% of Measles and 17.8% of OPV doses were given at the correct time.

Vaccination Delay

The mean of delay for the administration of each vaccine dose ranged from 54 (1st OPV) to 90 days (2nd Measles). Again, the later doses of each vaccine showed a longer delay. Overall, the average delay for all vaccines was 73 days, or 2.5 months.

Table 5.6. Delay of vaccination in Hiri iHDSS

Vaccines	N=314	%	Mean (days)
BCG	80	25.5	63
HepB1	59	18.8	67
DTP/Hib/HepB dose1	93	29.7	72
DTP/Hib/HepB dose2	120	38.3	76
DTP/Hib/HepB dose3	117	37.4	83
Measles1	118	37.7	88
Measles2	109	34.8	90
OPV1	148	47.1	54
OPV2	156	49.7	61
OPV3	152	48.6	75

Premature Vaccination

Between 5-17% of participants received at least one vaccine prematurely compared to PNG vaccine schedule. When DTP/Hib/HepB vaccine was given prematurely, the difference ranged from 7 day to 13 day. Fifteen percent of participants received the 1st Measles vaccine approximately 1 month prematurely as well as 17% received the 2nd Measles 2 months too early (ie around 7 instead of 9 months of age).

Table 5.7. Receiving vaccine prematurely in Hiri iHDSS.

	N=314	%	Mean (days)
BCG	N/A		
HepB1	N/A		
DTP/Hib/HepB dose1	20	**6.4**	7
DTP/Hib/HepB dose2	21	**6.7**	9
DTP/Hib/HepB dose3	12	**3.8**	13
Measles1	36	**11.5**	39
Measles2	41	**13.1**	57
OPV1	N/A	**N/A**	N/A
OPV2	23	**7.3**	18
OPV3	14	**4.5**	13

CONCLUSION

The “Health Book” is the only means of health record keeping for individuals in PNG. This survey showed that 17% of children in the survey had no health books. However, among those with health books most kept their health books in good condition. The vaccine coverage rate varied and decreased for all vaccines from the first to later doses. The lowest coverage rate was with DTP/Hib/HepB at 57%. Vaccine dose completion rates of all three vaccine-types (DTP/Hib/HepB, OPV and Measles) were lower than Global vaccine coverage rates [2].

This survey showed that even for vaccines given at birth (BCG and HepB) less than 60% of participants received the vaccines at right time. Rates were even lower among later doses such as 2nd measles at 15.9% and or 3rd DTP/Hip/HepB at 15.9%. Conversely, 5-17% received vaccines prematurely compared to the EPI schedule. Delay of vaccination was seen with all vaccines with overall average delay of 73 days, or ~2.5 months. Again, the later doses of each vaccine showed a longer delay and the most delayed vaccine was 2nd measles at 90 days.

5.2 HIDES/KOMO iHDSS

RESULTS

There are 482 children aged from 1 to 5 years old in the Hides/Komo iHDSS census list (conducted in May-Oct 2012). There was a slightly higher number of female than male children (50.8% vs 49.2%). At the time of the survey, 170 children were not present, 153 migrated out of the area, 16 were not available after twice visits, and only 1, the parents refused to participate in this survey. Total of 312 children were available to check for their health books. Of these, 229 children had health books, and 83 children did not have health books (26.6%). Those who did have health book, 47.0% (of 83) had lost their health books, and 53.0% (of 83), their health books were badly damaged.

Table 5.8. Gender of study participants and health book ownership in Hides/Komo iHDSS

	N= 482
Female	245 (50.8%)
Male	237 (49.2%)
Migrated out	153 (31.7%)
Not available after twice visits	16 (3.3%)
Refused	1 (0.2%)
Did not have health book	83 (26.6%*)
Had Health book	229 (73.4%*)

* % of 312 = from total of 482 -170 (who were not available, migrated out and refused)

Table 5.9. Conditions of health books in Hides/Komo iHDSS

Condition of health books (N=229)		**%**
Good	100	43.7
Moderate	89	38.8
Bad	40	17.5

Of the 229 children who had health books, nearly half of health books were kept in good condition. Although 17.5% were in bad conditions with damages, we were able to record the dates of vaccination.

Vaccination Coverage Rates

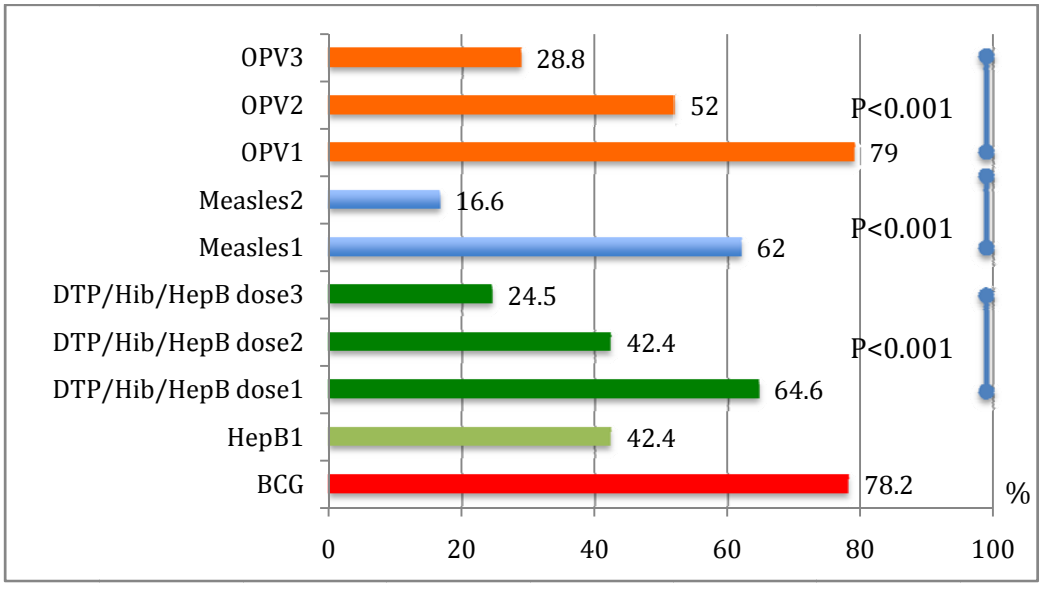
Table 5.10. Vaccination coverage rates in Hides/Komo iHDSS

Vaccines	**N=229**	**%**
BCG	179	78.2
HepB1	97	42.4
DTP/Hib/HepB dose1	148	64.6
DTP/Hib/HepB dose2	97	42.4
DTP/Hib/HepB dose3	56	24.5

Measles1	142	62.0
Measles2	38	16.6
OPV1	181	79.0
OPV2	119	52.0
OPV3	66	28.8

The vaccination coverage rates for 1st vaccines doses were 78.2% for BCG, 79% for OPV, 64.6% for DTP/Hib/HepB and 62.0% for Measles, however HepB coverage was low at 42.4%. Lower coverage was found for the 2nd and 3rd doses of all vaccines. The Figure 5.4 shows decreasing coverage rates in the later vaccine doses. DTP/Hib/HepB coverage rates decreased from 64.6% at the 1st dose to 24.5% at the final dose (p <0.001), Measles (1st Dose: 62.0% vs 2nd Dose: 16.6%, p <0.001) and OPV (1st OPV 79.0%, 2nd OPV 42.4%, 3rd OPV 24.5%, p<0.001) coverage rates decreased similarly.

Figure 5.4. The coverage rates among vaccine doses in Hides/Komo iHDSS



Vaccine Dose Completion

The rates of completion of all vaccination doses were between 16-30% in the study areas. It is noted that 38.0% of children had not received any Measles vaccine. In this iHDSS, 59.8% of children received at least one dose of measles vaccine before 2 years of age. Comparing the vaccine dose completion rate in Hides/Komo iHDSS with the Global Immunization coverage figures; dose completion rates of DTP/Hib/HepB and OPV in this study were approximately 2-3 times lower than the Global rates e.g., DTP/Hib/HepB was 24.5%; the Global coverage rate of this vaccine was 83%.

Table 5.11. Dose completion of vaccination in Hides/Komo iHDSS

Vaccines	Hides/Komo iHDSS Coverage with Vaccine Doses (N=229)	%	Global Coverage with Vaccine Doses (%)*
DTP/Hib/HepB	56	24.5 %	83 %
OPV	66	28.8 %	84 %
Measles	38	16.6 %	N/A
Measles 1 dose at 2 years old	137	59.8 %	84%

* WHO & UNICEF, 2013

Vaccination at Correct Time Schedule

For vaccination to offer optimal protection against the respective diseases, vaccines should be given at the right time. Adherence to the EPI schedule is thus and important component of EPI. 24.5% and 18.3% of participants received BCG and HepB between at birth up to 2 weeks old. The vaccination rates at the correct time

for the 1st dose of other vaccines were very low and ranged from 7.9% for DTP/Hib/HepB, 3.1% for Measles and 2.2% for OPV. The adherence to vaccination schedule was even lower for final doses of vaccines and only 0.9% of DTP/Hib/HepB, 0.4% of Measles and 1.7% of OPV doses were given at the correct time.

Table 5.12. Receiving vaccination at correct time schedule in Hides/Komo iHDSS

Vaccines	**N=229**	**%**
BCG	56	24.5
HepB1	42	18.3
DTP/Hib/HepB dose1	22	9.6
DTP/Hib/HepB dose2	9	3.9
DTP/Hib/HepB dose3	3	1.3
Measles1	8	3.4
Measles2	1	0.4
OPV1	17	7.4
OPV2	14	6.1
OPV3	5	2.2

Vaccination Delay

The mean of delay for the administration of each vaccine dose ranged from 125 (2nd Measles) to 253 (1st Measles). Except for Measles, the later doses of each vaccine

showed a longer delay. Overall, the average delay for all vaccines was very pronounced at 202 days, or 6.5 months.

Table 5.13. Delay of vaccination in Hides/Komo iHDSS

Vaccines	N=229	%	Mean (days)
BCG	123	53.7	185
HepB1	55	24.0	151
DTP/Hib/HepB dose1	113	49.3	222
DTP/Hib/HepB dose2	82	35.8	232
DTP/Hib/HepB dose3	47	20.5	236
Measles1	108	47.2	253
Measles2	32	14.0	125
OPV1	164	71.6	195
OPV2	98	42.8	198
OPV3	58	25.3	221

Premature Vaccination

Between 1-11% of participants received at least one vaccine prematurely compared to PNG vaccine schedule. When DTP/Hib/HepB vaccine was given prematurely, the difference ranged from 16 day to 26 day. One fifth of participants received the 1st

dose of Measles vaccine approximately 1 month prematurely (ie around 5 instead of 6 months of age).

Table 5.14. Receiving vaccine prematurely than the schedule time in Hides/Komo iHDSS.

Vaccine	N=229	%	Mean (days)
BCG	N/A		
HepB1	N/A		
DTP/Hib/HepB dose1	13	**5.7**	17
DTP/Hib/HepB dose2	6	**2.6**	31
DTP/Hib/HepB dose3	6	**2.6**	26
Measles1	26	**11.4**	30
Measles2	5	**2.2**	26
OPV1	N/A	**N/A**	N/A
OPV2	7	**3.1**	6
OPV3	3	**1.3**	13

CONCLUSION

These surveys showed that one third (31.7%) of children were not available for status ascertainmen. Of those children in the survey, 26.6% had no health books. Less than 50% of health books were kept their health books in good condition. The vaccine coverage rate in Hides/Komo iHDSS varied (16.6 to 79%) and was much lower than the vaccine coverage rate from Hiri iHDSS, e.g., the lowest coverage rate was 57% for DTP/Hib/HepB.

Vaccine dose completion rates of all three vaccine-types (DTP/Hib/HepB, OPV and Measles) in Hides/Komo iHDSS were 2 to 3 times lower than Global rates (2).

This survey showed that even for BCG given at birth, only 24.5% of participants received the vaccines at right time. Rates were even lower among later doses such as 3rd OPV at 1.7%, 2nd Measles at 0.4% and or 3rd DTP/Hip/HepB at 0.9%. Conversely, 1-11% received vaccines prematurely compared to the EPI schedule.

Delay of vaccination was seen with all vaccines with overall average delay of 202 days, or ~6.5 months. The most delayed vaccine was 1st Measles at 253 days, or ~8 months. Again, the later doses of each vaccine (except for Measles vaccine) showed a longer delay.

5.3 ASARO iHDSS (Eastern Highland Province)

RESULTS

There are 494 children aged from 1 to 5 years old in the Asaro iHDSS census list (conducted in Oct-Dec 2012). There was a slightly higher number of female than male children (52.8% vs 47.2%). At the time of the survey, 55 children were not present after twice visits, 40 migrated out of the area, none of parents refused to participate in this survey. Total of 399 children were available to check for their health books. Of these, 288 children had health books, and 111 children did not have health books (26.6%). Those who did not have health book, 94 children or 84.7% (of 111) had lost their health books, and 15.3% (of 111), their health books were badly damaged.

Table 5.15. Gender of study participants and health book ownership in Asaro iHDSS

Total	494
Female	261 (52.8%)
Male	233 (47.2%)
Migrated out	40 (8.1%)
Not available after twice visits	55 (11.1%)
Refused	0 (0.0%)
Did not have health book	111 (26.6%*)
Had Health book	288 (58.3%*)

* % of 399 (from total of 494 -95 who were not available e.g, migrated out)

Of the 288 children who had health books, 38.9% of health books were kept in good condition. Percentage of health book bad conditions (16.7%) in Asaro was similar to the other iHDSS.

Table 5.16. Conditions of health books in Asaro iHDSS

Condition of health books (N=288)		%
Good	112	38.9
Moderate	128	44.4
Bad	48	16.7

Vaccination Coverage Rates

Table 5.17. Vaccination coverage rates in Asaro iHDSS

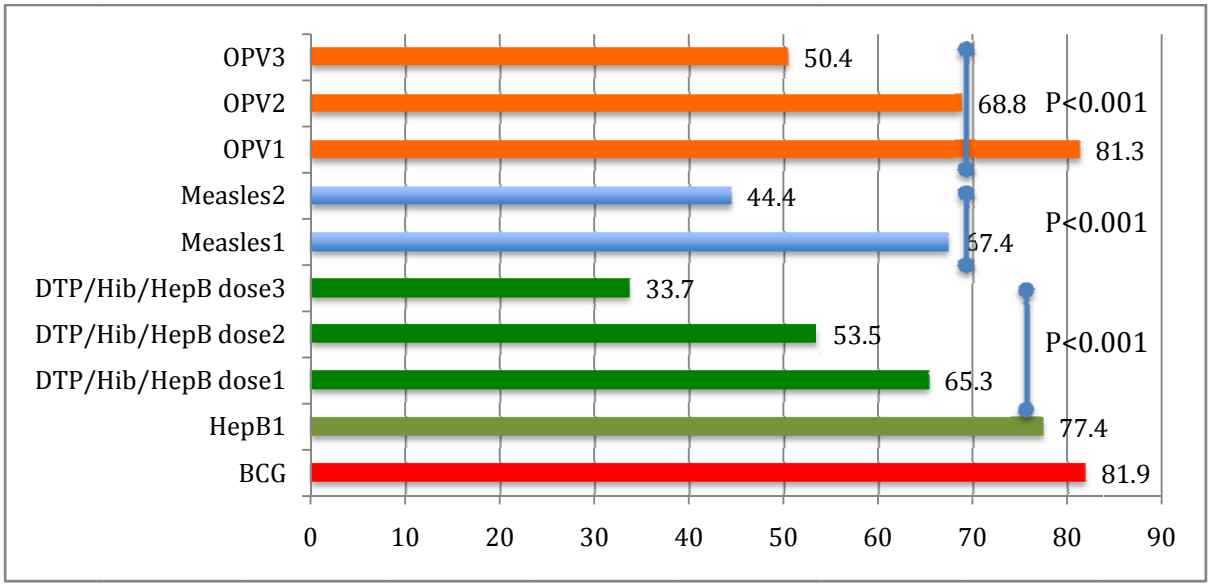
Vaccines	N=288	%
BCG	236	81.9
HepB1	223	77.4
DTP/Hib/HepB dose1	188	65.3
DTP/Hib/HepB dose2	154	53.5
DTP/Hib/HepB dose3	97	33.7
Measles1	194	67.4

Measles2	128	44.4
OPV1	234	81.3
OPV2	198	68.8
OPV3	145	50.4

The vaccination coverage rates for the 1st vaccines doses were 81.9% for BCG, 77.4% for HepB, 81.3% for OPV, 65.3% for DTP/Hib/HepB and 67.4% for Measles. Lower coverage was found for the 2nd and 3rd doses of all vaccines.

The Figure 5.5 shows decreasing coverage rates in the later vaccine doses. DTP/Hib/HepB coverage rates decreased from 65.3% at the 1st dose to 33.7% at the final dose (p <0.001), Measles (1st Dose: 67.4% vs 2nd Dose: 44.4%, p <0.001) and OPV (1st OPV 81.3%, 2nd OPV 68.8%, 3rd OPV 50.4%, p<0.001) coverage rates decreased similarly.

Figure 5.5. The coverage rates among vaccine doses in Asaro iHDSS



Vaccine Dose Completion

Table 5.18. Dose completion of vaccination in Asaro iHDSS

Vaccines	Asaro iHDSS Coverage with Vaccine Doses (N=288)	%	Global Coverage with Vaccine Doses (%)*
DTP/Hib/HepB	97	33.7 %	83 %
OPV	145	50.4 %	84 %
Measles	128	44.4 %	N/A
1st Measles at 2 years old	189	65.6 %	84%

* WHO & UNICEF, 2013

The rates of completion of all vaccination doses were between 34-66% in the study areas. Table 5.18 shows a comparison the vaccine dose completion rate with the Global Immunization coverage figures; dose completion rates of all three vaccine-types in this study were approximately 2 times lower than the Global rates, the lowest rate was with DTP/Hib/HepB at 33.7%; the Global coverage rate of this vaccine was 83%.

