ESTIMATION OF FERTILITY
A Case Study of Rusinga DSS

BY

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DECLARATION

This proposal is my original work and has not been presented for a degree course in any other university.

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This project has been submitted for examination with our approval as university supervisors.

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DEDICATION

To my dear parents Josiah N. and Teniin J. Gakuruh. Thanks for all the support and encouragement you have given me through the years.

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ABSTRACT

A method of collecting longitudinal demographic data was introduced in Rusinga Island in 2001- Rusinga DSS (Demographic Surveillance System) by Population and Research Institute, but the extent to which it yields demographic measures that are typical of rural Kenya had not been evaluated.

Data from the DSS was used to evaluate data quality and estimate the level of fertility in Rusinga using current fertility method, for three rounds; one, nine and ten.

The quality of data for the DSS as regards age and sex was found to be inaccurate with measures such as the Whipple's and Myer's blended Index noting presence of age heaping and preference at terminal digits especially '0'. Age accuracy Index established that the age data which is one of the most important variables in the estimation of fertility was inaccurate. Sex ratio at birth revealed that there was an excess of females than males, which was contrary to documented literature.

The Total Fertility Rate (TFR) for the Island is estimated to be 1.82, 1.54, and 1:00 births per woman in round one, nine and ten respectively. Gross Fertility Rate (GFR) is estimated at 71.87 for round one, 58.89 for round nine and 46.80 (births per 1000 women in the reproductive age) for ten. Crude birth rate (CBR) for round one, nine and ten are estimated at 16.78, 26.53 and 11.33 births per 1,000 population.

The results from the present analysis give lesser estimates than that estimated by the 1999 Censes for Suba district of 5.9 births per woman in Suba district or 5.6 births per woman in Nyanza province as estimated by Kenya demographic and Health Survey. This could be as a result of the inaccuracy noted in the evaluation of the DSS data quality.

The study recommends data quality assurance to be undertaken first before additional studies are undertaken. Issues such as revision of research tools should be undertaken as well maintaining a consistent time frame of data collection backed with a defined system of data processing and management.

CHAPTER ONE
GENERAL INTRODUCTION

1.1 Background

Estimates of fertility are among the most widely used demographic statistics. In many developing countries recent levels and trends in fertility are keenly watched by policymakers, family planning program managers, and demographers to determine whether and how rapidly fertility is moving in the desired downward direction (Bongaarts and Feeney., 1998)

Also estimating fertility levels and differentials helps support effective social planning and the allocation of basic resources across generations. Sustained high fertility rates create large populations of young dependents, creating demand for supports for young children, for an adequate number of schools, and for affordable child care. On the other hand, sustained low fertility rates can lead to a rapidly aging population and, in the long-run, may place a burden on the economy and the Social Security system. This is because the pool of younger workers responsible for supporting the dependent elderly population is, when excluding immigration, smaller, and the dependent elderly population is comparatively larger (Weeks, 1999).

In Kenya, continued collection of such data as the Censuses and Kenya Demographic and Health Surveys through birth histories and other means has been important in recognizing the important role that fertility plays in balancing Kenya's overall population growth equation. The fact that fertility reduction became the thrust of the country's population policy as early as 1967 underlines the deliberate efforts made by the Government to contain it.

Nationally, Kenya's fertility in the 1960s and 1970s was high, about eight births per woman and seemed to be rising slightly. In the decade from the late 1970s to the late 1980s, fertility fell approximately 20 percent to a little more than 6.5 births per woman (KDHS, 2003). This decrease was unexpected by many and was due principally to an increase in contraceptive use (Brass and Jolly, 1993). The decrease was further evidenced in the 1990's with 1993 and 1998 Kenya Demographic and Health Survey indicating 5.4 and 4.7 births per woman. This was interestingly followed by a slight increase in the 1999 census of 5.0 and then 4.8 births per woman in 2003 Kenya Demographic and Health Survey indicating a stalling fertility. This fertility trends has not, however, been uniform across the country and the differential rates are mainly responsible for the change in population growth rates across regions.

In Nyanza province for instance, fertility trend according to KDHS for 1998 of 5.0 and 2003 5.6 indicate an increase in fertility. This trend can further be analyzed by sub-regional fertility estimates such as that of demographic surveillance site (DSS) providing information on the divergent needs of different population groups in the province. This is the fundamental reason why over the past 30 years demographic surveillance site (DSS) have been established in a number of field research sites in various parts of the developing world where routine vital-registration systems were poorly developed or nonexistent (Jahn et al., 2007).

1.2 BACKGROUND OF THE STUDY AREA

Rusinga Island, the site of the Population Studies and Research Institute (PSRI) Demographic and Surveillance System (DSS) is in Suba district, formerly part of Homabay district in Nyanza Province. The Island is located at Mbita point Township about 40 Kilometers from Homa Bay town. The Island consists of two administrative locations, Rusinga East and West. Rusinga East is further divided into two sub-locations Waware South and Waware North while Rusinga West is divided into four sub-locations: Kamasengere East, Kamasengere West, Kaswanga and Wanyama. According to the 1999 census the locations were sub-divided into a total of forty two Enumeration Areas (EA`s) as shown in appendix II and Map 1 (PSRI, 2003).

1.3 PROBLEM STATEMENT

Since 2001 the Population Studies and Research Institute (PSRI) has been collecting data on demographic events (Births, Deaths and Migration) in the Rusinga DSS. A report on the baseline survey was documented in 2003 by PSRI, discussing the DSS's objectives, design, population and mortality; however fertility level was not estimated. The reason fertility at baseline was not estimated was because birth history was not collected then, but in the subsequent years (rounds) births forms were administered to collect birth histories of the women who had delivered in the specified time period.

Birth history data as noted from round 1 in 2002 up to round 10 in 2007, had never been analyzed for fertility level. By estimating fertility level for the Island using the Demographic Surveillance System (DSS) data, period fertility estimates will be available and data quality will be established.

Fertility estimation will also enable the Institute (PSRI) establish the progress of Demographic Transition that was underway at the time of setting up the population laboratory.

1.4 OBJECTIVES

The general objective of this study is to estimate Rusinga Island fertility level, specifically the study intends to:

1 establish data quality of Rusinga Island DSS; and

2 estimate Rusinga Island total fertility rate using the direct method (current fertility)

1.5 JUSTIFICATION

While many studies have been done on the subject of fertility in Kenya, especially since the mid-1980s when fertility transition started, few have estimated fertility levels at administrative areas even with the introduction of Demographic Surveillance System (DSS) being established around the world and a partnership of active DSS institutions forming the INDEPTH Network. PSRI DSS as one of Africa's population studies research institution need to explore the extent to which the DSS a longitudinal data collection system can yield demographic measures that are typical of Kenya's population.

Estimating the fertility level in the Island will be useful not only to know the level from national and provincial estimates but also help in policy formulation for health improvement and development in Rusinga Island as well as provide future research gaps for the Island and sub-groups or pockets of the country.

1.6 SCOPE AND LIMITATIONS

The study used the University of Nairobi, Population Studies and Research Institute (PSRI) DSS data. The DSS covers the entire of Rusinga Islands which consists of forty two villages (Clusters) in the Island (See Appendix 2).

Since the survey was conducted by retrospective interviewing, the data has some limitations which are likely to affect the outcome of the study. The following are likely to be the major source of limitation:

a) Age misreporting: age heaping in ages which end with the digit 0 and 5. The digit preferential is likely to push some respondents into or out of the group under focus.
b) Poor knowledge about the exact date of birth: the data on date of birth gives evidence of births in the last three years, and if unsure some births occurring during the three years may not be reported or inclusion of births not in the three year period.
c) Mother's age at birth: Data on mother's age at birth is a key variable in fertility estimation; however the birth forms did not include this question. To obtain this information, mother's name on the birth form was linked to the population form which contained the date of birth of all household members.
d) Children Ever Born: Data on parity level was not collected on the birth form
e) Rusinga DSS data suffer from diverse deficiencies particularly coverage, content and consistency which can be noted as follows:
    - Round Ten births were under reported because cluster 42 (Ngodhe) births were not recorded
    - Birth forms did not ask the women's age at time of birth or the number of live children given birth (CEB)
    - The duration between the rounds has not been consistent which could lead to undocumented events during long period or double recording of events if the period is short.

It is also important to note that literature on small administrative areas or DSS site's fertility level studies are few to non existent compared to national and provincial estimates which are readily available.

CHAPTER TWO

LITERATURE REVIEW

2.0 INTRODUCTION

Interest in obtaining reliable estimates of both fertility and mortality for small local areas in many countries seems to be growing rapidly, irrespective of the adequacy of vital registration or national surveys. The reasons for this increased interest, derives from the recent spate of efforts to either decentralize or target social policies, and the importance of demographic parameters - present and projected population sizes to such efforts. This tendency has been furthered by the interest of international organizations, in developing local level indices of development such as the Human Development Index (Cavenaghi, Potter, Schmertmann, Assunção 2004).