Vaccination at Correct Time Schedule

Nearly half of children received BCG and HepB at correct vaccination schedule, 46.2% and 46.5%, respectively. The rate for 1st OPV was at 29.9%, however, rates of other vaccines were very low and ranged from 9.4% for 1st DTP/Hib/HepB, and 4.9% for 1st Measles. The adherence to vaccination schedule was even lower for final doses of vaccines and only 0.3% of DTP/Hib/HepB, 1.4% of Measles and 0.7% of OPV were given at the correct time.

Table 5.19. Receiving vaccination at correct time schedule in Asaro iHDSS

Vaccines	N=288	%
BCG	133	46.2
HepB1	134	46.5
DTP/Hib/HepB dose1	27	9.4
DTP/Hib/HepB dose2	6	2.1
DTP/Hib/HepB dose3	1	0.3
Measles1	14	4.9
Measles2	4	1.4
OPV1	86	29.9
OPV2	22	7.6
OPV3	2	0.7

Vaccination Delay

The mean of delay for the administration of each vaccine dose ranged from 85 (HepB 1) to 318 (2nd Measles). The later doses of each vaccine showed a longer delay. Overall, the average delay for all vaccines was very pronounced at 200 days, or 6.5 months.

Table 5.20. Delay of vaccination in Asaro iHDSS

Vaccines	N=288	%	Mean (days)
BCG	103	35.8	93
HepB1	89	30.9	85
DTP/Hib/HepB dose1	147	51.0	206
DTP/Hib/HepB dose2	146	50.7	242
DTP/Hib/HepB dose3	95	33.0	303
Measles1	152	52.8	228
Measles2	114	39.6	318
OPV1	148	51.4	106
OPV2	172	59.7	177
OPV3	142	49.3	242

Premature Vaccination

Between 0.3-9.7% of participants received at least one vaccine prematurely compared to PNG vaccine schedule. When DTP/Hib/HepB vaccine was given prematurely, the difference ranged from 9 day to 12 day. One tenth of participants received the 1st Measles vaccine approximately 2.7 month prematurely (ie around 3-4 instead of 6 months of age).

Table 5.21. Receiving vaccine prematurely than the schedule time in Asaro iHDSS.

	N=288	%	Mean (days)
BCG	N/A		
HepB1	N/A		
DTP/Hib/HepB dose1	14	**4.9**	10
DTP/Hib/HepB dose2	2	**0.7**	9
DTP/Hib/HepB dose3	1	**0.3**	12
Measles1	28	**9.7**	84
Measles2	10	**3.5**	58
OPV1	N/A	**N/A**	N/A
OPV2	4	**1.4**	21
OPV3	1	**0.3**	3

Similar to Hides/Komo iHDSS, one quarter (26.6%) of children in Asaro iHDSS had no health books. Less than 50% of health books were kept their health books in good condition. The vaccine coverage rate in Asaro iHDSS varied from 33.7% to 81.9% and was higher than the vaccine coverage rate from Hides/Komo iHDSS, e.g., the lowest coverage rate was 16.6% for 2nd Measles.

Vaccine dose completion rates of all three vaccine-types (DTP/Hib/HepB, OPV and Measles) in Hides/Komo iHDSS were approximately 2 times lower than Global rates [2].

This survey showed that even for BCG given at birth, 46.2 % of children received the vaccines at right time. Rates were even lower among later doses such as 3rd OPV at 0.7%, 2nd Measles at 1.4% and or 3rd DTP/Hip/HepB at 0.3%. Conversely, 0.3-10%-received vaccines prematurely compared to the EPI schedule.

Delay of vaccination was seen with all vaccines with overall average delay of 200 days, or ~6.5 months. The most delayed vaccine was 2nd Measles at 318 days, or ~10 months. Again, the later doses of each vaccine showed a longer delay.

CONCLUSION

In terms of meeting international standards for vaccination coverage, there is a major health systems failure across all locations. While there are locations and clinics that are performing at adequate levels, there are major performance gaps across many locations, particularly in the highlands. The risk of a significant epidemic of a vaccine preventable infectious disease is significant. The poor vaccination coverage is undoubtedly contributing to the underlying morbidity and mortality patterns documented by the iHDSS.

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PUBLICATION

Fasi S et al. Vaccination coverage and delay among children living in resource development impact areas, Hiri district, Central Province, Papua New Guinea. In preparation

Marava L et al. Factors determining the Vaccination coverage in rural Komo-Hides community: A Cross-sectional study analysis using multivariate, socioeconomic survey and Geographic Information System. In preparation

PRESENTATION

Fasi B et al. Vaccination coverage and delay among children living in resource development impact areas, Hiri district, Central Province, Papua New Guinea. Paper presented to the *49th Annual Medical Symposium*, Lae, Papua New Guinea, 2-6 September, 2013.

Marava L et al. Factors determining the Vaccination coverage in rural Komo-Hides community: A Cross-sectional study analysis using multivariate, socioeconomic survey and Geographic Information System. Paper presented to the *49th Annual Medical Symposium*, Lae, Papua New Guinea, 2-6 September, 2013.

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CHAPTER 6. SANITATION AND HYGIENE STUDY

Evaluation of a WASH intervention demonstrates the potential for improved hygiene practices in Hiri District, Central Province

Introduction

The PNG LNG is extremely interested in the burden of disease in impacted communities related to water and sanitation/hygiene issues. Water Sanitation and Hygiene interventions (WASH) aim to improve health outcomes through provision of safe water supplies and improved sanitation facilities, while also promoting better hygiene practices in communities.

Within the iHDSS platform there is extensive morbidity and mortality monitoring. Not surprisingly, potential water and sanitation/hygiene related diagnoses are common. Febrile and diarrheal illnesses are under surveillance using the newly established infectious disease research laboratory in Port Moresby with backup in Goroka. As part of the overall PNG LNG health mitigation programme, there is an active NGO component that includes water and sanitation/hygiene outreach. As part of the PiHP effort, IMR performed an extensive evaluation of outreach efforts in the Hiri villages. This chapter presents the results of this evaluation.

Outcome Summary

Population Services International (PSI) introduced a WASH intervention project in the Hiri District, Central Province in May 2012. Shortly after its introduction we conducted a survey to determine the uptake of the intervention, and gauge its impact. We invited 400 households to participate in the study, which consisted of a questionnaire for the head of the household. A total of 395 questionnaires were completed: 314 from households that had participated in the WASH intervention and 81 that had not. Results demonstrated that improved water sources are not routinely used, with a high dependence on well and surface water. While self-reported hand washing was common, use of soap was not common. Treatment of water inside the house was common in the intervention group (95%), compared to 50% in the non-WASH group. The study indicates that people in the Hiri district are supportive of

WASH interventions, with good uptake of some aspects of the intervention. The sustainability of the intervention remains unknown. Targeted interventions focusing on community priorities might be beneficial in the future.

Background

In low income countries, diseases associated with unsafe water and inadequate sanitation are of considerable public health importance; indeed, it is estimated that improved water, sanitation and hygiene (WASH) could prevent at least 9.1% of the global disease burden [1]. Given its importance in health and development, there has been renewed interest in WASH interventions in recent years. This has been largely driven by the United Nations through UNICEF and the Millennium Development Goals (MDG) with uptake by many government and non-government organizations. MDG 7 aims to halve the number of people living without access to sanitation and safe water by 2015. Recent data indicate satisfactory progress globally in terms of access to safe water: 89% of world's population has access to safe water, exceeding the 2015 target for MDG 7. Nonetheless, over 700 million people still lack access to safe water. Of greater concern is the lack of progress in delivering improved sanitation, which is behind schedule to meet the 2015 target [2]. In 2011, 2.5 billion people lacked access to an improved sanitation facility. Of these, 761 million use public or shared sanitation facilities and another 693 million use facilities that do not meet minimum standards of hygiene [2].

The situation in Papua New Guinea (PNG) reflects that of other low-income settings globally; however, there has been little or no improvement in WASH in PNG in recent years. According to recent World Health Organization (WHO) data 40% of the population has access to improved water [3], considerable lower than the global rate (~89% access) and one of the lowest in the Western Pacific region. Similarly, approximately 80% of the population is without access to improved sanitation [3]; although one other creditable source suggests better access, estimating that 55% of the population lack access to sanitation [4]. This discrepancy does not mask the fact that access to WASH remains poor; and there has been little improvement in the past 25 years [3].

The poor WASH indices no doubt impact on the burden of diarrhoeal disease in

PNG, as they do globally. In PNG, diarrhoeal disease is one of the leading causes of morbidity and mortality, accounting for 8% of deaths among children aged less than 5 years [3]. However, the burden of enteric illness in PNG is not restricted to children. Outbreaks of cholera and shigellosis in the recent past highlight the risk to the broader population of enteric disease outbreaks [5,6]; and endemic illnesses such as typhoid fever continue to cause illness [7]. The cholera outbreak is of particular interest, given cholera had not been reported in PNG prior to 2009. New incursions of cholera often follow natural or human-induced disasters (e.g. Haiti, Zimbabwe) [8,9]; however the cholera epidemic in PNG was not preceded by any such disaster. The outbreak spread throughout coastal PNG and resulted in over 15,500 cases and approximately 500 deaths with a case fatality rate of 3.2% [6]. It has been postulated that lack of sanitation and hygiene in PNG was key to its spread throughout the country [10].

Given the above considerations, a WASH project was introduced to the Hiri integrated Health and Demography Surveillance Site (iHDSS) in mid-2012 by PSI. IMR has evaluated the hygiene and hand washing practices in the Hiri iHDSS, and the impact of the WASH intervention.

MATERIAL AND METHODS

Study location and population

The Hiri iHDSS covers four coastal villages in Hiri West, Kairuku-Hiri District, Central Province, PNG. It is situated 9° south and 147° east of the equator and approximately 30 km west of Port Moresby. Of these four villages, three are Motuan (Lea Lea, Boera and Porebada) and one (Papa) is Koita (who are referred to as Koitabu by the Motu). In the 2011 Hiri iHDSS census survey 1347 households were recorded, with a total population of 11,531. The average density was approximately 10 persons/km^2. The area has a mean annual rainfall of 995 mm with a long dry season. All villages lie within a 5 km radius of the PNG Liquefied Natural Gas (PNGLNG) plant, and are classified as resource development impact areas.The village centres in Boera and Porebada are on the beach, and in all four villages the majority of houses are built on the beach and the reef. The Motu are an essentially maritime people: the villagers engage in fishing, hunting and gardening activities to

sustain their daily livelihoods. Other activities that the villagers are engaged in to earn income include small-scale commerce (trade stores, street markets) and working for the PNGLNG project.

The WASH Intervention

PSI, who managed the intervention, distributed WASH kits consisting of: a bucket with a tap to store drinking water; 30 water purification tablets (Aquatabs®, active ingredient sodium dichloroisocyanurate; see www.aquatabs.com); 2 bars of soap; 2 sachets of oral rehydration salts (ORS) and 10 tablets of zinc for treating diarrhea; and an information, education and communication (IEC) brochure. Distribution of kits was conducted primarily though PSI trained community-based volunteers called healthy man/women (Helti man/Helti mari). These trained volunteers then educated local communities in the use of kits as well as resupplying ORS, zinc, and water treatment tablets. The WASH kit included enough contents to last for 1 month, with re-supply given regularly.

Data collection

A cross-sectional survey was conducted from September 2012 to May 2013 (prior to the survey, a questionnaire was developed and piloted in July-August 2012). The questionnaires sought information about: water sources; water collection and storage; treatment of drinking water; water contamination; hygiene practices; and people's perception and knowledge on causes and risks factors associated with diarrhea. People's perception was ranked on a Likert scale, ranging from strongly disagree (1) to strongly disagree (4). The WASH project was being rolled out by PSI as we conducted the survey, thus at the time of the survey the intervention had not reached all households in the study villages. This enabled a comparison of responses between households that had access to the WASH intervention to those that did not yet have access.

A sample size of 400 (of the total 1347) households was randomly selected from the Hiri Demography Surveillance database: 167 households in Porebada; 73 in Boera; 54 in Papa; and 106 in Lealea. After obtaining consent from the heads of

households, research scientists and village reporters conducted the survey.

.Data analysis

Research staff checked all questionnaires to ensure there were no data missing and numeric codes were assigned to responses before data processing. Data entry was done using Epi Info 7 (Centers for Disease Control and Prevention, USA). Statistical analysis was performed with STATA software version 12 (STATACorp,. College Station, TX). Chi-square (χ^2) and Fisher's exact tests were used to determine association between hygiene practices and exposure to WASH intervention. Probability values were considered to be statistically significant when the calculated P-value was ≤ 0.05. For the perception and knowledge of diarrrhoea (Likert scale 1 to 4) the mean was calculated and compared between WASH and no-WASH groups.

Ethical consideration

The study was granted ethical approval from PNG Institute of Medical Research Institutional Review Board (IRB 1113) and the PNG Medical Research Advisory Committee (MRAC 11.20). Informed consent was sought from every participating household through the self-identified head of the household. Participants were informed about their right to withdraw from the study at any stage.

RESULTS

Of the 400 randomly selected households, 395 consented and completed the survey: 72 from Boera; 103 from Lealea; 50 from Papa and 170 from Porebada). The distribution of study households is presented in Figure 6.1-6.4. Of the 395 participating households, 314 participated in the WASH intervention and 81 did not (as the WASH intervention had not reached those households).

Figure 6.1. Maps showing households in **Boera** randomly selected for the study survey and water sources in the Hiri iHDSS, Central Province.

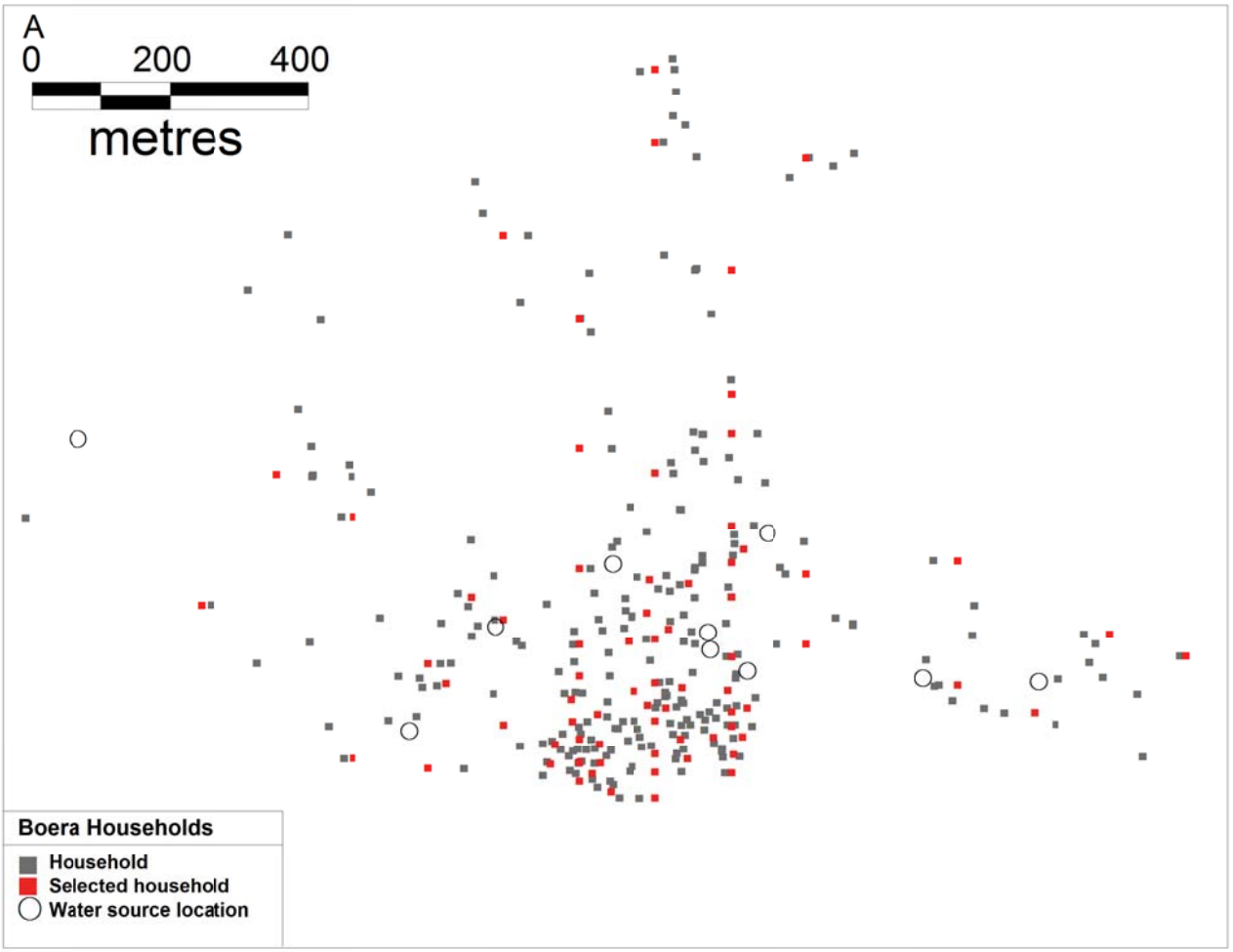


Figure 6.2. Maps showing households in **Porebada** randomly selected for the study survey and water sources in the Hiri iHDSS, Central Province.

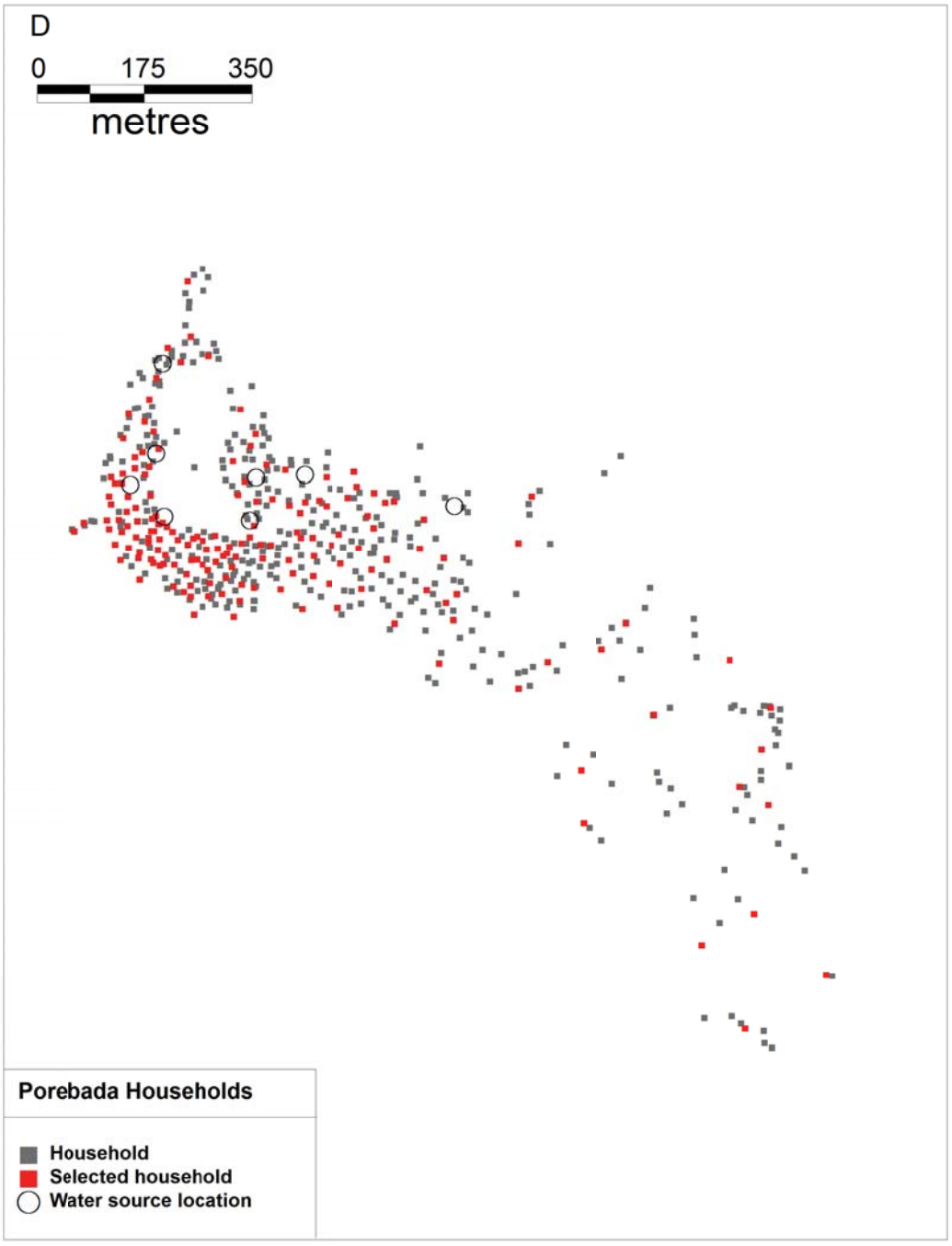


Figure 6.3. Maps showing households in **Papa** randomly selected for the study survey and water sources in the Hiri iHDSS, Central Province.

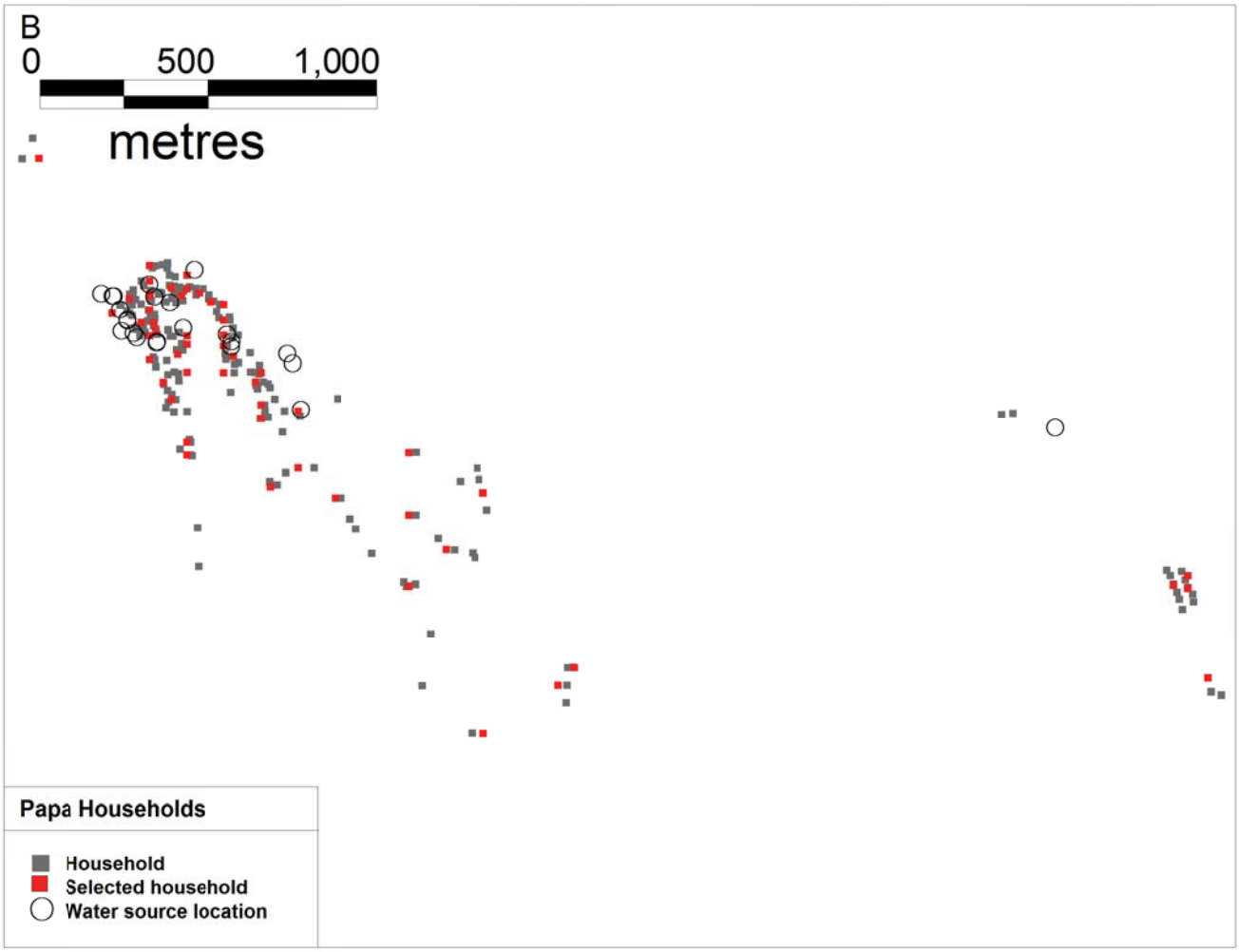
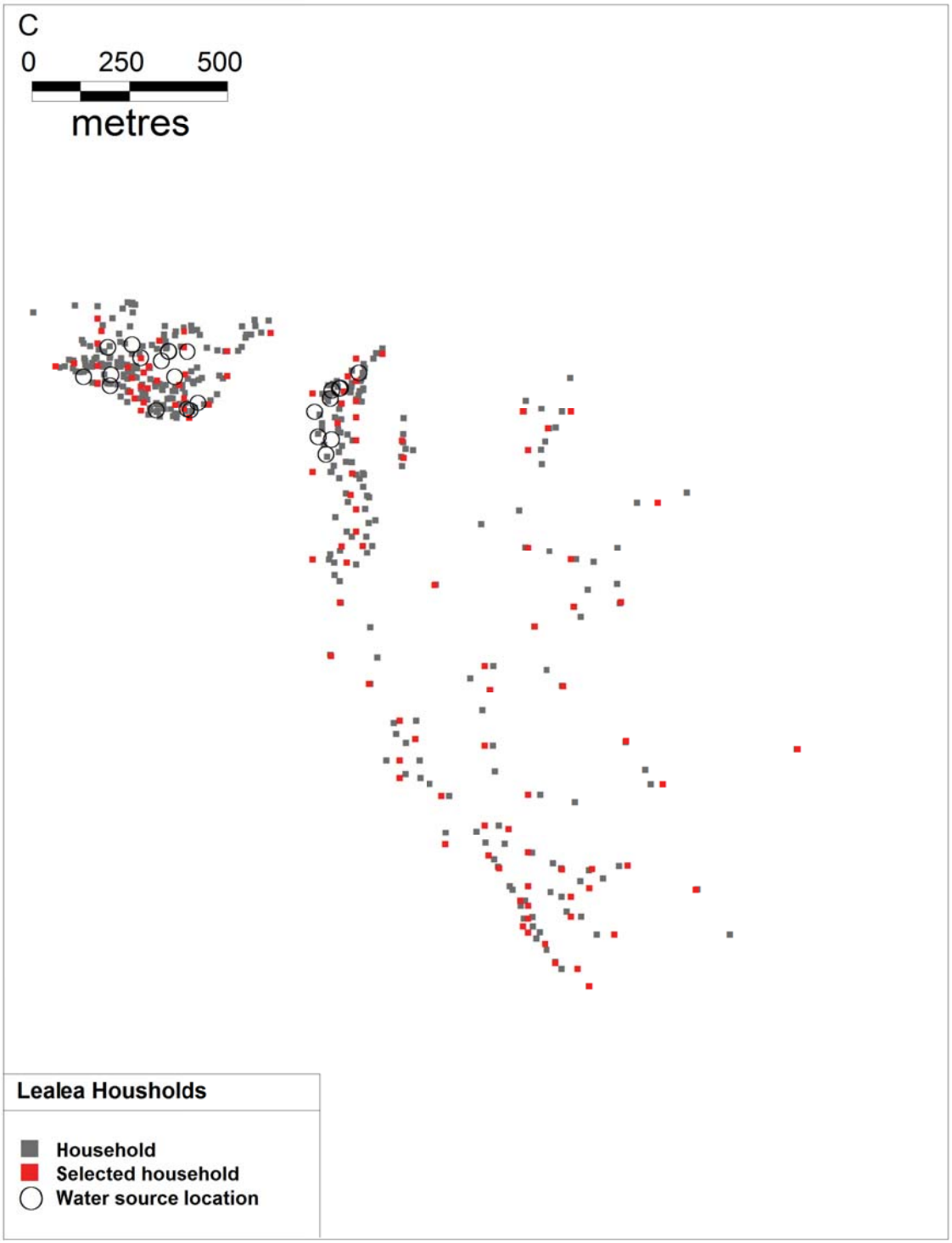


Figure 6.4. Maps showing households in **Lae Lae** randomly selected for the study survey and water sources in the Hiri iHDSS, Central Province.



The primary source of water varied between villages. In Porebada and Boera there is at least some access to village piped water (75.3% and 40.9% of respondents, respectively, used piped water). However, even when piped water was available, it was not always widely used. In Boera more households used deep well water (52.1%) than piped water; and only 4.2% of households used piped water compared to 45.8% using river/creek water and 31.3% using deep well water. In Lea Lea almost two-thirds (63.4%) of households used surface well water (Figure 6.5). Where reticulated water (pipe water or rain water tanks) was absent, there was no protection of the water sources, in particular to surface well in Lae Lae and deep well in Boera and Papa. It was commonly reported that water sources had potential causes of contamination nearby (65.2% of participants in Boera, 52.1% in Lealea, and 13.3% in Papa); nonetheless, participants considered water from these sources to be sufficiently clean (Boera 69.6%, Lealea 63.4%, Papa 76.7%).

Figure 6.5. The water sources used in four study villages in Hiri iHDSS, Central Province.

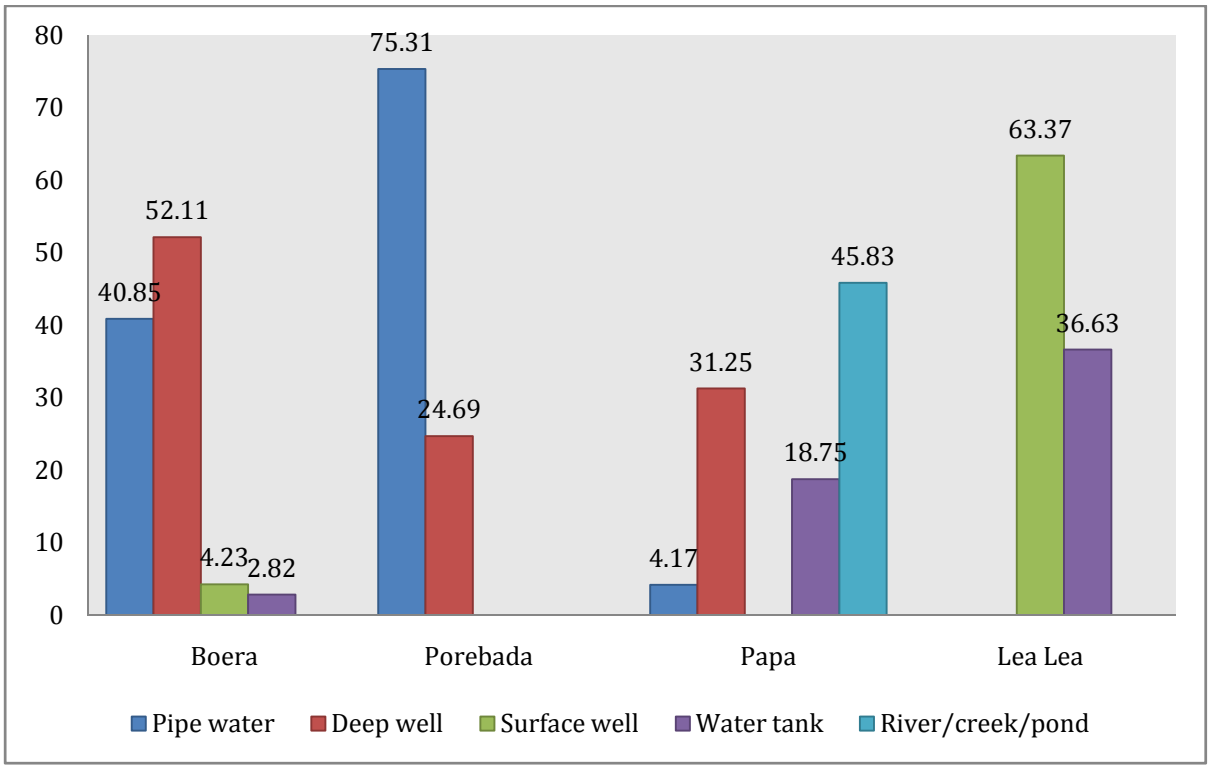


Table 6.1. Hygiene practices of the WASH and non-WASH intervention group

Hygiene practices	Total population		WASH		Non-WASH		P-value
	N= 395	%	N=314	%	N=81	%	
Hand wash after toilet	378	95.7	304	96.8	74	91.4	**0.031**
Hand wash before eating	373	94.4	303	96.5	70	86.4	**<0.001**
Hand wash before breast feeding	346	87.6	277	88.2	69	85.2	0.453
Hand washing + soap after toilet	161	40.8	122	38.9	39	48.2	0.129
Hand washing + soap before eating	156	39.5	119	37.9	37	45.7	0.202
Hand wash + soap before breast feed	151	38.2	115	36.6	36	44.4	0.197
Separated drinking water from washing water	276	69.9	230	73.3	46	56.8	**0.004**
Kept water containers in safe and clean places	379	95.9	299	95.2	78	96.3	0.68
Sick children and elderly had separate drinking water	45	11.4	39	12.4	6	7.4	0.205

Most households travel by foot to fetch water. Adult females (65.3%) and adult males (25.6%) were primarily responsible for fetching water. As water sources (well, rainwater tanks and piped water) were typically located in or nearby villages, the majority of population (71.4%) took less than 10 minutes to travel to fetch water. All participants washed at least once a day, with children washing more frequently than once a day.

Hand washing was common practice after using toilet (95.9%), before eating food (94.4%), and before breast-feeding babies (87.6%). The WASH intervention group more commonly washed their hands after using toilet (96.8% vs 91.4%; p = 0.031) and before eating food (96.5% vs 86.4%; p<0.001) than non-WASH group (Table 6.1). The frequency of hand soap use varied: 59.3% (234 of 395) used soap whenever soap was available and 40.8% (161 of 395) used soap to wash hands all the time. Alternatives to soap were using leaves, sand and ashes. Despite soap being distributed with WASH kits, rates of using soap to wash hands among the WASH households was lower than in non-WASH households, although the difference was not statically significant. The buckets distributed from WASH project for storing drinking water were well accepted by communities. WASH participants were more likely to separate drinking water containers from washing water containers (WASH 73.25% vs. non WASH 56.8%, p=0.004) (Table 6.1).

Households participating in the WASH were more likely to treat their drinking water than non-WASH households (WASH 95.2% vs non-WASH 49.4%, p=0.001, Table 6.2). Water purification tablets were used by 90.1% of WASH participants, and 51.3% used water purification tablets alone to treat their drinking water, while 38.9% used combination methods including water purification tablets, boiling and/or filtering (Table 6.2). In the absence of water purification tablets, approximately 50% of non-WASH group treated their drinking water.

Table 6.2. Treatment of drinking water in WASH intervention and non-WASH intervention groups in Hiri iHDSS area.