In Kenya, national and provincial fertility levels are estimated from the Kenya Demographic and Health Survey (KDHS) and the census. Local level estimate especially district level are quite rare even though regional disparities are high among and within the provinces. According to KDHS (2003), national Total Fertility Rate (TFR) was 4.9, with Nyanza recording 5.6 births per woman.

Researchers estimating fertility for small areas or communities have noted differences from the national or provincial estimates. For example Khan (1993) estimating fertility and mortality levels of a minority group – Asian community in Kenya using 1989 census found fertility among Asian in Kenya to be similar to developed country's fertility trend because of low fertility rates, hence concluded that demographic characteristics should not be not be generalized at the national or macro level since pockets or sub-groups of the total population could differ significantly as evidenced by the Asian case. In other studies a different pattern is observed like that of Manhiça district demographic surveillance (in Maputo province) where fertility is at a similar level as in Maputo province and has remained around 5 children per woman, during the eight years of surveillance in Manhiça (Ariel et al., 2006).The two different results; one estimate being the same as the provincial while the other being different indicate that provincial estimates are not necessarily the same as small administrative estimates. Fertility differentials at the national and small administrative areas have also been significantly different.

Estimating the fertility level of Rusinga Island located in Nyanza Province would not only meet Rusinga Demographic Surveillance System (DSS) objective, but also establish the degree of disparity from the national and provincial estimates documented by KDHS.

2.1 Demographic Transition

Rusinga Island was selected as Population Studies and Research Institute (PSRI) site for its DSS because it is in a region which is in the early stages of demographic transition. The demographic transition according to Weeks (1999) is the process whereby a country moves from high birth and death rates to low birth and low death rates with periodic spurt in population growth. From this definition, the underling hypothesis is that births were high in the Island and are expected to decrease with time. It is for this reason that estimating fertility levels at different points in time to get the trend would either confirm or refute this hypothesis.

2.2 Fertility Estimation in Kenya

Kenya fertility estimates has been estimated at national, provincial, and district level by nationally representative surveys like the Kenya Fertility Survey (KFS) and the Kenya Demographic and Health Survey (KDHS) as well as the Censuses.

The Kenya Fertility Survey (KFS) (1977-1978) was a government of Kenya program that was inspired by its desire to enhance its study to social, economic, and cultural factors affecting fertility. The direct and unadjusted national TFR estimate for the 3 years preceding the survey was 8.1 children per woman (CBS, 1980).

The Kenya Demographic and Health Survey (KDHS) is national survey carried out by Central Bureau of Statistics (CBS) to provide data to monitor the population and health situation in Kenya. The survey began in 1989, then followed by another survey in 1993 and 1998 with the latest being in 2003. The KDHS collected information on fertility levels, marriage, sexual activity, fertility preferences, awareness and use of family planning methods, breastfeeding practices, nutritional status of women and young children, childhood and maternal mortality, maternal and child health, awareness and behavior regarding HIV/AIDS and other sexually transmitted infections. According to KDHS, fertility levels in Kenya began high at 6.7 births in the 1989, decreasing to 5.4 in the 1993 and then 4.7 in the 1998. However, this decrease stopped and a slight increase to 4.9 children per woman in 2003 was note indicating that fertility in Kenya was stagnating. In 2003, TFR for the rural area was 5.4 births while that of the urban area was lower by 3.3 births. Nyanza province in which the Island is located was estimated at 5.6 births per woman (CBS, 2003).

Census in Kenya was first held in 1948, when Kenya was still a Colony administrated by the British. Since 1969, census has been taken every ten year, with the last census to date in 1999. The Census collects information on demographic, socio-economic, and fertility characteristics from all the households in the country. District Fertility estimates was first calculated in the 1999 census, with an estimate of 5.0 children per woman for the country and a TFR of 5.9 children per woman in Suba District. This was a decrease from the 1989 census that recorded a TFR of 6.6 nationally.

2.3 Fertility Estimation

Although the demographic literature offers many measures of fertility, the total fertility rate (TFR) is now used more often than any other indicator. The TFR is defined as the average number of births a woman would have if she were to live through her reproductive years (ages 15– 49) and bear children at each age at the rates observed in a particular year or period. It is a hypothetical measure because no real group of women has experienced or will necessarily experience these particular rates. The actual childbearing of cohorts of women is given by the completed fertility rate (CFR), which measures the average number of births 50-year-old women had during their past reproductive years. The CFR measures the true reproductive experience of a group of women, but it has the disadvantage of representing past experience: women currently aged 50 did most of their childbearing two to three decades ago when they were in their 20s and 30s. The advantage of the TFR is that it measures current fertility and therefore gives up-to-date information on levels and trends in fertility. Another reason for the popularity of the TFR is its ease of interpretation compared with some other measures. Most interested persons will have little difficulty interpreting fertility measures expressed in births per woman, but few non-demographers will know intuitively whether populations with a crude birth rate of 10 (births per 1000 population) or a general fertility rate of 100 (births per 1000 women of reproductive age) have high or low fertility.

This study used the direct method of estimating fertility although the indirect method would have been preferred to check on data errors however information on children ever born (CEB) was not available.

Fertility Estimation Using Date of last Birth (DLB):

Census data for calculating period age-specific fertility rates typically come in one of two forms. For each woman of childbearing age, census questionnaires usually record either the number of children born in the last year (*BLY*), or the date of the woman's last live birth (*DLB*).

When estimating fertility rates from census data (still a common situation in many countries, particularly when estimates are for sub national areas), efficient use of DLB data is often an important concern. In principle, DLB data contain more information than BLY data, because a researcher can observe not only the fertility histories of the sampled women in the past year, but also many other births and periods of exposure that occurred more than one year earlier. Standard procedures for estimating age specific fertility rates from DLB data merely convert to BLY form:

$$BLY = \begin{cases} 1 \; if \, DLB \leq 1 \; year \\ 0 \; otherwise \end{cases}$$

and then utilize this censored version of DLB in all subsequent calculations (Schmertmann and Caetano, 1999).

In calculating small area fertility estimates like for the DSS, Schmertmann (1999) proposes a new method for consistent estimation of period fertility from DLB information. The essential intuition is to change the unit of analysis from *women* to *woman-years*. A sample of N women who report the date of their last live birth will, in general, contain fertility information on many more than N woman-years. For example, a woman who is interviewed on her 32nd birthday and reports that her last live birth occurred 46 months earlier provides information on not one, but four, years of exposure to fertility risks: She had one birth in age interval (28,29], followed by no births in age intervals (29,30], (30,31], and (31,32].

Like standard BLY calculations based on {1}, DLB estimators are consistent under the strong mathematical assumptions of many formal demographic models (unchanging fertility schedules and identical fertility rates for all women of a given age, regardless of parity). DLB estimators also have low bias under more realistic conditions. In contrast to BLY methods, estimators based on the multiple woman-years implicit in open-interval DLB data have much lower sampling variability. Thus, when basic fertility information comes from DLB data, it is possible to produce far more accurate fertility estimates from small samples or for small populations (Schmertmann and Caetano, 1999).

2.4 Demographic Surveillance System (DSS)

2.4.1 DSS Historical Background

Collecting information on population dynamics in a defined geographic area is a practice that is as old as demography itself. Parish records and civil registers provided information that was used in the earliest attempts to characterize mortality and population dynamics. The earliest known calculations of mortality rates were based on civil registers for a segment of London. Fertility models have been based on archival registers that are similar to contemporary surveillance systems. The first model life tables were based on population register mortality regimes (Linder, 1971).

In the twentieth century the role of population observatories expanded from description to investigation. Early studies focused on epidemiological questions (e.g., Goldberger et al., 1920). After World War II, controlled trials were used for the demographic evaluation of health experiments (e.g., Ferebee and Mount 1962) and research stations were created where vital registration in defined geographic areas was applied to estimate demographic characteristics and carry out an expanding range of epidemiological, social policy, and demographic studies. By the 1960s the health and population research role of those research stations and population laboratories was recognized as an area of scientific specialization within the field of task load of individual observation systems. Most continuous demographic surveillance systems incorporate procedures for recording marital events, causes of death, and status in a household structure defined by headship or by spousal, parental, and familial relationships. This is design used by the Population Studies and Research Institute (PSRI) DSS.

2. The *population observation model* registers births and deaths and employs repeat censuses to estimate populations at risk of these events over time. Studies conducted by the British Medical Research Council in Gambia and in eastern and southern Africa used this approach (e.g., Greenwood et al.1990). Dual registration systems were used to adjust coverage errors in population laboratories. This approach has been useful in descriptive demography and studies that employ area units of analysis. Health interventions consigned to clusters of households, for example, can be evaluated by monitoring births and deaths over time, enumerating cluster populations at the baseline and at the end of the project period, and estimating cluster populations over the study period. This approach obviates the need to monitor individual migration continuously or to link event data with individual census registers, thus simplifying data management processes and reducing the complexity of field operations in comparison to individual surveillance approaches.

Despite the advantages of the aggregate population observation approach, most demographic surveillance systems that have been established since the 1990s have utilized continuous individual registration designs. This practice can be explained in part by the advent of low-cost computer technologies that overcome many of the limitations of the individual surveillance approach (e.g., MacLeod et al., 1996) and the emergence of health technologies that require individual-level trials.

Individual observation expands the range of social, demographic, and health research that can be conducted in conjunction with surveillance. In the individual continuous observation approach, any cross-sectional study that records demographic surveillance identification numbers eventually permits a longitudinal study of demographic processes. A few well-designed surveillance sites have produced several thousand scientific publications (e.g., Behar et al. 1968; Scrimshaw et al. 1968; D'Sousa 1984; Menken and Phillips 1990). The longest-running and best-known DSS is Matlab, in Bangladesh.

Unique Identifiers

Unique identifiers for primary subjects are an indispensable element of DSSs. All systems invariably formulate rules for assigning unique identifiers at the start of the DSS, but their methods for assigning these identifiers to DSS subjects may vary from one site to another. According to Linder (1971) there are two main approaches. One common strategy is to transparently link the subjects in a single residential unit through a hierarchical system of unique numbers. These are built up from a unique number for the residential unit, followed by serial numbers for each of the households within it (where the notion of households applies) and then for each of the enumerated individuals within each household. This is the system used by the Population Studies and Research Institute (PSRI), which begins with cluster numbers assigned by PSRI then Central Bureau of Statistics (CBS) and finally the household number. Individuals in the household are assigned serial numbers from the head of the household.

The other strategy for assigning identifiers to individuals is to avoid any fixed link to residential units and households. In this system, identifiers for each subject are simply serial numbers incremented each time a new DSS subject is registered. This system requires providing field staff with block allocations of ID numbers with enough latitude to register new subjects. This approach should be coupled with computer generation of the identifiers to safeguard against the assignment of the same ID to multiple subjects on the ground. This strategy helps to preserve people's anonymity outside their residential units, or when their attribute data are accessed through the database.

Visits

DSSs collect data during rounds, or cycles, of visits to registered residential units in the DSA. The interval between visits depends on the frequency of the changes in the phenomena under study and on the length of recall intervals for the collected data, and thus on the research focus of each field site. However, like the size of the DSA and observed population, it also depends on funding and logistics. This interval varies from one site to another, ranging from 1 week to 1 year. The Population Studies and Research Institute (PSRI) DSS, collects data during round with an interval of one year (Linder 1971).

Primary DSS subjects

DSSs are typically structured around three main subjects within the DSS. From a logistical point of view, it is not feasible to interview all individuals directly, and for this reason individuals are put in groups with physical and social meaning, and information is collected from credible and informed respondents within these groups (Linder 1971).

- *Residential units* — these are the places where individuals live. They are defined in physical and geographic terms.
- *Households* — these are the groups to which individual members belong. They are often defined as social subunits of the residential unit sometimes determined by the kitchen(s).
- *Individuals* — these are the people who are living in the residential units and households. They are the subject of main interest in any DSS.

Core DSS events

To know the size of the registered resident population at any time, a DSS collects information about three core events that alter this size, namely, births, deaths, and migrations..These events are described by the following fundamental demographic equation:

$$P_{t_1} = P_{t_0} + B_{t_0 t_1} - D_{t_0 t_1} + I_{t_0 t_1} - O_{t_0 t_1}$$

where P is the population; B is the number of births; D is the number of deaths; I is the number of in-migrants; O is the number of out-migrants; and t_0, t_1 is the time interval of their occurrence.

An underlying principle for recording events in a DSS is that of a **population at risk**. Mortality, fertility, and migration rates are calculated by counting the number of deaths, births, or migrations occurring within a registered population exposed to the risk. For example, an individual who is not resident within the DSA is not considered at risk of dying within the area. Consequently, most DSSs do not observe nonresident individuals or households and do not record their events.

Births and their outcomes for all women registered in the DSS are recorded regardless of the place of occurrence of such events. The recording of births has two purposes: for estimating fertility and for identifying a criterion for registering an individual.

Deaths of all registered and eligible individuals are recorded, regardless of the place of death. It may be impossible to record the deaths of previously eligible individuals who then out-migrated. In this case, observation of their survival is censored at the time of migration. Some DSSs collect more detailed information about deaths to establish the cause of death, generally through the so-called verbal autopsies (VAs) (Linder 1971).

Two types of migration events occur:

- *External migration* — where residence changes between a residential unit in the DSA and one outside it; and
- *Internal migration* — where residence changes from one residential unit to another in the same DSA.

Both of these migration events are documented in the PSRI DSS.

Other events

In addition to births, deaths, and migrations, other events are of interest for the understanding of demographic, health, and social dynamics. One event on which data are commonly collected relates to nuptiality or marital status. Most DSSs collect information about events such as marriage, defined as an event that starts a marital relationship, and divorce, that is, an event that ends a marital union. Other events recorded by DSSs depend on their complexity and research interests but may include the change of a head of household, a household's formation or dissolution, or the construction or destruction of building structures (INDEPTH Network, 2002), all of which are documented by PSRI DSS (Linder 1971).

2.4.3 INDEPTH Network

The INDEPTH Network is an International Network of field Sites with Continuous Demographic Evaluation of Populations and their Health in Developing Countries (INDEPTH Network, 2004b). INDEPTH Network was established in 1998 to provide an association for DSS sites that would allow them to establish and share best practices for DSS and to coordinate the development and implementation of multi-site investigations. Beginning with 17 member sites in 1998 the Network has grown to 36 member sites in 19 countries: 25 sites in Africa, 9 in Asia, 1 in Oceania and 1 in Central America (INDEPTH Network, 2004). The network now has a permanent Secretariat located in Accra, Ghana with six permanent staff to coordinate and run the activities of the network.

In Kenya, there are four major DSS programmes operated by four different institutions under the INDEPTH network: Kisumu DSS by CDCKEMRI project, Kilifi DSS by Wellcome-KEMRI Research programme, and Nairobi Urban DSS by APHRC (African Population and Health Research Centre) and Rusinga Island DSS by the Population Studies and Research Institute (PSRI). The underlying components of the DSS are the same in all programmes and are designed to complement each other, since they are located in different geographical areas with different environmental, epidemiological and cultural backgrounds (INDEPTH network, 2002).

2.4.4 The Population Studies and Research Institute (PSRI) Rusinga Island DSS Design

2.4.5.1 Baseline Survey

PSRI Rusinga Island DSS as a population laboratory began its setup process in May 2001 and was completed in August 2001 through a United Nation's Population Fund (UNFPA) funding. During this setup period, a baseline survey was conducted where demographic and socio-economic data on each of the households was collected. This was supposed to serve as the baseline data upon which all future studies would be based. The data was collected using a household questionnaire attached as Appendix 3 (PSRI, 2003).

Preliminary visits in May 2001 included advocacy activities through a series of meetings attended by the local administration leaders including the chiefs, assistant chiefs, and village elders. Maps by the Central Bureau of Statistics (CBS) were used to verify village boundaries by visiting each village under the guidance of the village elder.

For the baseline survey, eight research assistants were recruited from the Island to assist in the data collection. They had a minimum of primary education, mostly females and were able to communicate in the local language. The eight were paired with PSRI students to form eight pairs for which the students were in charge of. The research assistants were trained on data collection and area of coverage using Geographical Information System (GIS), by both PSRI staff and a cartographer. After training, the research assistants were introduced to the chiefs, assistant chiefs, and the village elders they were to work with in assigned clusters.

In each cluster, all households were first identified with the assistance of the village elder. Each identified household was given an identification number, which was written on the door. Once all the households in the cluster were identified, the household questionnaire was used to collect the household data. The identification number was also used in collecting GIS of the household. Household data was entered on Social Package for Social Scientist (SPSS) and the GPS data were processed to produce maps on the distribution of the household.

2.4.5.2 Subsequent Surveys

A total of ten surveys have been conducted since the baseline survey in 2001. Each of the survey became known as round i.e. round 1: July 2001-July 2002, round 2: August 2002, round 3: September 2003, round 4: October 2002, round 5: November 2002, round 6: December 2002, round 7: January 2003, round 8: February 2003-Nov. 2003, round 9: Dec. 2003-March 2006, and round 10: April 2006 – September 2007.