Treat drinking water	Total population		WASH		No WASH		P-value
	N= 395	%	N=314	%	N=81	%	
Treat water	**339**	**85.8**	**299**	**95.2**	**40**	**49.4**	**<0.001**
Boiled alone	20	5.1	7	2.2	13	16.1	0.487
Filtered alone	12	3.0	0	0	12	14.8	0.055
WPT alone	161	40.8	161	51.3	0	0	<0.001
Boiled + Filtered	24	6.1	9	2.9	15	18.5	<0.001
Boiled + WPT	28	7.1	28	8.9	0	0	0.002
Filtered + WPT	18	4.6	18	5.7	0	0	0.031
Boiled + Filtered + WPT	76	19.2	76	24.2	0	0	<0.001
Total boiled	148	37.5	120	38.2	28	34.6	0.545
Total filtered	130	32.9	103	32.8	27	33.3	0.928
Total WPT	283	71.7	283	90.1	0	0	<0.001

WPT: Water purification tablets

Overall there was a trend towards better comprehension of the potential severity of diarrhea in the WASH group than the non-WASH group, as demonstrated by higher mean knowledge scores (Table 6.3). The WASH group had higher mean knowledge scores than the non-WASH group for all but one statement: presence of animal and human faeces around the house being a risk for diarrhoea (although scores were very similar). The mean knowledge score was above 3 for all statements, in both the WASH and non-WASH households.

Table 6.3. Knowledge score of households in four villages on diarrheal diseases (total score of 4)

Knowledge	WASH	Non-WASH	P-value
Diarrhoea can cause weight loss among children	3.66	3.47	<0.05
Diarrhoea causes the body to dehydrate very quickly	3.56	3.43	0.052
A child could die from diarrhoea	3.43	3.37	0.08
Having animal or human faeces in or around the house can increase risk of diarrhoea	3.15	3.17	0.37
Diarrhoea can be prevented	3.42	3.32	0.16
It is important to use ORS and zinc at the first sign of diarrhoea in a child	3.37	3.08	<0.05
Unseen germs in clear water can cause diarrhoea	3.21	3.2	0.24
Unseen germs in food, flies, and fingers can cause diarrhoea	3.42	3.28	0.06

* (Score: 1 Strongly disagree; 2 Disagree; 3 Agree; 4 Strongly agree)

DISCUSSION

The findings of this study demonstrate a willingness to take up WASH interventions. There was an improved understanding of aspects of sanitation and hygiene in the households that received the WASH intervention.Participants demonstrated a willingness to treat water when provided with water purification tablets, with the proportion of households treating water almost double in WASH intervention households compared to non-WASH households. In WASH households 90% used water purification tablets, either as the sole source of treatment or in combination with other methods. This suggests that if simple, user-friendly methods of water treatment are provided to this community they will be used. It is noteworthy that half of all non-WASH respondents treated their water. Recent data on point-of-use treatment of drinking water in PNG are not available, but personal observations suggest this rate is higher than in many other parts of PNG [Phuanukoonnon & Greenhill, pers. comm.]. It may be that the higher than expected rate of water treatment is an outcome of the cholera epidemic that affected the area in 2010, at which time public health awareness was conducted.

When piped water was available it was not always used, despite piped water being one of only two improved water sources available to study participants (Figure 6.5). The other improved water source, tank water, was not the main source of water at any of the villages included in the study. We can only speculate as to why improved water is not routinely used when available, but it is likely that people will use the nearest water source that they deem to be sufficiently safe. Carrying large volumes of water is heavy, and is most commonly done by women. Unfortunately, the dependence on, or preference for, non-improved water sources presents a health risk. Adding to the health risk, study participants commonly acknowledged that their water was potentially contaminated, but also considered the water to be sufficiently clean. This incongruence is indicative of a lack of understanding of sanitation, hygiene, safe water and agents of infectious disease. It highlights the need for ongoing IEC in PNG.

The proportion of study respondents' self-reporting hand washing was high, with approximately 95% of participants reportedly washing their hands after using the toilet and before eating. Soap use; however, was considerably less commonplace. Approximately 40% of participants reported use of soap all the time, and despite soap being part of the WASH intervention kit. Indeed, self-reported use of soap was lower in WASH intervention households than non-WASH households, though the difference was not statistically significant. It appears that washing hands with soap is not a high priority, which is unfortunate given the demonstrated benefits of hand washing with soap in low-income settings [11].

The results of the knowledge-based questions demonstrated a general understanding of issues relating to diarrhoeal diseases, with a general trend (though not always statistically significant) towards better understanding in the WASH intervention group than in the non-WASH group. The average scores were higher for responses to questions about the symptoms of diarrhea than responses to risk factors (faecal contamination and germs). Knowledge of symptoms of diarrhea can come through experience; whereas an understanding of the germ theory of disease comes through education and understanding. Our study indicates that knowledge pertaining to WASH is incomplete, but nonetheless people are willing to adopt many of the interventions.

It has been long recognized that the provision of infrastructure does not guarantee improved WASH outcomes, as highlighted by Jenkins almost 20 years ago. At that time very few, if any, hygiene education campaigns had been conducted in PNG [12]. Ongoing education and community engagement may lead to better uptake of interventions. However, we know from international research and local experiences that health outcomes may not be the main motivational factor for people adopting improved hygiene practices. Fewtrell and colleagues highlighted "the desire to feel and smell clean, and the desire to follow social norms" as an important motivation [13]. In the PNG context Jenkins noted, that "norms of personal hygiene are subject to change under social pressure" [12]. In addition to improving knowledge of infectious diseases, the promotion of improved personal hygiene as a socially desirable trait may also lead to improved health outcomes.

This study provides insight into community engagement of a WASH intervention. The

importance of the study stems, in part, from the paucity of available data on the topic in PNG. The reporting of water treatment at the household level, use of improved water by some participants (particularly at Porebada), and hand washing (though commonly without soap), all indicate that carefully considered WASH interventions may be successful. However, it is acknowledged that the study and the intervention are not without limitations. Hygiene practices were evaluated based on self-reporting, which can lead to bias: hand-washing practices may be over-reported [14]. We have not been able to determine long-term behavior change, nor sustainability: would a similar uptake be possible with the availability of the intervention, as opposed to the provision of the intervention? Singular interventions as opposed to multiple interventions might be considered, given that a meta-analysis of WASH studies demonstrated no cumulative benefit of multiple interventions [13]. Carefully planned studies that investigate motivational factors for adopting WASH interventions, and led to a better understanding of the transmission of pathogens may be an appropriate next step in WASH research.

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PRESENTATION

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CHAPTER 7. NON-COMMUNICABLE DIEASES STUDY

A Survey of Non-communicable diseases (NCD) and associated risk factors in four sites across Papua New Guinea: The PNG NCD Study

INTRODUCTION

Rapid economic development triggered by resource development projects like the PNG LNG can kick-start an epidemiological transition that sees a reduction in infectious disease and a simultaneous increase in non-communicable diseases (NCDs) as a result of associated lifestyle change [1, 2, 3].

The PNG LNG through the iHDSS system has an active and ongoing surveillance programme that monitors potential changes in morbidity and mortality. As discussed in other chapters in this report, there is accumulating evidence that at least of the impacted areas (Hiri) is undergoing the epidemiological transition. This transition is likely to be more pronounced and rapid in households that economically benefit from employment and revenue streams associated with the PNG LNG. As part of the overall PiHP, IMR has begun evaluating the burden of diseases associated with NCDs. This report describes the underlying strategies and methodologies. There are no preliminary results available for this interim report.

Background

Non-communicable diseases (NCD) are a leading cause of morbidity and mortality throughout the world. In 2005, an estimated 35 million deaths were caused by NCDs (principally, cardiovascular diseases (CVDs), diabetes, cancers, and chronic respiratory diseases), a number predicted to rise by 17% by 2015 [4]. Chronic diseases are further responsible for about 47% of the 1.49 billion years of healthy life “lost” to illness globally [5]. The burden is highest in low-income countries where 80% of NCD related deaths occur [4]. Furthermore, about 29% of all NCD related deaths occur in those aged less than 60 years (i.e. an economically active age group) in low-middle income countries compared to 13% in high income countries [6]. The NCD burden is already substantial and growing in the Western Pacific

Region (WPR). The WHO estimates that more than 30 million people across WPR countries currently have diabetes mellitus alone and this figure is expected to double by the year 2025 [7].

NCDs and associated risk factors such as smoking, excessive alcohol consumption, obesity, hypertension, abnormal cholesterol and lipid profiles, and physical inactivity have not been well investigated in PNG. A number of relatively small studies conducted among specific populations have identified an increasing or relatively high prevalence of diabetes, cardiovascular disease and cancers [8-14]. Available evidence further suggests variation in NCD risk within PNG based on ethnic origin [15-17] and lifestyle and living environment [18, 19]. For example, the Wanigela people of Port Moresby have some of the highest rates of diabetes recorded in the Pacific [9] and urban dwellers of any ethnic origin in PNG are more at risk of NCDs relative to their rural peers [11, 18], although even rural populations appear to be increasingly prone to NCDs [12]. NCDs currently account for a minor proportion of outpatient and inpatient admissions within the country [20], yet this is not necessarily reflective of treatment need. According to a survey completed in 2000, less than half of the estimated 180,000 diabetes cases in PNG were on treatment [8], suggesting a majority of diabetic cases go undiagnosed or untreated. Given the acknowledged shortcomings of the PNG health system, including deteriorating infrastructure, poor governance, aging and inadequate healthcare workforce and a paucity of specialist services [21-24], then it is likely that many (if not most) other forms of NCD are equally undetected or untreated.

Despite the aforementioned studies, the PNG evidence-base is currently insufficient to reliably identify the prevalence of NCDs across the country. Neither is there the capacity within the current health system to monitor the anticipated epidemiological transition and the expected rise in NCD prevalence and associated risk factors. As such, it is prudent to establish prevalence for NCDs and their risk factors in the early stages of the development ‘boom’ as well as implement a reliable monitoring system. By doing so, subsequent changes in NCD burden and their associated risk factors may be readily identified and appropriate public health interventions and policies developed and deployed in a timely manner. Accordingly, the aims of the IMR NCD survey are to:

1. Establish a baseline data set to determine among people living in iHDSS sites:
    a. The prevalence of selected NCDs (namely diabetes mellitus type 2, hypertension, acute coronary syndrome, stroke, chronic lung diseases and cancers) and associated lifestyle risk factors;
    b. Dietary habits and food security; and

2. Establish a surveillance system for longitudinal monitoring to detect any changes in the prevalence of NCDs and associated lifestyle risk factors, and also any changes in dietary habits and food security, among the five study sites.

Specific study hypotheses include:

1. Rapid economic growth at the national level will result in an increase in body mass index (BMI), hypertension, tobacco and alcohol consumption, and fat and sugar consumption as well as a decrease in physical activity levels in five study sites across PNG;

2. Rapid economic growth at the national level will change household food security across the iHDSS locations;

3. Increase in the aforementioned NCD risk factors will be greatest in study sites directly impacted by the PNG LNG project relative to non-impacted comparison sites;

4. Decrease in household food insecurity will be greatest in PNG LNG impacted study sites relative to the comparison sites.

MATERIAL AND METHODS

Study Design

The PNG NCD Study is a cross sectional survey conducted in four integrated Health and Demographic Surveillance Sites (iHDSS)[25]. Detailed demographic records

are maintained and regularly updated for each site and a wide range of socio-demographic and health data are continuously collected at an individual and household level. The PNG NCD study comprises adult (15-65 years) and child (6-59 months) components. The adult component includes completion of a standardised questionnaire loosely based on the WHO STEPS NCD Risk Factor survey, a 24 hour dietary recall, selected physical measurements and biological sample collection. The child component includes selected physical measurements taken from the child and a nutrition survey completed with the child's primary caregiver. Pending continued funding, repeat cross sectional surveys will be completed in each iHDSS site to allow longitudinal surveillance of NCD risk factors and prevalence. The study was approved and granted ethical clearance by the Medical Research Advisory Committee of Papua New Guinea (MRAC No.12.34; 19 November, 2012).

Sample Size and Selection

A total of 1200 adult participants and 400 child participants stratified according to gender and age (6-59 mo, 15-29, 30-44, 45-65 years) will be recruited from each iHDSS (200 participants per age group, per sex), resulting in a final sample of 6400 community-based participants across all iHDSS locations. This sample size has been calculated to confer 80% power at 5% level of significance based on findings from previous NCD studies conducted on multi-cultural populations in urban New Zealand [26-28]. All adult participants are selected using a simple random sampling strategy. The sampling frame is the census adult population in each iHDSS. Child participants are selected on-site at the homes of participating adults (if the household in which the adult resides houses any children) via a simple random sampling strategy (if more than one eligible child resides in the household; a maximum of one child per household is recruited).

Study Sites

Two iHDSS are located in PNG LNG project impact sites including the West Hiri iHDSS in Central Province, and Hides iHDSS in Hela Province. The West Hiri iHDSS comprises the villages Porebada, Boera, Papa, and Rearea in Hiri District with the baseline (2011) population recorded at 11,531 people [25]. The Komo iHDSS comprises the Gigiria, Haliago and Hibiria divisions with an approximate population of 13-15,000 people [25]. The West Hiri iHDSS surrounds the PNG LNG

processing site whilst the Hides iHDSSincludes the gas conditioning plant site and Komo Airfield. The remaining two iHDSS are located in non-project comparison sites including the Asaro Valley iHDSS, Eastern Highlands Province and Karkar Island iHDSS, Madang Province. The Asaro Valley iHDSS comprises a baseline (2011) population of 10,034 people, whilst the Karkar Island iHDSS comprises an approximate population of 20,000 people [25].

Procedures

Interviews are conducted at participants' homes or community-based health centres. The study purpose and procedures are explained to participants and/or their primary caregivers and written consent obtained prior to participating in the study. To be eligible to take part in this survey, an individual must meet the following criteria: Living in one of the four iHDSS; aged between 6-59 months or 15-64 years; and consented to be part of the study. Individuals will be excluded from the study if they are pregnant or are known or reported to have a mental illness. All survey forms and procedures are completed at a single time point; however, adult participants are provided a specimen container the evening prior to survey for urine collection or the urine specimen may be collected the day after survey. Non-clinical components of the adult NCD questionnaire, 24-hour dietary recall, child nutrition survey and all physical measurements are completed by a trained research officer. Clinical components of the adult NCD questionnaire and all biological samples are collected by a qualified health professional.

After the collection of all data, each adult participant's blood sample is analysed and investigated for anaemia, Haemoglobin A1c (as a marker for diabetes mellitus) and associated NCD risk factors including glucose levels, cholesterol and lipid levels. NCDs may be determined based on clinical findings during the NCD survey in the field and later complemented with laboratory results from the biomarkers. However, those identified to have NCDs during the field survey are referred to the local General Hospital for further investigation and management without delay. Participants with laboratory confirmed NCDs are scheduled to be seen by a visiting medical registrar in the health facility closest to the respective iHDSS.

Measures: Adult Participants

- *Adult NCD Risk Factor Questionnaire*: An interviewer administers questionnaire based on the WHO STEPS NCD Risk Factor survey. Question domains include: participant demographics, self-reported health status, self-reported stress or anxiety, diet, food security, tobacco, buai (betel nut) and alcohol use, physical activity and participant history of NCD and/or associated treatments. All questionnaires, inclusive of the Child Nutrition Survey, are available in English and *Tok Pisin*.
- *24 Hour Dietary Recall*: A structured interview designed to collect quantitative information on all foods and drinks consumed by the participant the day prior to survey (from midnight to midnight), including foods and drinks consumed both at and away from home.
- *Physical Measurement*: Weight, height, waist and hip circumference, blood pressure and lung function.
- *Biological Specimens*: 30 mls Venous Blood and early morning urine sample.
- *Complementary data*: Information pertaining to morbidity, education, income and household assets will be available for all adult iHDSS populations, including PNG NCD Survey participants, from complementary datasets collected as part of the larger iHDSS research program.

Measures: Child Participants

- *Child Nutrition Survey*: An interviewer administered questionnaire conducted with a parent or primary caregiver of the participating child. Question domains include: participant demographics, breastfeeding history, and introduction of complementary foods, childhood illness and birth weight.
- *Physical Measurement*: Weight, height, head and mid-upper arm circumference.

PROGRESS

Following extensive preparation and piloting, including the development of PNG specific physical activity and diet/nutrition measures (see instrument development below), participant recruitment has now commenced in all study sites. The first phase of participant recruitment is ongoing and should be completed in late 2014.

By this time, it is anticipated that at least 600 adults and 200 children will have been recruited from each iHDSS (total sample: 2400 adults, 800 children). A sample of this size will be sufficient to reliably calculate the prevalence of target NCDs and associated risk factors at the population level (combined iHDSS samples) and between project impact (combined Hiri and Hides iHDSS samples) and comparison sites (combined Karkar and Asaro iHDSS samples). However, a sample of this size will be insufficient for more detailed site-specific analyses or analyses by age and sex (e.g. prevalence of diabetes in males aged 40 years or older compared to females). A second phase of recruitment will be conducted throughout 2015 to achieve the preferred sample size of 1200 adults and 400 children per iHDSS (total sample: 4800 adults, 1600 children) pending continued funding. A sample of this size will allow site-, age- and sex-specific analyses. Table 7.1 presents the number of participants recruited per iHDSS as of August 30th, 2013.