These subsequent surveys collected household demographic events data i.e. household formation and dissolution, births (fertility), deaths (mortality) and migration (movement within the Island and from outside the Island). For each of the event a different form was used; a birth form was use to collect birth information, a death form was used to collect information on all the deaths that had occurred during a particular period, a migration from was used to collect information of in and out migrants and a list of all household was used to cross all dissolved households. Household questionnaire was not administered in the subsequent surveys unless it was a new household.

As with the baseline survey, data from round one to round nine was entered on SPSS, but change in round ten to FoxPro a database system to enable the different demographic processes in the household to be linked.

Fertility is estimated using births from the birth database and women population from the population database which was transformed to SPSS for analysis.

2.5 Definition of Key Concepts

- Fertility: the number of children born to women or the reproductive performance rather than the capacity to do so; one of the three basic reproductive processes
- Demographic Transition: the process whereby a country moves from high births and high death rates to low birth rates with an interstitial spurt in population growth.
- Fertility Differentials: a variable in which people show clear differences in fertility according to their categorization by that variable.
- In-migrant: a person who migrates permanently into an area from somewhere else (internal migration)
- Out-migration: a person who permanently leaves an area and migrates someplace else (internal migration).
- Demographic Model: sets of mathematical relations between relevant demographic variables so as to reduce a mass of confusing number to a few intelligible basic parameters.

CHAPTER THREE

DATA AND METHODOLOGY

3.1. Description

The data used is obtained from the Rusinga Islands Demographic Surveillance System (DSS). Rusinga Islands DSS is a population laboratory by the Population Studies and Research Institute (PSRI) with the main objective of investigating the dynamics of the demographic transition process that was underway in the Island and a specific objective of providing PSRI with a database which was to be used to design in-depth studies in population. The laboratory was also expected to give PSRI a site for its training activities.

The Demographic Surveillance Area (DSA) covers an area of about 44 Sq. Km. stretching 4 kms east-west and 12 kms North-South. Rusinga Island is in Suba district formerly part of Homa Bay District in Nyanza Province, Kenya.

The process of setting up the laboratory commenced in 2001 and was completed in August 2001. Initially the laboratory was designed to gather data using continuous registration and modular surveys beginning with a baseline survey. Subsequent surveys (rounds) continuously gathered data on births, deaths, migration, and marital status which was undertaken using four registration forms each for the particular event. Registration of these events was done by research assistants recruited from the community on the Island in collaboration with the local administration and PSRI students.

3.2. Data Collection and Processing

a. Mapping

At the baseline, processing of the GIS data was undertaken concurrently at the Geography department of the University of Nairobi by the cartographer and test maps on the distribution of the households were ready in October 2001. A success link of the two data sets was also undertaken therefore household characteristics could be displayed on the GIS maps.

b. Initial Census

A baseline census was carried out from May to August 2001, during which all households and residents were registered into the DSS system. Since September 2001, every registered household had been visited every month by an interviewer up to December 2003 then the duration became inconsistent due to funding. During the interview, an adult household member is asked about demographic events such as births, deaths, in and out migrations within the household. All information is recorded in either the household questionnaire, or birth, death and migration form which recorded each type of event.

c. Regular Update Rounds

Continuous registration and updates of all new and existing households and individuals occurs during each round of data collection. All households in the DSA were initially visited on a monthly basis from round 1 that that covered events from July, 2001 to July 2002; followed by round 2 in September 2002; round 3 covering events for October 2002; round 4 November 2002; round 5 December 2002; round 6 January 2003; and round 7 February, 2003. Round 8, 9 and 10 undertaken in December 2003, April2006, and September 2007 respectively were inconsistent.

Each of the rounds registered all new households and individuals in the households, to update demographic variables on registered individuals, and to record all births, deaths and migrations. Dissolved households were also checked off the household register.

3.3. Data Management and Analysis

3.3.1 Data Handling and Processing

Compiling longitudinal population information poses unique data-management challenges. Projects must maintain changing individual-level information on the composition and household structure of a large, geographically defined population. Events that arise — births, deaths, migrations, etc. — must be linked to individuals and other entities at risk of these events. These events affect not only demographic rates, for instance, but also relationships within and between households. As event histories grow, records of new events must be logically consistent with those of events in the past. Seemingly obvious checks on data to meet minimal standards of integrity can result in hundreds of lines of code.

Maintaining a detailed record of demographic events, relationships, and exposure to risks or interventions requires complex data-management operations, with a carefully controlled field-operation infrastructure to oversee and support data collection and entry, and a comprehensive computer system for the data-management operation.

Rusinga DSS questionnaires containing the household data are edited in the field and then sent to PSRI for data entry. Data entry for the baseline up to round nine was done by done by two PSRI computer staff and in round 10 the author of this paper and another student entered data on the new database system: FoxPro.

From the baseline data to round 9, data was entered on SPSS, where the household and the events were entered on different work sheets and merged on completion of data entry. This system had a major deficiency in that it did not adjust the household to the events that had taken place like removing dissolved household, migrated persons and increasing the in-migrants and births. These lead to the introduction of a database system that could update the household status as data is entered. The database chosen was FoxPro due to the fact that the only other similar system, Household Registration System (HRS) is based on FoxPro.

FoxPro Data System

In FoxPro data systems are identified as 'projects' and the Rusinga System is referred as 'Rusinga DSS Project'. The data base consists of three components: Tables, Forms and a Software Programme: Tables contain the data, forms are for data entry and the programme links controls in the database to produce the appropriate results. Rusinga system is designed to contain the following seven tables and corresponding forms for data entry.

Rusinga DSS FoxPro System

TABLE	FORM
Household	Household
Population	Population

Birth	Birth
Death	Death
Migration	Migration
Marital status	Marital status
Dissolved HH	Dissolved HH

The two main tables in the system are the 'Household' and 'Population'. The Household Table contains the updated Households by adding new households and indicating dissolved households. Data on the New Household is entered using the Household Form. The form is designed such that when the household table is updated the Population Form is automatically activated to update the Population Table.

Data on the Dissolved Households is entered using the Dissolved Household Form. The form is designed such that the Household Table is updated to indicate the Household is dissolved in the Household Table. In addition the Dissolved Household Table is updated to include the dissolved household.

Finally the Population Table is updated to remove the members of this particular household from the Population Table. Changes in the household populations occurring due to births, deaths or migration are achieved by updating the Population Table by entering data using the respective forms. Data on a registered birth, for example, entered using the birth registration form updates the Population Table in the specific household and at the same time updates the Birth Table.

3.3.2 Assessing Data Quality at the data center

Undercounts and misplacements of events are very often encountered in DSS activities. Other errors resulting in the misclassification of population characteristics also occur. Even with the best quality assurance, it is impossible to overcome all these errors in the field and at the data center. More specifically, errors and biases which may affect the information in fertility surveys include:

I. Errors in reporting of Age and,

II. Errors in the retrospective Information

However, several standard statistical and demographic methods are available to DSS sites for evaluating the accuracy of data.

I. Errors in Reporting of Age

a. Age preference

The degree of age preference can be used to test for deficiencies in the DSS data. Although age is the most important variable in demographic analysis, it is typically prone to errors of recall and other types of biases. Age misreporting takes two basic forms: "heaping," or digit preference, and "shifting." In less literate populations, the reporting of events, especially births, is usually clustered at certain preferred digits, as a result of ignorance, genuine reporting errors, or deliberate misreporting. Thus, it is common to find concentrations of people at ages with numbers ending in digits 0 and 5 and, to a lesser extent, 4, 6, or 9. Indexes such as Whipple's index and Myers' blended index have been developed to statistically assess the extent of age preference, based on the assumption that the population is rectangularly (there are equal numbers in each age) distributed over some age range (Shryock and Siegel 1976). Whereas Whipple's index is a measure of preference for ages ending in 0 and 5, Myers' index provides an overall measure of age heaping, as well as an index of preference for other terminal digits.

Whipple's Index

To measure the extent of heaping on digits 0 and 5, Whipple's index employs the assumption of rectangularity over a 10-year range and compares the population reporting ages ending in 0 and 5 in the range 23–62 years. The index varies between 100, indicating no preference for digits ending in 0 or 5, and 500, indicating that only digits ending in 0 or 5 were reported. A United Nations-developed scale can be used to evaluate the reliability of any data set based on the estimated Whipple's index, as follows: <105 = highly accurate; 105–109 = fairly accurate; 110–124 = approximate; 125–174 = rough; 175 = very rough.