Table 7.1. Participant Recruitment in the PNG NCD Study by iHDSS

iHDSS	**Date Commenced**	**No. Participants Recruited**		**Total**
		Adults	Children	
Hiri	April, 2013	117	27	144
Asaro	May, 2013	81	13	94
Hides/Komo	July, 2013	25	2	27
Karkar Island	June, 2013	53	12	65
Total		276	54	330

Instrument Development:

A validated Papua New Guinea Physical Activity Questionnaire (PPAQ) has been developed for use in the PNG NCD Study (see Appendix C). The development of the PPAQ was necessary, as existing physical activity questionnaires used internationally do not adequately reflect the type and diversity of physical activity and sedentary behaviours common to peri-urban and rural communities in PNG. The resulting metrics of the PPAQ (currently being prepared for publication) are equal to or better than existing physical activity questionnaires and it is the first such instrument of its kind specifically developed for use in the PNG context. Once published, the PPAQ will be made available to the National Department of Health and other relevant government and non-government organisations.

A PNG-specific diet and nutrition module has also been developed for use with the nutrition analysis software program *Foodwerx*©. This module incorporates the wide and diverse range of foods consumed in Papua New Guinea into the *Foodwerx*© program and allows detailed nutritional analyses to be conducted on these food items. This PNG diet and nutrition module will also be shared with relevant government and non-government organisations.

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Figure 7.1. A woman in Iyafoka, Asaro iHDSSharvesting sweet potato in the garden for her pig meal

This is a newly introduced sweet potato in Asaro iHDSS. This type has high yields but is not preferred for household consumption. Usually it is given to pigs, local people consumed when preferred sweet potato is not available. So this new type of potato is now seen as the bridging food supply source.

APPENDIX A

ABSTRACTS of presentations to

the *49th Annual Medical Symposium*, Lae, Papua New Guinea, 2-6 September, 2013.

Mortality and cause of death in four sites across Papua New Guinea

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ABTRACT

Background: Cause specific mortality statistics by age and sex are essential for assessing the health needs of populations, setting priorities for interventions, monitoring the effects of health programs, and for rational allocation and distribution of resources within the health sector. Papua New Guinea (PNG) mortality statistics are based on deaths in health facilities which are a biased sample of all deaths in the population. Furthermore, PNG lacks a comprehensive civil registration system for births and deaths. The only other reliable source of mortality data are demographic and health surveys and small population studies. Only a few of those who die have seen a medical practitioner during their terminal illness. The only means of obtaining cause of death (COD) data in the general population in PNG is by use of verbal autopsy (VA) techniques. Over the last 5 decades PNGIMR has employed two different VA instruments in different regions of PNG in small populations.

Methods: We have reviewed mortality data and the instruments employed to investigate mortality and COD in PNG from 1970 through 2004 as a single data set principally. These studies were done in the Southern and Eastern Highlands and in the Wosera area of East Sepik Province. VA interviews were reviewed by physicians and a probable cause of death was assigned to each case. We compare these results with surveys from 2011 to the present in the Asaro Valley and Western Hiri which were done as a component of the Partnership in Health Demographic and Health Surveillance system.

Results: The older data reflects mortality patterns which had changed little since the 1950s. The more recent data gives evidence of an epidemiologic transition from infectious to non-communicable diseases.

Conclusions: PNG mortality patterns are changing rapidly. The country exhibits wide differentials in levels of mortality and causes of death between and within provinces. For the purpose of monitoring mortality PNG needs methods that are validated locally. Much can be learned from the strengths and weaknesses of the two VA instruments used here. Particular care must be taken in the selection of study populations that are representative of the national population.

Epidemiology of Tuberculosis in remote Kikori, Gulf Province

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ABSTRACT

Background Tuberculosis in Papua New Guinea is of high burden as identified by WPRO. DOTS was introduced to most parts of PNG, however, it is yet to be fully implemented in Kikori. Even though it is challenging to carry out a TB control program in remote areas of PNG, proper coordination and commitment from partners and individuals can move the program forward. We present part of theTB epidemiology study in Kikori, the operational challenges and lesson learned to improve the TB program in remote areas of PNG.

Methods From June to December 2012 we prospectively collected data from patients presenting to Kikori Rural Hospital who qualify under the study's selection criteria. Patients with cough were asked to submit three sputum samples for microscopic examination. Where possible, sputum was collected for GeneXpert analysis to detect rifampicin and isoniazid resistance. Samples were also processed, packed and stored for culture at the Port Moresby Class II laboratory. We also conducted patients' follow up to determine their treatment outcomes.

Result Of 317 patients, 152 were diagnosed with pulmonary TB (PTB) and 165 were extra-pulmonary TB. Of the 152 PTB, 94 submitted sputum for microscopic examination while 58 were clinical diagnosis. 55% (52/94) had positive AFB. 127 samples were tests by GeneXpert with 29 positive with PTB and 2/7 positive for extra pulmonary TB. The outcomes were: 7 cases were cured, 218 completed treatment, 2 defaulted, 1 died, 2 transferred out, 110 were lost to follow-up and 108 are still on treatment.

Conclusion Kikori has one of the highest numbers of TB cases in PNG not driven by HIV co-infection. To conduct successful DOTS intervention, it is important to make sure patients are diagnosed and treated early. Most of the patients are still

undergoing treatment and are being followed-up monthly but the greatest challenge was that patients were always mobile, making it difficult to track them down. Another important issue is the poor delivery systems of vital drugs to remote places. With further collaborations from local partners more can be done to curve TB incidence in this remote area.

TB Incidence and Characteristics in the Remote Gulf Province of PNG.

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Background The incidence and characteristics of tuberculosis (TB) in remote areas of Papua New Guinea (PNG) are largely unknown. Resource development companies with projects in remote regions have raised awareness that tuberculosis is a major problem in these areas. We assessed the incidence of TB in the remote Gulf Province of PNG.

Methods From March 2012 to June 2012, we prospectively collected data on patients presenting to Kikori Hospital with a presumptive diagnosis of TB, and on hospital inpatients and outpatients receiving TB treatment during the study period. Where possible, sputum was collected for microscopy and GeneXpert analysis was used to detect rifampicin resistance.

Result We estimate the incidence of TB in Kikori to be 1130 per 100, 000 people (95% CI 1000 to 1300) in 2012. The proportion of TB patients co-infected with HIV was 1.9%. Ten percent of TB cases tested were caused by rifampicin resistant strains. Typing of 6 isolates demonstrated allelic diversity and most were related to Beijing strains.

Conclusion The incidence of TB in Kikori is one of the highest in the world and it is not driven by HIV co-infection. Rifampicin resistance is not infrequent and TB is caused by diverse genotypes with a predominance of Beijing like strains. TB characteristics and demographic data shed light on possible contributors to the high TB incidence. Further research is required to understand the major determinants of TB disease in this isolated community that is now being accessed by global corporations.

Human papillomavirus and other sexually transmitted infections among women attending antenatal, well woman and sexual health clinics in PNG

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BackgroundCervical cancer is the most common cancer among women in Papua New Guinea and a leading cause of premature death. Despite the estimated burden of cervical cancer, there is very limited information available on the epidemiology of human papillomavirus (HPV) in PNG. The PNG Institute of Medical Research (PNGIMR) is currently leading a collaborative HPV and cervical cancer research program that will provide the first robust estimates of HPV type prevalence among women at different levels of sexual risk in PNG.

Methods Cross-sectional bio-behavioural surveys are underway to investigate the epidemiology of HPV and other STIs among 2500 women attending antenatal (ANC), well woman (WWC) and sexual health clinics (SHC) in six provinces in PNG. DNA extracted from self-collected vaginal swabs is being tested for *C. trachomatis*, *N. gonorrhoeae* and *T. vaginalis* by real-time PCR, and HPV genotyping conducted using the Roche Linear Array kit. Participants are offered voluntary HIV counselling and testing and asked to provide venepuncture specimens for syphilis and *Herpes simplex* Type-2 (HSV-2) serology.

ResultsAt end-May 2013, a total of 863 women had been enrolled at nine participating clinics (ANC:426; WWC:103; SHC:334). High HPV/STI prevalences have been observed in all clinical settings. The prevalence of HPV infection was 56.1%, 27.5% and 50.6% among ANC, WWC and SHC attendees respectively. Vaccine preventable HPV types 16 and 18 were the most prevalent high-risk types in all settings. Among ANC attendees at five sites, the prevalence of *C. trachomatis* was 20.9%; *N. gonorrhoeae*, 7.1%; *T. vaginalis,* 19.6%; HSV-2, 38.6%; and active syphilis, 4.0%.

Conclusion This research is providing the first geographical, age and type-specific prevalence data on HPV infection in PNG. Study findings will inform evidence-based public health policy on HPV and cervical cancer control in PNG, including the introduction of polyvalent HPV vaccines for primary cervical cancer prevention. This work is also expected to inform national policy on the elimination of mother to child transmission of HIV and syphilis.

Investigations into the first outbreak of chikungunya in Papua New Guinea

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Abstract

Chikungunya is a mosquito-borne virus that causes acute fever and persistent polyarthritis. Recent explosive outbreaks of chikungunya have been reported from many Asian countries and Islands in the Indian Ocean. Many of these outbreaks were caused by strains from the East/Central/Southern African (ECSA) genotype and harboured a mutation (E1:A226V) in the E1 glycoprotein gene that enables CHIKV to replicate and spread more efficiently in *Aedes albopictus* mosquitoes. In June 2012 an outbreak of fever and arthritis was detected in Vanimo, Papua New Guinea through a Mobile Phone-based Surveillance system. Subsequent investigations showed that the outbreak was caused by a CHIKV strain from the ECSA genotype. Sequence analysis of the E1 glycoprotein gene revealed that the outbreak strain harboured the E1:A226V mutation. Entomological investigations revealed a high density of *Aedes albopictus* mosquitoes in the outbreak area. The outbreak in Vanimo resulted in >1,500 suspected cases of chikungunya. In the following months the chikungunya outbreak spread throughout the country. To date, chikungunya outbreaks have been confirmed, by laboratory testing, from 10 Provinces of Papua New Guinea and another 2 Provinces have suspected outbreaks. This is the first time that chikungunya has been reported in Papua New Guinea. There is a high risk of the chikungunya outbreak spreading to other regions of the South Pacific due to the prevailing social, environmental and entomological factors.

Detection of Enteric Pathogens UsingField-based Loop Mediated Isothermal Amplification (LAMP) in Papua New Guinea

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Abstract

Enteric illnessesarea leading cause of morbidity and mortality inPapua New Guinea (PNG) and other developing countries. Diagnosis of enteric infections is important as a broad range of aetiological agents are involved; thus optimal treatment regimens differ. Rapid diagnostic methods that are sensitive, specific and inexpensive are needed for routine diagnostic purposes and for disease outbreak investigations in resource-poor settings.Loop-mediated isothermal amplification (LAMP) assays can facilitate the diagnosis of enteric diseases through single-temperature amplification of nucleic acid, thusreducing the system complexity of PCR-based methods. Inorder to develop a LAMP assay suitable for use in resource-poor settings, we have a) evaluated colorimetricdyes to increase visibility of positive results; and b) developed a field-based LAMP instrument that does not require electricity. We evaluated SYBR Green, hydroxynapthol blue (HNB) and propidium iodide in laboratory-based LAMP assays for the detection of three important enteric pathogens: *Vibrio cholerae*, *Shigella* spp. and *Salmonella* spp. HBN and SYBR Green werehighly effective, enabling detection of DNA(through colour change) visible to the unaided eye in DNA dilutions comparable to real-time PCR (within 1 log). In early trials our field-LAMP instrument has demonstrated similar levels of sensitivity to our dedicated laboratory-based LAMP instrument. These adaptations to the LAMP assay make it well suited to routine diagnostic applications in regional hospitals and healthcare settings in PNG or low-income countries, where electricity supply is often unreliable and maintenanceof complex scientific equipment is challenging. In addition, such an assay could be well suited to field applications.

Aetiology of Paediatric Acute Watery Diarrhoea in Goroka, Papua New Guinea

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Abstract

In Papua New Guinea (PNG) acute watery diarrhoea in children under 5 years of age is one of the greatest causes of hospital admissions and deaths. Microbiological surveillance for detection of aetiological agents of diarrhoeal cases is valuable for public health interventions and case management, however, culture based methods are expensive, require specialised skills and have long turnaround times. Application of molecular diagnostics in selected laboratories may be a viable way of disease diagnosis in low-income settings. As proof-of-principle, and to better understand the aetiology of childhood diarrhoea in PNG, faecal samples were collected from children (<5 years of age) that were hospitalized with acute gastroenteritis at the Goroka Base Hospital from March 2009 through May 2010. Stool specimens were stored at 4°C and were transported to the laboratory within 4 hours of collection. Viral and bacterial pathogens were detected using fluorescence-based quantitative real-time polymerase chain reaction (qPCR).We have found a high proportion of important enteric pathogens such as rotavirus, norovirus, *Shigella* spp., and Enteropathogenic *Escherichia coli,* which are associated with acute watery diarrhoea in children. The qPCR is a very sensitive technique for the detection of enteric pathogens or enteric virulence genes, but are only applicable to diagnostic laboratories with considerable resources.

Vaccination coverage and delay among children living in resource development impact areas, Hiri district, Central Province, Papua New Guinea

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ABTRACT

BackgroundHiri West in Central Province is one of the sites of major and rapid economic development inducing population migration, which adds burden on existing health care facilities. Vaccination coverage is one of the indicators to show the performance of the health care delivery. Here we report the results of the vaccination coverage survey conducted in four villages in Hiri Health and Demography Surveillance sites (iHDSS).

MethodsA cross-sectional household survey was conducted in the first quarter of 2013 in the Hiri iHDSS. The target group was all children age 1 to 5 years old in iHDSS. The questionnaire consisted of the records of vaccination dates from the children's health book and condition of health book. Consent was obtained from the parents of children. Then data are entered and analyzed to determine vaccination status and the delay of vaccination and by linking this data to iHDSS database to identify the demographics characteristics.

ResultsA total of 398 children aged 1-5 years old in Hiri iHDSS were included. Of 314 health books reviewed, 68% were kept in good condition. The vaccination coverage rates for first vaccine doses were 86% for BCG, 74% for HepB, 85% for OPV, 78% for DTP/Hib and 80% for Measles. A lower coverage of vaccine was found for the second and third doses of all vaccines. For vaccinations that are to be given at birth, approximately 60% received the vaccine at the right time. However, only 16% received the last doses of DTP/Hib/HepB, OPV and Measles at the right time. The mean vaccination delay for the first dose of vaccines was 63 days for BCG, 67 days for HepB, 54 days for OPV, 72 days for DTP/Hib/HepB and 88 days for Measles. The most delayed vaccine dose was Measles dose 2 (90 days). 57.2%

of children received all 3 doses for DTP/Hib/HepB, while 69.4% received all 3 OPV and 63.7% both Measles doses, respectively.

ConclusionThe vaccination coverage rate in Hiri West is similar to those previous surveys in 2009 in Asaro (68-95%) and Wosera (70-85%). However, the delay is pronounced in averages of 2.5 months of all vaccines. The Maternal and child health mobile clinic will help to increase the coverage along with the health education. Public health policy in PNG needs to be well prepared and adapted to rapid transitions where the demands of health care delivery are potentially increased.

Factors determining the Vaccination coverage in rural Komo-Hides community: A Cross-sectional study analysis using multivariate, socioeconomic survey and Geographic Information System.

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BackgroundVaccine coverage in PNG range between 60%-70% and remain one of the lowest amongst developing countries. Like many rural areas in PNG socioeconomic, infrastructural and geographical factors to name a few act as barriers in to receiving these health care services. This study aims to assess the vaccination coverage rate and investigate the socioeconomic factors that act as barriers preventing children from receiving vaccine.

MethodsA sub-sample of children between 0-5 years was extracted from Health and Demography Surveillance System (iHDSS) database. This iHDSS was established in Komo area in the LNG impacted area in 2011 to evaluate the social and health impact the LNG project will have on populations living around the project area. A 500km^2 radius was defined around the main health service provider (Malanda Health Centre) to all 3 divisions of the iHDSS.

ResultsA total of 314 children were surveyed of which 52.3 % were females. Of the 314 surveyed, 70% (138/314) of the children had health books while 30% mentioned that the health book was either damaged (54.6%) or lost (45.6%). Comparison of education and employment levels between mothers and fathers showed that more 50 percent of the mother (65.2%) had no formal education and a further 80 percent were unemployed (84.8%). Overall vaccine coverage rates range between 0.74% (BCG: dose 3) and 85.3% (BCG: at birth). Oral Polio Vaccine (OPV) the only vaccine that had higher coverage levels for all required doses (dose 1: 85.3%, dose 2: 61.8%, dose 3: 34%, dose 4: 15%) compared to the other vaccines. High coverage were observed for dose one for all vaccines with BCG and OPV having the highest of 85.3% followed by HIB (68.3%), Measles (65.4%), Hep B (36.3%) and DTP with the lowest of 9.6%.

ConclusionDespite high coverage levels across all vaccines for dose 1, coverage levels generally remain low for doses 2 onwards. Variations in employment and education also act as barrier in children receiving the scheduled doses. There is need for more health education on the importance of immunization in these areas. Furthermore, more studies are required to understand better the social and cultural barriers hindering access to child health care services.

Sanitation, water use and hygiene practices in Hiri district, Central Province, Papua New Guinea: Evaluation for diarrhoea prevention intervention

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BackgroundIn 2009-2011, PNG has experienced the first cholera outbreak with total cases of 15,582 and total deaths of 493. Hiri was one of the outbreak areas. Hygiene interventions (hand washing and hygiene education) are tools to reduce contamination of hands, food, water, and fomites. To select water, sanitation, and hygiene interventions, it needs to be effective at motivating people to use them. The aim of this study is to assess the hygiene practices intervention (WASH) currently conducted in Hiri, in order to improving hygiene practices to prevent diarrhea.

MethodsThis is a cross-sectional survey being conducted from September 2012 to May 2013, covering 400 randomly selected households in Hiri Health and Demography Surveillance System (iHDSS). Questionnaire survey was developed and piloted in July-August 2012. The questionnaires contained details of water sources, water collection and storage, treating drinking water and hygiene practices, including people's knowledge and practices on existing WASH program, which conducted by Population Services International (PSI). Data entry was done using EpiInfo 7 and statistical analysis was performed with STATA software version 12.