Whipple's index measurement of heaping on the digit '0' and '5' in the 10 year range for the ages 23-62 is:

$W_{10} = \{Sum\ (P_{30} + P_{40} + P_{50} + P_{60})/1/10(Sum\ (P_{23} + P_{24} + P_{25} -- P_{62}))\}* 100$ .... (3.1)

$W_5 = (Sum\ (P_{25} + P_{30} + P_{35} + P_{40} -- P_{60})/1/5(Sum\ (P_{23} + P_{24} + P25 - P_{62}))\}* 100$ .... (3.2)

Myers' Blended Method

The Myers' blended index involves determining 10 times the proportion of the population reporting in each terminal digit for any 10-year age group. This yields an index of preference for each terminal digit representing the deviation from 10% of the total population reporting the particular digit. The overall index is derived as half the sum of the absolute deviations from 10% and is interpreted as the minimum proportion of individuals for whom an age with an incorrect final digit is reported. The index is 0 when no age heaping occurs and 90 when all age reports have the same terminal digit.

Method

Steps

1. Select the age range for which the digital preference has to be measured. For instance, age 10-89 years
2. This range is than divided into two overlapping age ranges-- 10-89 years, 20-89 years
3. Population totals are calculated for ages ending in each of the 10 digits and then recorded (see columns 1 and 2, see Table 8-2, page 117)
4. Apply weights to each digit selected. See column 3 and 4 for weights applied (weights for 0 digit is 1 and 9, for digit 1 is 2 and 8.) and then sum the weighted totals for column 1 and 2. (Sums given in column 5).
5. Covert the distribution into percent (Column 6).
6. Find the deviations from 10 percent-- The deviations from 10 percent indicate the preference or non-preference of digits.
7. A summary index of deviations for all ages is calculated by dividing the sum of the deviations by 2 or it is one half the sum of the deviations from 10 percent

b. Age ratios

Another way to evaluate DSS data is to compare age ratios with expected or standard values. Age ratios are defined here as the ratio of the population in a given age group to one-third the sum of the populations in that age group and in the preceding and following groups, multiplied by 100. The age ratio is expressed for a 5-year age group as follows:

$$\text{Age ratio} = \frac{{}_5P_a}{1/3({}_5P_{a-5} + {}_5P_a + {}_5P_{a+5})} \times 100 \qquad [3.3]$$

where ${}_5P_a$ is the population in the given age group; ${}_5P_{a-5}$ is the population in the preceding age group; and ${}_5P_{a+5}$ is the population in the following age group. In the absence of extreme fluctuations in the past vital events, the age ratios should be about equal to 100, based on the assumption that coverage errors are about the same for all age groups and that complementary errors in adjacent age groups offset age-reporting errors. The average absolute deviation from 100 of the age ratios, over all ages, gives the age-accuracy index, or overall measure of the accuracy of the age distribution: the lower the age-accuracy index, the more accurate the age data.

II. Errors in Reporting of Births

The accuracy of fertility estimates will depend on the quality of the data involved in both the numerator and the denominator of the rates. Age reporting errors above, may affect the denominator of the rate, while the numerator will be affected by errors in reported live births (Guzmán, 1980). Data on live birth is obtained from birth forms which are collected retrospectively, so that their quality depends on the respondent's capacity for remembering each of the events occurred, as well as their willingness to report all their event.

A frequent error in the birth histories is the omission of births. Generally, omission occurs more often among older women and for births that occurred long before the time of the survey. However, more recent births may also be omitted, mostly those that occurred in unstable unions. In addition children are more frequently omitted if they had died during their first years of life or were living outside the home at the time of the interview. Goldman et al. have found a high correlation between the poor information about age and the omission of births in the study on the quality of the data obtained in the Nepal Fertility Survey. (Goldman et al., 1979)

One test for detecting omissions of live births is Sex Ratios at Birth.

Sex Ratios at Birth

From an examination of the sex ratios of registered births for a wide array of countries, it is apparent that the component of births tends to bring about or to maintain and excess of males in the general population. The sex ratio of births is above 100 for nearly all countries for which relatively complete data are available and between 104 and 107 in most such countries.

3.3.3 Data Analysis

The study analyses the quality of data for Rusinga Island DSS as well as estimating period fertility levels using the current fertility level. Before any analysis was done, data was first converted to SPSS and then cleaned by checking missing and inconsistent values (e.g. having a value 3 for sex which has only 1 and 2 for male and female).

This required extracting questionnaires and forms from the baseline to round 10 that had queries and the necessary amendments made. Generally, the data did not have a lot of inconsistent value although there were a lot of missing values mostly arising during the exportation of data from SPSS to FoxPro. One example is the missing household member's serial number that is necessary to link an individual to their other events like household characteristics. Dates of events were also lost during conversion in a number of rounds especially round ten.

3.3.2.1 Data Quality

The study uses both age and sex of the population for the estimation of fertility; hence data quality assessment involves calculating indexes and ratios to checks for the quality of these data. Variable of interest consequently being:

a. Age
b. Sex and

Both Whipple's index and Myers' blended index are used to calculate the presence of age heaping, and age ratios are used to check the accuracy of age data. Analysis of omissions of live births involves calculating sex ratio at birth.

3.3.2.2 Fertility Estimation

The most preferred fertility estimation model for a DSS site is the Open Birth Interval (DLB) proposed by Schmertmann (1999) where total births are aggregated for the survey period and dividend by the exposure period. However, since date of birth for the mothers' was not well documented, this method was not possible. The study thus uses current fertility method to calculate three period fertility estimates i.e. Age Specific Fertility Rate (ASFR) General Fertility Rate (GFR), Crude Birth Rate (CBR) and Total Fertility Rate (TFR). These estimates are calculated as:

$$ASFR = \frac{\text{Births in a year to women aged } x \text{ to } (x+5)}{\text{Total mid-year population of women aged } x \text{ to } (x+5)} * 1000 \quad \ldots\ldots (3.5)$$

$$GFR = \frac{\text{Total number of births in a year } x}{\text{Mid-year population of women aged 15-44 in year } x} * 1000 \quad \ldots\ldots (3.6)$$

$$CBR = \frac{\text{Number of live births in year } x}{\text{Mid-year population in year } x} * 1000 \quad \ldots\ldots (3.7)$$

$$TFR = \sum (ASFR * 5) \quad \ldots\ldots (3.8)$$

Variable of interest in estimating period fertility rates for the three rounds to be used are:

a. Births
b. Total population and
c. Women of reproductive age in five year age groups

Data on the total births in the three rounds was extracted from the birth database and converted to SPSS, the same was done for the population data. However, since birth forms did not include the mother's age at the time of birth, the birth data set was linked to the population data set using the household number and the mother's serial number enabling the date of birth of the mother variable to be merged to the birth data set. The mother's date of birth variable was used to compute the age of the mother at the time of birth in each of the rounds.

CHAPTER FOUR

QUALITY OF DATA AND FERTILITY ESTIMATION

4.1 Data Quality

Rusinga Island DSS data quality is assessed for age accuracy using Whipple's index, Myers' Blended Index and age ratios. Omission of live births is also estimated by calculating sex ratio at birth for the three rounds under study which checks the quality of birth data.

4.1.1 Whipple's index

Table 4.1.1 Rusinga Population

Population aged 23 to 62 for round 1, 9 and 10

	Round 1	Round 9	Round 10
Population age 23 to 62	5,996	7,443	7,752

Source: Gakuruh (2008)

Round 1 had 5,996 people between age 23 and 62 while round 9 and 10 had 7, 443 and 7,752. These populations will be used as the denominator for the calculation of Whipple's Index.

Table 4.1.2 Whipple's Index for termination index '0'

Round one, nine and ten age heaping on terminal digit '0'

Terminal Digit 0	**Rounds**		
	1	**9**	**10**
30	366	466	486
40	205	245	254
50	127	136	137
60	76	83	83
Total	774	**930**	**960**

Source: Gakuruh (2008)

$W_{10} = \{\text{Sum } (P_{30} + P_{40} + P_{50} + P_{60})/1/10(\text{Sum } (P_{23} + P_{24} + P_{25} -- P_{62}))\} * 100$ .... (3.1)

Round 1 = 774 / (0.1* 5996)

= 129

Round 9 = 774 / (0.1* 7443)

= 125

Round 10 = 774 / (0.1* 7752)

= 124

The estimated Whipple's index for termination digit '0' for round one, and nine are 129, and 125 respectively indicating that in these two rounds, age accuracy for '0' terminal digit was rough. Round ten however, was slightly better with an index of 124 which according to the United Nations-developed scale, is approximately accurate.

Table 4.1.3 Whipple's Index for terminal index '5'

Round one, nine and ten age heaping on terminal digit '5'

Terminal Digit 5	**Rounds**		
	1	**9**	**10**
30	446	592	621
40	211	262	272
50	171	185	188
60	98	100	100
Total	**926**	**1139**	**1181**

Source: Gakuruh (2008)

$W_5 = (\text{Sum } (P_{25} + P_{30} + P_{35+} P_{40} \text{--} P_{60}) / 1/5(\text{Sum } (P_{23} + {}_{P24} + P25\text{-}P_{62}))\} * 100$ .... (3.2)

Round 1 = (926 / (0.2 * 5996)) *100

= 77

Round 9 = (1139 / (0.2 * 7443)) *100

= 77

Round 10 = (1139 / (0.2 * 7752)) *100

= 76

The age accuracy for terminal digit five has similar estimates i.e. 77, 77 and 76 for the three rounds respectively. This indicates that the data quality of Rusinga DSS age data on terminal digit five is highly accurate.

4.2.2 Myers' Blended Index

Table 4.2.2.1 Round One Myer's Blended Index

Round One digit preference

Round 1							
	Population with terminal digit a		Weights for ...		Blended population		Deviation of percent from 10.00 (6) - 10.00 = (7)
Terminal Digit, a	Starting at age 10+a (1)	Starting at age 20+a (2)	Column 1 (3)	Column 1 (4)	Number (1) * (3) + (2) * (4) = (5)	Percent distribution (6)	
0	2071	1424	1	9	14887	14.0	3.98
1	1446	768	2	8	9036	8.5	1.51
2	1467	899	3	7	10694	10.0	0.05
3	1143	675	4	6	8622	8.1	1.90
4	1135	627	5	5	8810	8.3	1.72
5	1567	1036	6	4	13546	12.7	2.72
6	1128	650	7	3	9846	9.2	0.75
7	956	528	8	2	8704	8.2	1.82
8	1350	787	9	1	12937	12.2	2.15
9	937	521	10	0	9370	8.8	1.20
Total					**106452**	**100**	**17.82**
Summary index of age preference = Total /2							**8.91**

Source: Gakuruh (2008)

Myers' Blended Index for round one is estimated at 8.91. On the scale of 0 to 90, this indicates a slight age heaping.

Table 4.2.2.2 Round Nine Myer's Blended Index

Round nine digit preference

Round 9							
	Population with terminal digit a		Weights for ...		Blended Population		Deviation of percent from 10.00 (6) - 10.00 = (7)
Terminal Digit, a	Starting at age 20+a (1)	Starting at age 10+a (2)	Column 1 (3)	Column 1 (4)	Number (1) * (3) + (2) * (4) = (5)	Percent distribution (6)	
0	2569	1817	1	9	18922	14.27	4.27
1	1948	956	2	8	11544	8.71	1.29
2	1845	1174	3	7	13753	10.37	0.37
3	1420	869	4	6	10894	8.22	1.78
4	1401	805	5	5	11030	8.32	1.67
5	1857	1257	6	4	16170	12.20	2.19
6	1393	830	7	3	12241	9.23	0.76
7	1159	651	8	2	10574	7.98	2.02
8	1664	938	9	1	15914	12.00	2.00
9	1153	613	10	0	11530	8.70	1.30
Total					132572	100.00	**17.70**
Summary index of age preference = Total /2							**8.85**

Source Gakuruh (2008)

Round nine gives a similar but slightly lower Myer's Blended Index of 8.95, which also indicates presence of age heaping.

Table 4.2.2.3 Round Ten Myer's Blended Index

Round ten digit preference

Round 10							
	Population with terminal digit a		Weights for ...		Blended population		Deviation of percent from 10.00 (6) - 10.00 = (7)
Terminal Digit, a	Starting at age 20+a (1)	Starting at age 10+a (2)	Column 1 (3)	Column 1 (4)	Number (1) * (3) + (2) * (4) = (5)	Percent distribution (6)	
0	2673	1896	1	9	19737	14.4	4.44
1	1504	993	2	8	10952	8.0	1.99
2	1914	1223	3	7	14303	10.5	0.46

3	1469	904	4	6	11300	8.3	1.74
4	1459	844	5	5	11515	8.4	1.58
5	1908	1289	6	4	16604	12.1	2.14
6	1448	862	7	3	12722	9.3	0.70
7	1224	692	8	2	11176	8.2	1.83
8	1729	977	9	1	16538	12.1	2.10
9	1188	626	10	0	11880	8.7	1.31
Total					**136727**	**100.0**	**18.3**
Summary index of age preference = Total /2							**9.14**

Source: Gakuruh (2008)

In round ten, Myer's Blended Index increases from 8.95 in round 9 (2006) to 9.14 (2007). This estimate also indicates a slight increase in age heaping in round 10 data.

4.2.3 Age Ratio

Table 4.2.2.4 Age Ratio

Age accuracy Index for Round 1, 9 and 10

Age Group	Round 10		Round 9		Round 1	
	Frequency	Age Ratio	Frequency	Age Ratio	Frequency	Age Ratio
0-4	4333		4111		2973	
5-9	3321	44.33	3199	44.54	2584	46.18
10-14	3159	49.58	3071	50.05	2622	52.44
15-19	3051	50.45	2937	50.55	2416	53.08
20-24	2889	54.68	2739	54.19	1930	48.33
25-29	2232	52.59	2117	52.41	1577	53.28
30-34	1355	42.78	1300	43.19	1030	43.96
35-39	935	45.34	893	45.15	766	47.46
40-44	707	46.03	678	45.63	584	44.68
45-49	601	52.40	593	53.23	541	54.92
50-54	440	46.86	436	46.93	401	47.34
55-59	338	50.52	336	50.53	306	49.59

60-64	229	40.82	229	40.97	216	42.02
65-69	223	55.75	223	55.75	208	54.74
70-74	171	52.78	171	52.78	164	53.42
75-79	101	42.08	101	42.26	99	42.67
80-84	69	47.26	68	46.58	68	47.89
85+	45	774.26	45	774.73	43	782.02
Average		**48.39**		**48.42**		**48.88**
Absolute deviation from 100		**51.61**		**51.58**		**51.12**

Source: Gakuruh (2008)

The age accuracy index for the three rounds under study approximate to 51, which indicates that the age data has some degree of inaccuracy.

4.2.3 Sex Ratio at Birth

Table 4.2.2.5 Sex Ratio at Birth

Round 1, 9 and 10 Sex Ratio

Sex	**Round 1**	**Round 9**	**Round 10**
P_m	153	303	131
P_f	166	325	145
Sex Ratio	**92.17**	**93.23**	**90.34**

Source: Gakuruh (2008)

Sex ratios for the three rounds are estimated at around 92, 93, and 90. These ratios are below 100, which indicate inaccuracy in recorded sex of children at birth for all the three rounds.

4.2 Rusinga Female Population and Births

The table below shows the population and birth information used in the calculation of period fertility rate for round one (2002), nine (2006) and ten (2007).

Table 4.1 Rusinga Population and Births

Total population, Female population and Births in Rusinga Island (round 1, 9 and 10)

	Round 1 (2002)	Round 9 (2006)	Round 10 (2007)
Total Population	18,775	23,668	24,616
Women 15 – 49	4815	11,257	5978
Women 15 – 44	4496	10,664	5978
Births	315	628	279

Source: Gakuruh (2008)

The total population of Rusinga Island was 18775, 23668 and 24616 in round one, nine and ten respectively. Women of reproductive age 15-49 were 4815 in round one, 11257 round nine and 5978 in round ten. Recorded births for the three periods were 315, 628 and 279 respectively.

4.3 Current Fertility

Table 4.3 Current fertility

Age-specific fertility rates, the general fertility rate, the crude birth rate and total fertility rate for the three rounds (one, nine and ten) are presented on the table below.

The ASFR, GFR and TFR of Rusinga Island

Age group	August 2002 Round 1	April 2006 Round 9	September 2007 Round 10
15-19	108	81	80
20-24	70	65	54
25-29	62	48	28
30-34	47	45	14
35-39	44	30	11
40-44	21	25	8

45-49	13	13	6
TFR	**1.82**	**1.54**	**1.00**
GFR	**71.87**	**58.89**	**46.80**
CBR	**16.78**	**26.53**	**11.33**

Source: Gakuruh (2008)

Note:
TFR: Total fertility rate for women age 15-49, expressed per woman
GFR: General fertility rate (births appendix 2, divided by the number of women age 15-44 appendix 4), expressed per 1,000 women
CBR: Crude birth rate, expressed per 1,000 population appendix 3

Table 4.1 presents TFR, along with the ASFR's on which they are based, for the three rounds; one, nine and ten as well as the gross fertility rate and crude birth rate. The TFR is estimated to be 1.82, 1.54, and 1.00 respectively. Gross fertility rate (GFR) is estimated at 71.87, 58.89 and 46.80 for round one, nine and ten respectively. Crude birth rate (CBR) for round one, nine and ten are estimated at 16.78, 26.53 and 11.33.