ResultsMain water sources varied in 4 villages, Boera was deep well; Lea Lea is rainwater; Papa is deep well and Porebada is pipe water. Average travel time to fetch water was 7 minutes, predominately adult female collecting water. Hand washing was common as 90% washing after using toilet, 89% before eating food, and 82% before breast-feeding. Approximately 88% used soap to wash hands and used when it is available. Over 82% bathed as frequent as twice a day. Majority (80%) received WASH kits from PSI, had significantly higher knowledge on the risk of diarrhoea ($p=0.002$), and on treatment of diarrhoea with ORS and zinc (87.5%, $p<0.05$). Aqua tab from WASH program was popular as over 90% of the recipients used it to purify drinking water.

ConclusionWASH program with health education has improved the quality of drinking water and hygiene practices. However, there is a need for a measure to maintain the long-term good hygiene practices in this community.

A survey of non-communicable disease and associated risk factors in five sites across Papua New Guinea (the PNG NCD Survey): Study description and methodology

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ABSTRACT

Introduction: The rapid rate of economic development currently occurring in Papua New Guinea (PNG), attributable in large part to the mining of natural resources and the large scale PNG liquefied natural gas (PNG LNG) project, suggests an increase in Non-Communicable Disease (NCD) is inevitable. Accordingly, it is prudent to establish the prevalence for NCDs and their associated risk factors in the early stages of this development 'boom' so that any subsequent changes may be readily identified and appropriate public health interventions developed and implemented in a timely manner. This paper will present a methodological overview of an NCD epidemiological survey recently commenced in PNG that aims to:

1. Establish a baseline data set to determine among people living in three diverse study sites across PNG that are directly impacted by the PNG LNG project, and also in two non-impacted comparison sites:
    a. the prevalence of selected NCDs (namely diabetes mellitus type 2, hypertension, acute coronary syndrome, stroke, chronic lung diseases and cancers) and associated lifestyle risk factors;
    b. dietary habits and food security; and
2. Establish a surveillance system for longitudinal monitoring to detect any changes in the prevalence of NCDs and associated lifestyle risk factors, and also any changes in dietary habits and food security, among the five study sites.

Method: The proposed study will consist of a cross sectional survey conducted in five sites over a three year period or until the target sample size has been achieved. The survey will comprise adult (15-65 years) and child (6-59 months) components. The adult component of the survey will include completion of a standardised questionnaire, a 24 hour dietary recall, selected physical measurements and biological sample collection. The child component will include selected physical measurements taken from the child and a nutrition survey completed with the child's primary caregiver. A total of 1600 participants aged between 6 – 59 months (n=400) and 15-65 years (n=1200), stratified according to gender and age, will be recruited by random sampling from each study site. Pending continued funding, repeat cross sectional surveys will be completed over a comparable time period in the same study sites to allow longitudinal surveillance of NCD risk factors and prevalence.

Development of Papua New Guinea Physical Activity Questionnaire (PPAQ)

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Background

The rapid economic development currently underway in PNG creates a change in people's lifestyles, diets and physical activity, major determinants of non-communicable diseases. Physical activity patterns in PNG differ from those in developing countries but there is no validated questionnaire for measuring physical activity in PNG. The study aims to develop a questionnaire for measuring habitual physical activity in PNG, called PNG Physical Activity Questionnaire (PPAQ).

Methods

1) Investigation of physical activity patterns was conducted in the Health and Demographic Surveillance Sites (iHDSS) in Hiri and Asaro. Over a 12-hour period, 24 male and 22 female healthy participants wore the accelerometer (Suzuken) that records movement intensity. Scientific officers recorded the main physical activity (type, motion, and context) during the 2-minute interval. In total, 14,554 physical activities were recorded and grouped into 50 based on conceptual similarity.

2) Development and validation of PPAQ we further grouped and ask about time spent on each activity in the last 7 days. For validation of the questionnaire, another 59 men and 60 women volunteered to wear the accelerometer for the 7 days.

Results

On average, they spent 82 minutes on subsistence and cash cropping, 75 minutes on waged-work and study, 131 minutes on house chores, 135 minutes on transport and 189 minutes on leisure-time and other (e.g., sleeping). Sedentary activities

accounted for less than 10% of the total time. Participants only used vigorous intensity in playing sports (24.5% of the time). They used moderate intensity in performing 23 activities but mostly at less than 10% of the time, except when running and fast walking (83.5%), carrying load (36.4%), roaming (25%) and playing sports (18.4%). PPAQ containing 23 questions were successfully developed. Analysis for validation is underway.

Conclusion

Observed Metabolic Equivalents (METs) of most activities in PNG were substantially lower than the METs in the Compendium of Physical Activities. Our next step is to compare our results with published METs in PNG population and others in similar living environment, as well as to investigate the correlation between the PPAQ computed daily physical activity with the accelerometer data.

The following abstracts are from a study funded by the PNGLNG project (LCA)

Accelerated schedule of 10- and 13-valent pneumococcal conjugate vaccine is immunogenic in infants in the Asaro Valley, Papua New Guinea.

Wana S[1], Martin B[1], Richmond P[2], Solomon V , Francis J[1], Bele L[1], Kave J[1], Nivio B[1], Nenikuro M[1], Dreyam M[1], Saleu G[1], SibaP[1], Passey M[4], Lehmann D[3], Pomat WS[1] (on behalf of PCV team)

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Introduction With the planned introduction of pneumococcal conjugate vaccine (PCV) into the national immunisation schedule likely in Papua New Guinea (PNG) before 2015, it is necessary to determine the immunogenicity, safety and suitability of early schedules in line with EPI schedule in PNG. Two currently licensed pneumococcal conjugate vaccines, Synflorix (PCV10) and Prevenar 13 (PCV13), are estimated to provide 70-80% coverage of serotypes causing pneumonia and meningitis in PNG. It is anticipated that their introduction will reduce the high burden of these diseases in PNG to attain the United Nations Millennium Development Goal of reducing childhood mortality rate. This study investigated the immunogenicity of PCV10 and PCV13 in PNG children.

Methods To date 200 children have been randomised to receive either PCV10 (n=100) or PCV13 (n=100) in a 1-2-3 month schedule. Blood was collected pre-vaccination (1month) and at 4months (1 month post-dose 3). Serotype-specific pneumococcal IgG antibodies were measured using the WHO standardized ELISA

to PCV10 serotypes (ST 1, 4, 5, 6B, 7F, 9V, 14, 18C, 19F and 23F), PCV13 serotypes (PCV10 + ST 3, 6A, 19A) and a non- vaccine serotype (ST 2).

Results Interim analysis of 104 children who completed all doses of PCV showed good immunogenic responses to both vaccines. PCV10 (n=53) recipients at age 4months had antibody titres to all PCV10 serotypes as well as non-PCV10 serotypes 3 & 19A ≥ 0.35µg/mL, except ST 6A. PCV13 (n=51) recipients had antibody titres ≥ 0.35µg/mL to all serotypes. For non -vaccine serotype 2 at age 1month, both vaccines had antibody concentration of 0.6µg/mL, however; this declined at 4months to 0.37µg/mL and 0.27µg/mL in PCV13 and PCV10 immunised children respectively. Geometric mean antibody concentration (GMC) for PCV13 at 4months ranged from; 0.796µg/mL (ST 3) to 4.67µg/mL (ST 14) and PCV10 ranged from 0.32µg/mL (ST 6A) to 12.62µg/mL (ST 6B).

Conclusion PCV10 and 13 are immunogenic; though responses vary according to serotypes. To date our data suggests that PCV10 and PCV13 would be interchangeable should global supply of one of them be reduced by demand, but further analysis are required.

Antibiotic resistance to *Haemophilus influenzae* in the nasopharynx of children enrolled in the Pneumococcal Conjugate Vaccine trial

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Background Monitoring antibiotic resistance patterns to commonly used antibiotics for treatment of respiratory diseases is essential.Antibiotic resistance to *Haemophilus influenzae* b (Hib) was rarely seen in carriage, with previous carriage studies showing serotypeable *H.influenzae* to be susceptible to first line antibiotics; Ampicillin, Chloramphenicol, Tetracycline and Cotrimoxazole. We are however, beginning to observe resistance to these antibiotics by some carriage isolates. We report antibiotic resistance to *H. influenzae* in nasal swabs of children less than 5 years enrolled in a Pneumococcal Conjugate Vaccine study.

Methods Pernasal swabs were collected from 200 children enrolled in the pneumococcal conjugate vaccine trial at 1, 4, 9 and 10 months. Ear and eye swabs were collected during sick visits. Swabs were cultured on blood agar, chocolate agar, gentamicin blood agar and bacitracin chocolate agar.Tryticase soy agar was used to distinguish X and V factors and cefinase discs were used for betalactamase production on *Haemophilus influenzae* looking colonies. Mucoid colonies were serotyped using serotyping antisera.

Results We isolated 228 Haemophili from 304 nasopharyngeal swabs, 5 ear swabs and 1 eye swab. 24/228(11%) isolates showed resistance to Ampicillin 15/24 (63%), Chloramphenicol 19/24(79%), Tetracycline 21/24(88%), Cotrimoxazole 20/24(83%). The majority of these resistant isolates were non-typeable *H.influenzae* 13/24(54%).

Of the serotypeable isolates, there were 5/24(21%) serotype A, 2/24(8%) serotype D and 1/24 (4%) each of serotypes B, C and E .All children had received a dose of pentavalent vaccine.

Conclusion This study shows that antibiotic resistance is present in carriageisolates of *H. influenzae* and proper care is needed in the use of antibiotics.

APPENDIX B

A Poster presented in The International Union against Sexual Transmitted Infection, Sydney, Australia.

15-17 October 2012

The prevalence of sexually transmitted infections, including HPV, among antenatal clinic attendees in Asaro, Papua New Guinea

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Introduction

- In Papua New Guinea (PNG) little is known about the prevalence of sexually transmitted infections (STI), in particular human papillomavirus (HPV), among pregnant women.
- Infection with high risk types of HPV is necessary for the development of cervical cancer.
- High risk HPV types 16 and 18 are present in 70% of cervical cancer cases in the world (Clifford et al. 2006, Vaccine).
- HPV vaccines protective against HPV 16 and 18 are existing, however are not available in the public health system in PNG.

Study rationale

To contribute to the evidence base required to formulate a national HPV vaccine policy, this study aimed to collect the first ever HPV type prevalence data among pregnant women in the Asaro District in the Eastern Highlands Province, PNG. In addition, the prevalence of STIs including *Chlamydia trachomatis*, *Neisseria gonorrhoea*, *Trichomonas vaginalis*, *herpes simplex virus* type-2 (HSV-2) and syphilis was determined for this population.

Asaro Clinic, EHP

Study nurse recruiting local women

Methods

- A cross-sectional bio-behavioural survey is underway to investigate the epidemiology of HPV and other STIs among 1000 women attending antenatal clinics (ANCs) in four provinces in PNG, including the Asaro District, Eastern Highlands Province.
- Following the completion of informed consent procedures, participants are asked to take part in a face-to-face interview in which socio-demographic, sexual behaviour and clinical information were collected; to undergo an antenatal clinical examination; and to provide a 10 mL venepuncture specimen and a single self-collected vaginal swab.
- Venepuncture specimens were tested for syphilis (RPR and TPHA) and HSV-2 (IgG ELISA, Kalon Biologicals).
- DNA extracted from self-collected vaginal swabs was tested for *C. trachomatis*, *N. gonorrhoea* and *T. vaginalis* by real-time PCR, and HPV genotyping performed using the Roche Linear Array Genotyping kit.

Results

- A total of 140 participants have been enrolled in the Asaro study site to date (August, 2012). The mean age of participants was 24.
- HPV testing has been performed for 100 participants (Table 1 and Figure 1).
- STI testing has been completed for the first 108 participants (Table 1).

- The prevalence of *C. trachomatis* (18.5%) is similar to that previously reported from other Pacific Island Countries and Territories (Second Generation Surveillance Surveys, WHO and SPC, 2006)
- Syphilis prevalence (5.6%) was higher than that reported in the 2009 PNG national ANC surveillance (4.2% for rural areas), and is also higher than that reported in the Pacific (mean 3.0%). WHO considers PNG a priority for the elimination of congenital syphilis.
- The high HSV-2 prevalence in this study (47.2%) was higher than estimates from similar populations in other centres in the Pacific (30%) (Second Generation Surveillance Surveys, WHO and SPC, 2006), however is similar to that observed in high-risk populations in PNG (Simbiken *et al*, unpublished data). HSV-2 treatment is not available in the public health system.

Figure 1. HPV type distribution in 122 infections among 100 ANC attendees

- 56% of women were infected with at least one HPV type
- HPV 16 was the single most prevalent type.
- The proportion of HPV 16 and other HR HPVs is similar to the distribution observed in Asia and South America (Clifford *et al.* 2005, Lancet).
- Multiple infections were most common in the 20-29 year age group

Conclusions

- High rates of STIs were observed in this study, with half the women having at least one STI.
- High rates of *C. trachomatis* and syphilis may require intervention programs to protect the health of mother and child, particularly with the aim of eliminating congenital syphilis.
- HPV 16 is the most common HPV type in this population and is vaccine preventable.

The authors gratefully acknowledge Partnership in Health research funding, through Exxon Mobil, the dedicated PNG IMR field nurses; Anne, Janet and Caroline. Finally, we thank the study participants without whom this work would not be possible.

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This poster won the best poster award at IUSTI 2012

APPENDIX C

Questionnaires of the Non-communicable diseases study for ADULT participants

FORM 1	ADULT NCD SURVEY

Site Identification			
iHDSS Site:			
Village name:			
Village ID:			
Participant Identification			
ParticipantName:			
Participant ID:			
Participant Sex:	1. Male	2. Female	
Contact Attempts (a minimum of 6 contact attempts required. Record time & date of each contact)			
1. Time:	Date: / /	4. Time:	Date: / /
2. Time:	Date: / /	5. Time:	Date: / /
3. Time:	Date: / /	6. Time:	Date: / /
Consent			
Has consent been read to respondent?	1. Yes	2. No (read consent)	
Has written consent been obtained?	1. Yes	2. No (end interview)	

Interview Details				
Interviewer Name:				
Interview Date:	/	/		
Interview language:	1.	English	3.	Motu
	2.	Pidgin	4.	Other (specify):
Participant Contact Details				
Does the participant have a contact phone number?			1.	Yes
			2.	No (start interview)
Primary contact phone number:				
Alternative contact phone number:				

STEP 1: BEHAVIOURAL MEASUREMENTS

1. Demographic Information

Thank you for agreeing to participate. To start with I would like to confirm your age and date of birth *(and if female)* and possible pregnancy status

Age and date of birth information should be entered from iHDSS records prior to interview.

If the participant reports a substantially different age/DOB as compared to iHDSS records then clarify that you are interviewing the right person (e.g. a father and son may share the same name). It may not be unusual for older participants to report a widely different age (e.g. +/- 10 years), but this should be less common in younger participants.

If you subsequently discover the participant is less than 15 years of age or more than 65 years of age, then politely end the interview.

1.1a	Were you born on (*specify date*)? *Date* = *(enter date from iHDSS records)*	1. Yes *(go to 1.2a)* 2. No 77. Don't know 99. No response		
1.1b	When were you born?	/ /		
		Day	Month	Year

1.2a	Are you (*specify*) years of age? *Age* = *(enter age from iHDSS records)*	1. Yes *(go to 1.3 if female or 2.1 if male)* 2. No 77. Don't know 99. No response
1.2b	How old are you?	Age in years: 77. Don't know 99. No response
1.3	Are you pregnant? *Only ask females aged 15-45 yr*	1. Yes *(end interview after 1.4)* 2. No *(go to Q2.1)* 3. Not applicable *(go to Q2.1)* 77. Don't know*(go to Q2.1)* 99. No response *(go to Q2.1)*
1.4	If yes, gestation age?	No. of weeks: 77. Don't know 99. No response

2. Self-Reported Health Status		
Now I would like to ask you some questions about your health.		
2.1	How would you rate your general health today? Would you say... *Read out responses 1 to 5*	1. Excellent 2. Good 3. Moderate 4. Bad 5. Very Bad 77. Do not know 99. No response
2.2	How would you describe your general health compared to others of your own age? Would you say... *Read out responses 1 to 3*	1. Better than others 2. Worse than others 3. Same as others 77. Do not know 99. No response

3. Wari/hevi		
The next questions ask about sleep and appetite. We have many demands in our life such as study/work, relationships and money. Sometimes they become "*wari/hevi*", which can affect our sleep and appetite.		
3.1	You do not need to tell us what it is, but do you currently have any sort of wari or hevi?	1. Yes 2. No *(go to Q4.1)* 77. Don't know *(go to Q4.1)* 99. No response *(go to Q4.1)*
3.2	In the past week, how many days have you experienced sleep difficulty because of thinking about *wari/hevi*? *Read responses 1-5.*	1. Never 2. Less than 1 day/wk 3. 2-3 days/wk 4. 4-5 days/wk 5. 6-7 days/wk 77. Don't know 99. No response

3.3	In the past week, have you experienced a change in appetite such as eating less or more than usual because of thinking about *wari/hevi*?	1. Yes - less than usual 2. Yes - more than usual 3. No - same as usual 77. Don't know 99. No response

4. Dietary Questions		
Questions in this section will ask about the types of food that you have eaten in a typical week over the last month. There will also be questions on use of salt, sugar, and oil or fat.		
Vegetables, fruits, meat, chicken and fish		
4.1	During a typical week, on how many days do you eat any root vegetables or banana? For example, kaukau, taro, yam, or potatoes.	Number of days: 77. Don't know 99. No response
4.2	During a typical week, on how many days do you eat any greens or other vegetables? For example aibika, beans or avocado.	Number of days: 77. Don't know 99. No response

4.3	During a typical week, on how many days do you eat fruit? For example, pawpaw, orange or mango.	Number of days: 77. Don't know 99. No response
4.4	During a typical week, on how many days do you eat fresh – not tinned - meat, fish, chicken or pork?	Number of days: 77. Don't know 99. No response
4.5	During a typical week, on how many days do you eat tinned meat, fish, chicken or pork?	Number of days: 77. Don't know 99. No response
Sugary drinks		
4.6	On a <u>typical day</u>, how many teaspoons of sugar do you add to your drinks in total? *Nb. 1 tablespoon = 4 teaspoons*	Number of teaspoons: 77. Don't know 99. No response
4.7a	During a typical week, on how many days do you drink soft drinks? E.g. coke, fanta or sprite *If 0 days go to Q4.8*	Number of days: 77. Don't know 99. No response

4.7b	On one of those days, how many soft drinks do you drink in total? *Record response in measure (cup, can or bottle) used by participant.*	Number of cups (c.250ml): Number of cans (c. 330 ml): Number of bottles (c. 500ml): 77. Don't know 99. No response
Fried food		
4.8	During a typical week, on how many days do you eat fried food purchased from a shop or market? For example, flour balls, chips or lamb flaps	Number of days: 77. Don't know 99. No response
4.9	During a typical week, on how many days do you eat fried food cooked in your house? For example, fried flour, fried rice, fried vegetables or fried meat.	Number of days: 77. Don't know 99. No response
Salt intake		
4.10	During a typical week, on how many days do you put maggie/stock cube directly on any food you eat?	Number of days: 77. Don't know 99. No response

4.11	During a typical week, on how many days do you put salt directly on any food you eat?	Number of days: 77. Don't know 99. No response
Food security		
In this section I will ask you questions regarding possible food shortages in your village.		
4.12a	In the last 12 months, were there ever any times when people in this village ate less than they should because there wasn't enough food?	1. Yes 2. No *(go to Q5.1)* 77. Don't know *(go to Q5.1)* 99. No response *(go to Q5.1)*
4.12b	How often did this happen? Would you say… *Read responses 1-3*	1. Every month 2. Some months, but not every month 3. In only one or two months 77. Don't know 99. No response
4.12c	Here are some reasons why people don't always have enough to eat. For each one, please tell me if that was a reason why people in this village didn't always have enough to eat in the last 12 months:	1. They did not have enough money to buy food 2. They did not have a garden to grow food 3. Their garden did not produce sufficient food

	Read responses 1 – 7. *Multiple responses allowed.* *Circle each answer the participant responds 'yes' to.*	4. Their garden did not produce food because of season or damage 5. They were not able to fish or hunt due to seasonality or bad weather 6. They were not able to access food because of health problems or age 7. They chose not to eat because of specific diet or religious reasons. 8. Any other reason *(specify):* _____ 77. Don't know 99. No response
Tobacco, buai and alcohol		
I am now going to ask you some questions about tobacco, betel nut and alcohol use. The information is important for us, so please answer as honestly as you can. Any information you give me will not be shared with any other person in a way that could identify you.		
4.13	Do you currently smoke any tobacco products, such as cigarettes, spear/mutrus or brus? *Exclude cannabis/marijuana use*	1. Yes 2. No *(go to Q4.17)* 99. No response *(go to Q4.17)*

4.14	Do you currently smoke tobacco products daily?	1. Yes 2. No *(go to Q4.17)* 99. No response *(go to Q4.17)*	
4.15	How old were you when you first started smoking daily?	Age (years): 77. Don't know 99. No response	
4.16	On average, how many of the following do you smoke each day? *Record number smoked each day for each type. Record '0' if no use.* *Go to Q4.19 when completed*	Manufactured cigarettes:	
		Spear/mutrus:	
		Roll your own (brus):	
		Other *(specify):*	
		99. No response	
4.17	In the past, did you ever smoke daily?	1. Yes 2. No *(go to Q4.19)* 99. No response *(go to Q4.19)*	

4.18	How old were you when you stopped smoking daily?	Age (years): 77. Don't know 99. No response
4.19	During the **past 30 days**, on how many days did you chew betel nut? *If 0 days go to Q4.22*	No. days: 77. Don't know *(go to Q4.22)* 99. No response *(go to Q4.22)*
4.20	On average, how many betel nuts do you chew in a day? *On days when the participant chews*	No. nuts per day: 77. Don't know 99. No response
4.21	When you chew betel nut, do you also use mustard and lime? Would you say... *Read response options 1 to 4*	1. Always 2. Sometimes 3. Rarely 4. Never 99. No response

4.22	Have you **ever** consumed a drink that contains alcohol such as beer, wine, live lave or homebrew (steam or yawa)?	1. Yes 2. No *(go to Q5.1)* 77. Don't know *(go to Q5.1)* 99. No response *(go to Q5.1)*
4.23	Have you consumed an alcoholic drink within the **past 12 months**?	1. Yes 2. No *(go to Q5.1)* 77. Don't know *(go to Q5.1)* 99. No response *(go to Q5.1)*
4.24	During the **past 12 months**, how frequently have you had at least one alcoholic drink? Would you say… *Read responses 1 - 5*	1. Daily 2. 5-6 days per week 3. 1-4 days per week 4. 1-3 days per month 5. less than once a month 77. Don't know 99. No response
4.25	During the **past 30 days**, on how many daysdid you have at least one alcoholic drink?	No days: 77. Don't know 99. No response

5. PPAQ

The following questions will ask about activities you do at work, in your house or garden, to get from place to place, or in your free time. The questions will also ask you about the time you spent being physically active in the last 7 days.

*Work/study:*I would first like to ask you about any paid workor schooling you may have completed in the last 7 days.

5.1	Do you currently have a paid job outside your home such as office, construction or plantation work, or do you study at school?	1. Yes 2. No *(go to Q5.5)*
5.2a	As a part of your work/study, except travelling, how many days did you perform VIGOROUS work (i.e., an activity that makes you breathe much harder than normal such as heavy lifting, digging and heavy construction)?	Number of days: *(if 0, go to Q5.3a)*
5.2b	How much time did you spend on VIGOROUS work on a typical day?	Hours | Minutes
5.3a	As a part of your work/study, except travelling, how many days did you perform MODERATE work (i.e., an activity that makes you breathe somewhat harder than normal such as carrying light loads)?	Number of days: *(if 0, go to Q5.4a)*
5.3b	How much time did you spend on MODERATE	

	work on a typical day?	Hours	Minutes
5.4a	As a part of your work/study, except travelling, how many days did you perform LIGHT work (i.e., an activity that does not change your breathing such as desk work, operating machines, driving vehicles, guarding or studying)?	Number of days: *(if 0, go to Q5.5)*	
5.4b	How much time did you spend on LIGHT work on a typical day?	Hours	Minutes
*Subsistence/cash cropping:*Now I would like to ask you about subsistence/cash cropping work you may have completed in the last 7 days.			
5.5	Do you currently fish or perform subsistence or cash cropping, excluding the work you have already mentioned?	1. Yes 2. No *(go to Q5.15a)*	
5.6a	How many days did you CARRY HEAVY LOADS such as firewood, water and crops for at least 10 minutes continuously?	Number of days: *(if 0, go to Q5.7a)*	
5.6b	How much time did you spend on this activity on a typical day?	Hours	Minutes
5.7a	How many days did you CUT SHRUBS, CLEAR LAND, or BURN and PLANT in growing food for household consumption?	Number of days:	

		(if 0, go to Q5.8a)			
5.7b	How much time did you spend on this activity on a typical day?				
		Hours		Minutes	
5.8a	How many days did you CUT SHRUBS, CLEAR LAND, or BURN and PLANT in growing food for selling/cash crops?	Number of days: *(if 0, go to Q5.9a)*			
5.8b	How much time did you spend on this activity on a typical day?				
		Hours		Minutes	
5.9a	How many days did you WEED OR SPRAY AGROCHEMICALS IN A GARDEN in growing food for household consumption?	Number of days: *(if 0, go to Q5.10a)*			
5.9b	How much time did you spend on this activity on a typical day?				
		Hours		Minutes	
5.10a	How many days did you WEED OR SPRAY AGROCHEMICALS IN A GARDEN in growing food for selling/cash crops?	Number of days: *(if 0, go to Q5.11a)*			
5.10b	How much time did you spend on this activity on a typical day?				
		Hours		Minutes	

5.11a	How many days did you MAKE MOUNDS or DIG DITCHES and DRAINS?	Number of days: *(if 0, go to Q5.12a)*
5.11b	How much time did you spend on this activity on a typical day?	Hours | Minutes
5.12a	How many days did you HARVEST food for household consumption for at least 10 minutes continuously? Harvesting includes picking cash crops and gathering edible or medical plants.	Number of days: *(if 0, go to Q5.13a)*
5.12b	How much time did you spend on this activity on a typical day?	Hours | Minutes
5.13a	How many days did you HARVEST food for selling/cash crops for at least 10 minutes continuously?	Number of days: *(if 0, go to Q5.14a)*
5.13b	How much time did you spend on this activity on a typical day?	Hours | Minutes
5.14a	How many days did you HUNT or FISH?	Number of days: *(if 0, go to Q5.15a)*

5.14b	How much time did you spend on this activity on a typical day, including time you walked or paddled canoes looking for game/fish?				
		Hours		Minutes	
Household chores: Now I would like to ask you abouthousekeeping activities you may have done in <u>the last 7 days</u>. These questions exclude any work-related activities that you have already mentioned.					
5.15a	How many days did you perform CHILD CARE activities (i.e., direct contact with child such as feeding, carrying or washing) for at least 10 minutes continuously?	Number of days: *(if 0, go to Q5.16a)*			
5.15b	How much time did you spend on this activity on a typical day?				
		Hours		Minutes	
5.16a	How many days did you CLEAN INDOORS/OUTDOORS or WASH CLOTHES BY HAND for at least 10 minutes continuously?	Number of days: *(if 0, go to Q5.17a)*			
5.16b	How much time did you spend on this activity on a typical day?				
		Hours		Minutes	
5.17a	How many days did you CUT TREES or WOOD to build a house or make firewood for at least 10 minutes continuously?	Number of days: *(if 0, go to Q5.18a)*			
5.17b	How much time did you spend on this activity on a				

	typical day?	Hours	Minutes
5.18a	How many days did you COOK for at least 10 minutes continuously? Cooking includes all kinds of meal preparation including scraping coconuts	Number of days: *(if 0, go to Q5.19a)*	
5.18b	How much time did you spend on this activity on a typical day?	Hours	Minutes
Travel to and from places: Now I would like to ask you about the way you have travelled to and from places <u>in the last 7 days</u>. For example to garden/office, for shopping, to market, to place of worship. These questions exclude any work-related activities that you have already mentioned.			
5.19a	How many days did you RUN or WALK FAST (i.e., walking that makes you breath somewhat harder than normal) for at least 10 minutes continuously?	Number of days: *(if 0, go to Q5.20a)*	
5.19b	How much time did you spend on this activity on a typical day?	Hours	Minutes
5.20a	How many days did you WALK including ROAMING for at least 10 minutes continuously?	Number of days: *(if 0, go to Q5.21a)*	
5.20b	How much time did you spend on this activity on a typical day?	Hours	Minutes

5.21a	How many days did you RIDE ON A MOTOR VEHICLE for at least 10 minutes continuously?	Number of days: *(if 0, go to Q5.22a)*			
5.21b	How much time did you spend on this activity on a typical day?				
		Hours		Minutes	
5.22a	How many days did you PADDLE a CANOE, except for fishing purposes, for at least 10 minutes continuously?	Number of days: *(if 0, go to Q5.23a)*			
5.22b	How much time did you spend on this activity on a typical day?				
		Hours		Minutes	
Leisure-time activities: Now I would like to ask you about sports, fitness and activities that you may have performedin the last 7 days. These questions exclude any work- or travel-related activities that you have already mentioned.					
5.23a	How many days did you PLAY SPORTS for at least 10 minutes continuously?	Number of days: *(if 0, go to Q5.24a)*			
5.23b	How much time did you spend on this activity on a typical day?				
		Hours		Minutes	
5.24a	How many days did you PLAY CARDS/DARTS for at least 10 minutes continuously?	Number of days:			

		(if 0, go to Q5.25a)			
5.24b	How much time did you spend on this activity on a typical day?				
		Hours		Minutes	
5.25a	How many days did you LOOK AT SCREENS (i.e., TV, COMPUTER, PHONE) for at least 10 minutes continuously?	Number of days: *(if 0, go to Q5.26a)*			
5.25b	How much time did you spend on this activity on a typical day?				
		Hours		Minutes	
5.26a	How many days did you CHAT, REST, SELL or SIT DOWN FOR NOTHING aside from the leisure-time activities we have already listed?	Number of days: *(if 0, go to Q6.1)*			
5.26b	How much time did you spend on this activity on a typical day?				
		Hours		Minutes	

6. History of Non-Communicable Disease and Treatment Given		
Now I will ask you series of questions about non-communicable diseases and the treatment that you might have received.		
List of current medications		
6.1	In the past 2 weeks, have you taken any medications prescribed to you by a health worker?	1. Yes 2. No *(go to Q6.3)* 77. Don't know *(go to Q6.3)* 99. No response *(go to Q6.3)*
6.2	May I please see these medications? *If patient no longer has the medication, ask them for the name of the medication and/or to see their health book.*	1. Yes *(list in space below)* 2. Refused *(go to Q6.3)* 77. Meds unavailable/unknown *(go to Q6.3)*
Medication name (list below)		

Before moving to Q6.3, ask the participant "are there any other medications you have taken in the past 2 weeks?"		
Stroke		
6.3	Have you **ever** suffered from sudden onset of paralysis or weakness in your arms or legs on one side of your body for more than 24 hours?	1. Yes 2. No 77. Don't know 99. No response
6.4	Have you **ever** been told by a health worker that you have had a stroke?	1. Yes 2. No *(go to Q6.8)* 77. Don't know *(go to Q6.8)* 99. No response *(go to Q6.8)*
6.5	Did you **ever** receive medical treatment for this stroke?	1. Yes 2. No 77. Don't know 99. No response

6.6	At what age was your first stroke?	Age in years: 77. Don't know 99. No response
6.7	Does this stroke or its complications interfere with your daily activities? Would you say.. *Refer to most recent stroke if more than one* *Read responses 1-3*	1. Not at all 2. A little 3. A lot 77. Don't know 99. No response

Heart problems		
6.8	Have you **ever** been told by a health worker that you have a heart disease?	1. Yes 2. No *(go to Q6.12)* 77. Don't know *(go to Q6.12)* 99. No response *(go to Q6.12)*
6.9	Do you know what kind of heart disease it is? Eg ischaemic heart disease, rheumatic or valvular heart disease?	1. Yes,*specify:* _____ 2. No 77. Don't know 99. No response
6.10	Have you **ever** been admitted to the hospital for your heart disease?	1. Yes 2. No 77. Don't know 99. No response

6.11	During the last 12 months, have you experienced any pain or discomfort in your chest when you walk uphill or hurry?	1. Yes 2. No 3 Never walks uphill/ hurries 77. Don't know 99. No response
6.12	During the last 12 months, have you experienced any pain or discomfort in your chest when walking?	1. Yes 2. No 77. Don't know 99. No response
6.13	*Only ask if participant answered 'yes' to either Q6.11 or 6.12, otherwise go to Q6.16.* What do you do if you get the pain or discomfort when you are walking? *Read responses 1-3.*	1. Stop or slow down 2. carry on after taking a pain relieving medicine that dissolves in your mouth 3. carry on 77. Don't know 99. No response
6.14	If you stand still, what happens to the pain or discomfort? *Read responses 1-2.*	1. Relieved 2. Not relieved 77. Don't know 99. No response
6.15	Will you show me where you usually experience the pain or discomfort? *Ask the participant to point to their body and then select the most appropriate response*	1. Upper or middle chest 2. Lower chest 3. Left arm 4. Other (specify): 77. Don't know 99. No response

Diabetes mellitus type II		
6.16	Have you **ever** had your blood sugar measured by a health worker?	1. Yes 2. No 77. Don't know 99. No response
6.17	Have you **ever** been told by a health worker that you have high blood sugar or diabetes?	1. Yes 2. No *(go to Q6.19)* 77. Don't know *(go to Q6.19)* 99. No response *(go to Q6.19)*
6.18	How old were you when you were told you have diabetes?	Age in years: 77. Don't know 99. No response

Chronic lung disease/asthma		
6.19	Have you **ever** been told by a health worker that you have chronic lung disease or COPD (emphysema, bronchitis) or Asthma? *Read out options 1 to 4.*	1. Yes – COPD 2. Yes - ASTHMA 3. Yes for both 4. No for both *(go to Q6.22)* 77. Don't know *(go to Q6.22)* 99. No response *(go to Q6.22)*

6.20	Have you **ever** had ankle oedema or swelling?	1. Yes 2. No 77. Don't know 99. No response
6.21	Have you **ever** been treated for COPD/asthma?	1. Yes 2. No *(go to Q6.22)* 77. Don't know *(go to Q6.22)* 99. No response *(go to Q6.22)*
6.22	During the <u>last 12 months</u>, have you experienced any shortness of breath at rest? (while awake)	1. Yes 2. No 77. Don't know 99. No response
6.23	During the <u>last 12 months</u>, have you experienced any coughing or wheezing for ten minutes or more at a time?	1. Yes 2. No 77. Don't know 99. No response
6.24	During the <u>last 12 months</u>, have you coughed up sputum or phlegm for most days of the month for at least 3 months?	1. Yes 2. No 77. Don't know 99. No response