The above results indicate that fertility has been decreasing over the years from 1.82 to 1.00 births per woman. The same downward pattern is evident in the gross fertility rate (GFR) from 71.87 in 2001 to 46.80 births to women of child bearing age in 2007. However crude birth rate has an increase in 2006 of 26.53 from 16.78 in 2002, then reducing to 11.33 births per 1,000 midyear population in 2007.

By comparison to the 1999 Kenya Census national TFR of 5.0, and Suba district 5.9, as well as KDHS Nyanza province TFR of 5.6 births, the estimated Rusinga Island TFR of 1.8, 1.54 and 1.00 in the three rounds under study is quite low. This low rate is also evident in the Rusinga DSS CBR of 16.78 round one, 26.53 round nine, and 11.33 in round ten, as compared to the national CBR estimate of 41.3 and 49.9 for Suba estimated in the 1999 census.

Given the results and the poor quality of data as evidenced by the data quality evaluation above, indirect methods of fertility estimation using children ever born would have been ideal to correct the data errors. Unfortunately, birth history forms do not ask women of their parity level or the number of live children ever born.

CHAPTER FIVE
CONCLUSION AND RECOMMENDATION

5.1 INTRODUCTION

This being one of the first studies to use Rusinga DSS data, the results obtained, though quite limited with data errors, highlights the richness of longitudinal data that the DSS undertakes. This chapter makes general conclusions based on the results as well as providing recommendations for the DSS that would provide precedence for future research studies to be conducted once the recommendations are put to place.

5.2 CONCLUSION

The results from the present analysis do not corroborate with those obtained from the national census of 1999 - that the Fertility estimate of Rusinga Island is lower than the National and Suba fertility rates – however, given the data inaccuracy noted above, additional studies are needed to confirm this using Indirect techniques as well as determine fertility differentials for the Island.

Generally, Rusinga DSS data has been noted to not only be inaccurate especially as regards to age and sex data but vital variable like children ever born (parity level) is missing. Necessary steps and measures need to be put in place in order to make the DSS data more accurate and useful in determining demographic characteristics of the Island.

5.3 RECOMMENDATIONS FOR DSS

Data quality evaluation in chapter four have reveled that Rusinga Island data has a lot of errors that will need to be addressed before further analysis is done. It is for this reason that a lot of emphasis is made on data assurance recommendations in the systems main area of concern.

5.3.1 Data Collection Tools – Birth Form

The following information should be added to the form:

1) Mother's age at time of birth and
2) Mother's year, month and date of birth
3) Live children ever born (parity of mother)
4) Residency status of mother i.e. resident or migrant

5) Marital status at time of birth

5.3.2 Data Collection

1) Field staff should be qualified and well trained on the data collection tools as well as their geographical coverage.
2) Field editing is necessary to check on data completeness and errors
3) Their should be defined time points for updating the DSS data
4) Advance data collection technologies such as the paperless technology using handheld computers (PDA's) could be considered in the future.

5.3.3 Data Entry

1) Data entry should begin as soon as data is collected to reduce the chance of data loss
2) Technical challenges of converting FoxPro (the database in use) to SPSS should be corrected. These include, some date of birth not being transferred as well as the names of the child and the mother.
3) Previous birth data (as well as death and migration) should also be converted to FoxPro to enable the adjustment of the population for each round.

5.3.4 Data handling and back-up procedures

1) It is imperative that all entered data should be cleaned as soon as data entry ends so as to store the data in its unclean as well as clean form
2) Data sets should be stored for the entire population as well as subsets of various population for different analysis
3) Population data should be updated for natural increases (births and deaths) as well as net migration (in and out migration) for each round of data collection and each round stored separately so as to analyze trends.
4) A Standard Operating Procedure (SOPs) for identifying missing, incomplete, inconsistent, erroneous data and verifying correction should be developed
5) A Codebook describing the name, meaning, and coding of each variable should also be developed.

5.4 RECOMMENDATIONS FOR FURTHER RESEARCH

1) With improved data, fertility differentials by education, marital status and economic activity can be established.
2) A Family Planning study can also be conducted on the entire Rusinga Island population or a representative sample.
3) Indirect method using CEB can be used to determine data quality, that is detect and adjust for reporting errors typically observed in demographic data from less developed countries.
4) DSS being a longitudinal study, the Life time Fertility method – Cohort approach can be used to estimate fertility
5) Relating fertility to the seasonal migration (Beach) could also be studied
6) Establishing the relationship between fertility and mortality especially due to high HIV/AIDS rates in Nyanza province (15.1, KDHS 2003) could also be an interesting study. However this would necessitate conducting a verbal autopsy (VA) survey to infer causes of death for diseased persons in the DSS area or including specific cause of disease on the death form.

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APPENDIX I: RUSINGA ADMINISTRATIVE AND CLUSTERS

Location/Sub-location/Cluster

Rusinga East Location

- **Waware South**
  - Wakondo
  - Kakrigu South
  - Wariga
- **Waware North**
  - Wasaria
  - Bondo
    - Bondo B
    - Bondo A
    - Warengi East
    - Warengi West
    - Kolo B
    - Kolo A
    - Kamgere B
    - Kamgere A
    - Utajo B
    - Utajo A
  - Lianda
    - Lianda B
    - Lianda A

Rusinga West

- **Kamasengre East**
  - Sienga A
  - Sienga B
  - Kamayoge
  - Waembe
  - Wamwanya
- **Kamasengere West**

Nyangere A

Nyangere B

Ragoo

Ragoo A

Ragoo B

Ukowe

Lwanda A

Lwanda b

Kaswanga

Gunda

Kiagasa

Dier Aora

Warengo

Wakwala

Kakrungu

Wanyama

Kaktemo

Kabade

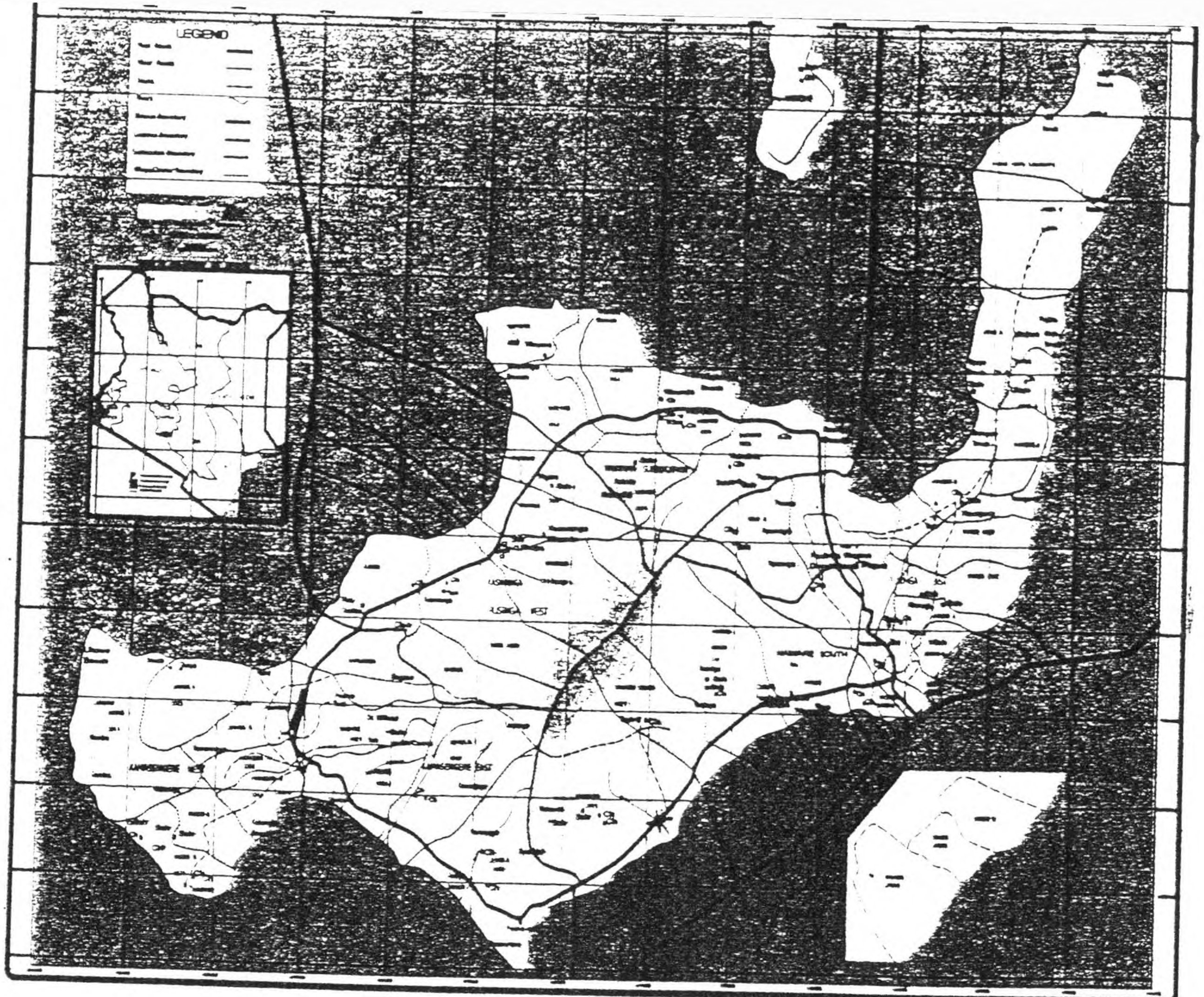
Wanyando

Nyakrato

Wamwaya

Warengo

Ngodhe



PREPARED BY POPULATION STUDIES AND RESEARCH INSTITUTE(PSRI)