Hypertension/high blood pressure		
6.25	Have you **ever** had your blood pressure measured by a health worker?	1. Yes 2. No 77. Don't know 99. No response
6.26	Have you **ever** been told by a health worker that you have high blood pressure or hypertension?	1. Yes 2. No *(go to Q6.30)* 77. Don't know *(go to Q6.30)* 99. No response *(go to Q6.30)*
6.27	Were you told in the past 12 months?	1. Yes 2. No 77. Don't know 99. No response
6.28	At what age were you first told that you have high blood pressure?	Age in years: 77. Don't know 99. No response
6.29	Were you pregnant at the time?	1. Yes 2. No 77. Don't know 99. No response

Cholesterol		
6.30	Have you **ever** had your blood measured for cholesterol, fat or lipids?	1. Yes 2. No 77. Don't know 99. No response
6.31	Have you **ever** been told by a health worker that you have high levels of cholesterol or fat in your blood?	1. Yes 2. No *(go to Q6.33)* 77. Don't know *(go to Q6.33)* 99. No response *(go to Q6.33)*
6.32	At what age were you told that you have high blood cholesterol or fat in your blood?	Age in years: 77. Don't know 99. No response
Cancer		
6.33	Have you **ever** been told by a health worker that you have cancer?	1. Yes 2. No *(go to Step 2)* 77. Don't know *(go to Step 2)* 99. No response *(go to Step 2)*
6.34	What is the name of the cancer you have been diagnosed with?	Specify: _____ 77. Don't know 99. No response

6.35	In which organ or part of your body did your cancer start?	Specify: _____ 77. Don't know 99. No response
6.36	At what age were you diagnosed with the cancer?	Age in years: 77. Don't know 99. No response
6.37	Have you **ever** been treated for cancer?	1. Yes 2. No 77. Don't know 99. No response

STEP 2: PHYSICAL MEASUREMENTS

Height and weight					
7.1	Technician name:				
7.2	Device ID height:				
7.3	Height (cms):				
7.4	Device ID weight:				
7.5	Weight (kgs):				
Waist and hip					
7.6	Device ID:				
7.7	Waist circumference (cms):				
7.8	Hip circumference (cms):				
Blood pressure and pulse rate (3 reads per participant at least 2-3 minutes apart)					
7.9	Technician name:				
7.10	Device ID:				
7.11	Time of first read (24 hour clock):				
		H	H	M	M
7.12	Cuff size used	1. Small 2. Normal 3. Large			
7.13	Reading 1 Systolic BP (mmHg): Diastolic BP (mmHg):				

	Pulse Rate (minute):	
7.14	Reading 2 Systolic BP (mmHg):	
	Diastolic BP (mmHg):	
	Pulse Rate (minute):	
7.15	Reading 3 Systolic BP (mmHg):	
	Diastolic BP (mmHg):	
	Pulse Rate (minute):	
Lung function		
7.16	Device ID:	
7.17	Perform lung function test (3 trials)	1. Yes, 3 trials 2. No
7.18	Lung function result:	1. Normal 2. Abnormal 3. Invalid

STEP 3: BIOCHEMICAL MEASUREMENTS

Blood glucose		
8.1	During the <u>last 12 hours</u> have you had anything to eat or drink, other than water?	1. Yes 2. No 77. Don't know 99. No response

8.2	Time blood specimen taken (24 hr clock)				
		H	H	M	M
8.3	Today, have you taken insulin or drugs (medication) that have been prescribed by a health worker for raised blood glucose?	1. Yes 2. No 77. Don't know 99. No response			
8.4	Technician name:				
8.5	Device ID:				
8.6	Blood taken for Hemoglobin AIc	1. Yes 2. No			
8.7	Bleed code for HbA1c sample				
Blood lipids					
8.8	Blood taken for lipids	1. Yes 2. No			
8.9	Bleed code for lipids				
Haemoglobin level					
8.10	Device ID:				
8.11	Haemoglobin value (g/dl)				
Urine sample					

8.12	Specimen container left with participant	1. Yes 2. No
8.13	Specimen container collected	1. Yes 2. No
8.14	Was sample the first morning urine?	1. Yes 2. No
8.15	Did participant void before going to bed?	1. Yes 2. No
8.16	Did participant go to the toilet at night?	1. Yes 2. No
8.17	Urine sample code	

PNG NCD SURVEY DATA ENTRY SECTION								
Date received at IMR office:					2	0	1	
	Day		Month		Year			
1st Entry By:	Signature:				Date: / /201			
2nd Entry By:	Signature:				Date: / /201			
Checked By:	Signature:				Date: / /201			
Archived By:	Signature:				Date: / /201			
Comments:								

APPENDIX D

Questionnaires of the Non-communicable diseases study for CHILD participants

FORM 2 | **CHILD NUTRITION SURVEY**

Site Identification			
iHDSS Site:			
Village name:			
Village ID:			
Infant Identification			
Infant Name:			
Infant ID:			
Infant Sex:	1. Male	2. Female	
Caregiver Identification			
Caregiver Name:			
Caregiver ID:			
Caregiver Sex:	1. Male	2. Female	
Relationship to Infant:	1. Biological Parent	2. Adopted parent	
	3. Grand Parent	4. Guardian	

Contact Attempts(a minimum of 6 contact attempts required. Record time & date of each contact)

1. Time:	Date: / /	4. Time:	Date: / /
2. Time:	Date: / /	5. Time:	Date: / /
3. Time:	Date: / /	6. Time:	Date: / /

Consent		
Has consent been read to respondent?	1. Yes	2. No (read consent)
Has written consent been obtained?	1. Yes	2. No (end interview)

Interview Details			
Interviewer Name:			
Interview Date:	/ / 201	Interview Time (24 hr):	:
Interview language:	1. English	3. Motu	
	2. Pidgin	4. Other (specify):	

Age of Infant		
Thank you for agreeing to participate. To start with, I would like to ask some questions about your child's age.		
1.	What is the age of the child? *Fill in age to the nearest month*	Years | Months 77. Don't know 99. No response
2.	Date of birth of the child?	Day | Month | Year (2 0 _ _) 77. Don't know 99. No response
3.	Source of birthdate information	1. Clinic book 2. Baptism card 3. Birth Certificate 4. Parents/Relative accurate recall 5. Parents/Relatives estimated recall 6. Other *(specify):* 77. Don't know 99. No response

This questionnaire should only be completed with children 6 months of age or older, but less than five years of age. If the child is five years of age or older or less than six months of age then thank the participant and end the questionnaire.		
BREAST FEEDING		
I would now like to ask you some questions about your child's feeding patterns now and in the past.		
4.	Was the child breastfed on the day he/she was born?	1. Yes *(skip to Q6)* 2. No 77. Don't know 99. No response
5.	What was the child fed instead of breast milk on the day he/she was born?	1. Formula milk 2. Powdered milk 3. Milk e.g. Indo-milk, Pauls-milk 4. Coconut 5. Soup 6. Other *(specify):* 77. Don't know 99. No response
6.	Is the child currently breast feeding?	1. Yes *(skip to Q8)* 2. No 77. Don't know 99. No response

7.	At what age did the child stop breastfeeding? *Calculate age to nearest month*				
		Years	Months		
		77. Don't know 99. No response			
8.	How old was the child when you started to give other fluids apart from breast milk? *Fill in the age OR choose one of the numbered options below (if the child always received another fluid eg formula from the day of birth fill the boxes marked 'months' with 00)*				*Identify age to the nearest month*
		Years	Months		
		1. Still exclusively breast feeding *(skip to Q15)* 2. Never breastfed 77. Don't know 99. No response			
9.	How old was the child when you started to give other fluids apart from breast milk AND/OR formula? *Fill in the age OR choose one of the numbered options below (if the child always received another fluid e.g. juice from the day of birth fill the boxes marked 'months' with 00)*				*Identify age to the nearest month*
		Years	Months		
		1. Only ever fed breast milk and/or formula *(skip to Q15)* 77. Don't know 99. No response			

<table>
<tr><td>10.</td><td>Name some common fluids the child was fed during initial introduction of other fluids.

List most common to the least.</td><td>1
2
3
4
5
77. Don’t know
99. No response</td></tr>
<tr><td>11.</td><td>For the fluids prepared at home can you please describe your preparation methods?

Include the 2 most common methods of preparation e.g. fresh fruit juice or boiling.

Prompt about additives such as salt, sugar and oil.</td><td>Preparation method description:

77. Don’t know
99. No response</td></tr>
<tr><td>12.</td><td>How old was the child when you started to give him/her solids?

Fill in the age OR choose one of the numbered options below.</td><td><table><tr><td></td><td></td><td></td><td rowspan="2">Identify age to the nearest month</td></tr><tr><td>Years</td><td colspan="2">Months</td></tr></table>1. Has not started solids yet (skip to Q15)
77. Don’t know
99. No response</td></tr>
</table>

13.	Name some common solids the child was fed during initial introduction of the solids. *List most common to the least.*	1 2 3 4 5 77. Don't know 99. No response
14.	For the solids prepared at home please describe the most common methods of preparation? *Include the two most common methods of preparation e.g. boiling and kaukau soup.* *Prompt about additives such as salt, sugar and oil.*	Preparation method description: 77. Don't know 99. No response

Child Illness		
In this next section we will ask if your child has had one or more of a number of common childhood illnesses.		
15.	Has the child had diarrhoea in the last 2 weeks?	1. Yes *(skip to Q18)* 2. No 77. Don't know 99. No response
16.	Was the child's stool loose and/or had any blood in the stool and needed attention?	1. Yes 2. No 77. Don't know 99. No response
17.	Was any treatment given to the child for the diarrhoea?	1. Yes 2. No 77. Don't know 99. No response

18.	Has the child been ill with a fever at any time in the last 2 weeks?	1. Yes 2. No 77. Don't know 99. No response
19.	Has the child had an illness with a cough at any time in the last 2 weeks?	1. Yes 2. No 77. Don't know 99. No response
20.	If the child had cough did the child have fast or difficult breathing?	1. Yes 2. No 77. Don't know 99. No response

Birth Weight		
Now I would like to ask you some questions about the birth weight of your child.		
21	Where was your child born?	1. Health facility 2. Elsewhere 77. Don't know 99. No response
22	Was the baby born in the hospital?	1. Yes 2. No 77. Don't know 99. No response
23	Birth weight of child (kgs): *Record weight up to two decimal places, e.g. 3.45 kg*	__ __ __ kgs 77. Don't know 99. No response
24	If birth weight is recorded what was the source?	1. Child health/Mother health book 2. Clinic/Hospital registration 3. Respondent's recall 77. Don't know

		99. No response
Anthropometric Measurements		
Finally, I would like to take some basic measurements of your child's height, weight and head and arm measurements. This will not cause any discomfort to your child.		
25.	Child's weight:	☐☐ ☐
26.	Child's height:	☐☐☐ ☐
27.	Head circumference measurement:	☐☐ ☐
28.	Mid-upper-arm measurement:	☐☐ ☐
Thank you for participating. We really appreciate you taking time out of your day to help us. Remember, you can contact us any time if you have questions about the study. Our contact details are listed on the information sheet given to you earlier.		
Instrument Details		
To be completed by the research officer at the conclusion of the anthropometric measurement		
29.	Technician Name:	

30.	Device ID weight:	
31.	Device ID height:	
32.	Device ID head/arm measurement:	

PNG NCD SURVEY DATA ENTRY SECTION								
Date received at IMR office:					2	0	1	
	Day		Month		Year			
1st Entry By:	Signature:			Date: / /201				
2nd Entry By:	Signature:			Date: / /201				
Checked By:	Signature:			Date: / /201				
Archived By:	Signature:			Date: / /201				
Comments:								

APPENDIX E

Letters of Ethical Approval of the sub-studies of PiH project

Government of Papua New Guinea
Medical Research Advisory Committee
National Department of Health

PO Box 807
WAIGANI 131, NCD
Papua New Guinea

Phone: + (675) 301 3693
Fax: + (675) 323 9670
Email: urarang_kitur@health.gov.pg

FILE:54-6-2
DATE: 08/07/2013

Dr.Paul Harino
PNG IMR
PO BOX 60
GOROKA 441

Dear Dr. Paul Harino

This is to certify that the proposal:

Ammendment: Tuberculosis epidemiology research for partnership in health project-Dr.Suparat Phuanukoonnon (MRAC 10.17)

An amendment to the study submitted by you and your colleagues has been examined by the Medical Research Advisory Committee of Papua New Guinea.

The committee acknowledged and endorsed this amendment and approved that Dr.Paul Harino be made the Prinicipal Investigator to the study.

The Medical Research Advisory Committee of Papua New Guinea act as the National Ethical Clearance Committee and as the Institutional Ethical Committee for the Papua New Guinea Institute of Medical Research and so there is no further bar to this project being carried out in Papua New Guinea.

Investigators are reminded of the importance of keeping provincial health and research authorities informed about their study and its progress, and of submitting progress and outcome reports to the Medical Research Advisory Committee.

With best wishes.

Yours sincerely

Dr.Urarang Kitur
Chairman-PNG Medical Research Advisory Committee

cc: Professor Peter Siba-Director for PNGIMR

Government of Papua New Guinea
Medical Research Advisory Committee
National Department of Health

PO Box 807
WAIGANI 131, NCD
Papua New Guinea

Phone: + (675) 301 3650
Fax: + (675) 323 9670
Email: elizabeth_gumbaketi@health.gov.pg

FILE:54-6-2
DATE:13/05/11

Dr. Andrew Vallely
PNGIMR
Goroka

Dear Dr. Vallely,

Request for amendments to MRAC approved study # 10.17 titled **"The epidemiology of sexually transmitted infections, including human papillomavirus, among pregnant women attending antenatal clinics at four sites in Papua New Guinea"** was submitted to the MRAC and discussed.

The amendments were to include a cross-sectional survey that investigators propose to undertake among 1600 pregnant women attend ANC at four LNG supported demographic surveillance sites in PNG in 2011 were approved and letter to be sent to Dr. Andrew Vallely.

The Medical Research Advisory Committee of Papua New Guinea act as the National Ethical Clearance Committee and as the Institutional Ethical Committee for the Papua New Guinea Institute of Medical Research and so there is no further bar to this project being carried out in Papua New Guinea.

Investigators are reminded of the importance of keeping provincial health and research authorities informed about their study and its progress, and of submitting progress and outcome reports to the Medical Research Advisory Committee.

With best wishes

Yours sincerely,

Dr. Urarang Kitur
Chairperson

cc: Prof. Peter Siba

ETHICS COMMITTEE CERTIFICATE OF APPROVAL

This is to certify that

Project No: 390/11

Project Title: The epidemiology of sexually transmitted infections, including human papillomavirus, among pregnant women attending antenatal clinics at four sites in Papua New Guinea

Principal Researcher: Ms Claire Ryan

Protocol: **version** 0.3 **dated:** 09-03-2011

Participant Information Sheet dated: 30-Jan-2012

was considered by the Ethics Committee on ***22-Dec-2011****, meets the requirements of the National Statement on Ethical Conduct in Human Research (2007) and was* ***APPROVED*** *on* ***30-Jan-2012***

It is the Principal Researcher's responsibility to ensure that all researchers associated with this project are aware of the conditions of approval and which documents have been approved.

The Principal Researcher is required to notify the Secretary of the Ethics Committee, via amendment or progress report, of

- Any significant change to the project and the reason for that change, including an indication of ethical implications (if any);
- Serious adverse effects on participants and the action taken to address those effects;
- Any other unforeseen events or unexpected developments that merit notification;
- The inability of the Principal Researcher to continue in that role, or any other change in research personnel involved in the project;
- Any expiry of the insurance coverage provided with respect to sponsored clinical trials and proof of re-insurance;
- A delay of more than 12 months in the commencement of the project; and,
- Termination or closure of the project.

Additionally, the Principal Researcher is required to submit

- A Progress Report on the anniversary of approval and on completion of the project *(forms to be provided)*;

The Ethics Committee may conduct an audit at any time.

All research subject to the Alfred Hospital Ethics Committee review must be conducted in accordance with the National Statement on Ethical Conduct in Human Research (2007).

The Alfred Hospital Ethics Committee is a properly constituted Human Research Ethics Committee in accordance with the National Statement on Ethical Conduct in Human Research (2007).

SPECIAL CONDITIONS

None

SIGNED:

R Frew
Secretary, Ethics Committee

Please quote project number and title in all correspondence

Government of Papua New Guinea
Medical Research Advisory Committee
National Department of Health

PO Box 807
WAIGANI 131, NCD
Papua New Guinea

Phone: + (675) 301 3650
Fax: + (675) 325 1825
Email: urarang_kitur@health.gov.pg

FILE: 54-6-2
DATE: 19/11/2012

Dr Patricia Rarau
PNG IMR – PORT MORESBY

Dear Dr Rarau,

This is to certify that the proposal:

A survey of non-communicable disease (NCD) and associated risk factors in five sites across Papua New Guinea

Submitted by you has been examined by the Medical Research Advisory Committee of Papua New Guinea and assigned **MRAC No. 12.34**. The proposal was approved and given ethical clearance for it to be carried out in Papua New Guinea.

MRAC noted this was a very good survey and noted that the study sites were LNG sites and a non LNG sites; sites from both ends of the spectrum and from general knowledge, the results are pre-determined. MRAC suggested the researchers compare LNG sites with an agricultural site like Middle Ramu District in Madang Province.

The Medical Research Advisory Committee of Papua New Guinea act as the National Ethical Clearance Committee and as the Institutional Ethical Committee for the Papua New Guinea Institute of Medical Research and so there is no further bar to this project being carried out in Papua New Guinea.

Investigators are reminded of the importance of keeping provincial health and research authorities informed about their study and its progress, and of submitting progress and outcome reports to the Medical Research Advisory Committee.

With best wishes.

Yours sincerely

Dr. Urarang Kitur
Chairperson