APPENDIX II

PSRI POPULATION LABORATORY IN RUSINGA ISLANDS

HOUSEHOLD QUESTIONNAIRE

CONFIDENTIAL
Data used for research purposes only

IDENTIFICATION

LOCATION ______	☐☐
SUB-LOCATION ______	☐☐
VILLAGE ______	☐☐
CLUSTER ______	☐☐☐☐
URBAN/RURAL (URBAN = 1 RURAL = 2)	☐
SERIAL NO OF HOUSEHOLD......	☐☐☐☐☐☐☐
NAME OF HOUSEHOLD HEAD ______	☐☐
LINE NO OF RESPONDENT ______	☐☐

INTERVIEWER VISITS	1	2	3	FINAL VISIT	
DATE	______	______	______	DAY	☐☐
INTERVIEWER'S NAME	______	______	______	MONTH	☐☐
RESULT*	______	______	______	YEAR	☐☐
				NAME	☐☐
				RESULT	☐
NEXT VISIT DATE	______	______		NO OF VISITS	☐
TIME	______	______		TOTAL IN HOUSEHOLD	☐☐

* RESULT CODES:
1 COMPLETED
2 NO HOUSEHOLD MEMBER AT HOME OR NO COMPETENT RESPONDENT AT HOME AT TIME OF VISIT
3 ENTIRE HOUSEHOLD ABSENT FOR EXTENDED PERIOD
4 POSTPONED
5 REFUSED
6 DWELLING VACANT OR ADDRESS NOT A DWELLING
7 DWELLING DESTROYED
8 DWELLING NOT FOUND 9 9 OTHER ______ SPECIFY)

TOTAL FEMALE 15-49 ☐☐

TOTAL MEN 15-54 ☐☐

LANGUAGE OF QUESTIONNAIRE: SWAHILI/DHOLUO

NAME TIME	FIELD EDITED BY ______	OFFICE EDITED BY ______	KEYED BY ______	KEYED BY ☐☐

No. of Persons in H.H. ☐☐ No. of Eligible women ☐☐

HOUSEHOLD QUESTIONNAIRE

H.H. NO. □□□□□□□

w I would like to know some information about the people who usually live in your
usehold

ial	Please give me Names of per who usually live in household starting with the head of househo	Relation to the head of household CODES FOR RELATIONSHIP TO HEAD OF HOUSEHOLD 01 = HEAD 02 = WIFE OR HUSBAND 03 = SON/ DAUGHTER 04=SON/ DAUGHTER IN-IN LAW 05 = GRANDCHILD 06 = PARENT 07 = PARENT-IN-LAW 08 = BROTHER OR SISTER	Sex Male = 1 Female=2	Age in completed years	Education (6 years & over) None 00 Nursery 01 Primary Incomplete 02 Complete 03 Secondary 00 Incomplete 04 Completed 05 A Level 06 Post Sec. Training 07 University 08 DK 09	Marital status (12 Years & over) Less 12 years = 0 Never Married = 1 Married = 2 Divorced = 3 Widowed = 4 Separated = 5 M/S = 8 Miss. = 9	Activity in last 7 days 01 Worked for pay or profit 02 On leave/sick leave 03 Working on family holding 04 No work 05 Seeking work 06 Student 07 Retired 08 Disabled 09 Home makers 10 Other
	2	3	4	5	6	7	8

here if the Household had more than 15 members

e: If there are more than 15 members in the household use additional sheet

nber of females in HH □□ Number of males in HH □□ TOTAL NUMBER IN HH □□

H.H. NO. ☐☐☐☐☐☐☐

Now I would like to know some information about the people who usually live in your household

Serial No.	Please give me Names of persons who usually live in household starting with the head of household	Relation to the head of household CODES FOR RELATIONSHIP TO HEAD OF HOUSEHOLD 01 = HEAD 02 = WIFE OR HUSBAND 03 = SON/ DAUGHTER 04=SON/ DAUGHTER IN-IN LAW 05 = GRANDCHILD 06 = PARENT 07 = PARENT-IN-LAW 08 = BROTHER OR SISTER	Sex Male = 1 Female=2	Age in completed years	Education (6 years & over) None 00 Nursery 01 Primary Incomplete 02 Complete 03 Secondary 00 incomplete 04 Completed 05 A Level 06 Post.Sec. Training 07 University 08 DK 09	Marital status (12 Years & over) Less 12 years = 0 Never Married = 1 Married = 2 Divorced = 3 Widowed = 4 Separeted = 5 M/S = 8 Miss- = 9	Activity in last 7 days 01 Worked for pay or profit 02 On leave/sick leave 03 Working on family holding 04 No work 05 Seeking work 06 Student 07 Retired 08 Disabled 09 Home makers 10 Other
1	2	3	4	5	6	7	8
11							
12							
13							
14							
15							
16							
17							
18							
19							

Tick here if the Household had more than 15 members

Note: If there are more than 15 members in the household use additional sheet.

Number of females in HH ☐☐ Number of males in HH ☐☐ TOTAL NUMBER IN HH ☐☐

H.H. NO. ☐☐☐☐☐☐☐

Now I would like to know some information about the people who usually live in your household

Serial No	Please give me Names of persons who usually live in household starting with the head of household	Relation to the head of household CODES FOR RELATIONSHIP TO HEAD OF HOUSEHOLD 01 = HEAD 02 = WIFE OR HUSBAND 03 = SON/ DAUGHTER 04 = SON/ DAUGHTER IN IN LAW 05 = GRANDCHILD 06 = PARENT 07 = PARENT IN LAW 08 = BROTHER OR SISTER	Sex Male = 1 Female = 2	Age in completed years	Education (6 years & over) None 00 Nursery 01 Primary Incomplete 02 Complete 03 Secondary incomplete 04 Completed 05 A Level 06 Post Sec Training 07 University 08 DK 09	Marital status (12 Years & over) Less 12 years = 0 Never Married = 1 Married = 2 Divorced = 3 Widowed = 4 Separated = 5 M/S = 8 Miss = 9	Activity in last 7 days 01 Worked for pay or profit 02 On leave/sick leave 03 Working on family holding 04 No work 05 Seeking work 06 Student 07 Retired 08 Disabled 09 Home makers 10 Other
1	2	3	4	5	6	7	8
11							
12							
13							
14							
15							
16							
17							
18							
19							

Tick here if the Household had more than 15 members

Note: If there are more than 15 members in the household use additional sheet

Number of females in HH ☐☐ Number of males in HH ☐☐ TOTAL NUMBER IN HH ☐☐

HOUSEHOLD CONDITIONS AND AMENITIES (to be asked the household head or any other responsible person)

Dwelling units		Main dwelling unit Tenure status	Dominant construction Materials of main dwelling unit			Main source of water	Main source of human waste disposal	Main cooking fuel	Main type of lighting	Household item
17		18	19	20	21	22	23	24	25	26
How many dwelling units does this household occupy?	How many habitable rooms does (do) this dwelling units contain?	If owner occupied Purchases 1 Constructed 2 Inherited 3 If rented/provided Govnt 4 Local auth 5 Parastatal 6 Private comp 7 Individual 8 Other 9	Roof Corrugated iron sheet 1 Tiles 2 Concrete 3 Asbestos sheets 4 Grass 5 Makuti 6 Tin 7 Other 9	Wall Stone 1 Brick/block 2 Mud/wood 3 Mud/cement 4 Wood only 5 Corrugated iron sheets 6 Grass/reeds 7 Tin 8 Other 9	Floor Cement 1 Tiles 2 Wood 3 Earth 4 Other 9	Well 1 Borehole 2 Piped/tap 3 Private vendors 4 Community-owned kiosk 5 Lake 6 Other 9	Main sewer 1 Septic tank 2 Pit latrine 3 Bucket latrine 4 Field/Bush 5 Paid toilet 6 Drains 7 Other 9	Electricity 1 Paraffin 2 Gas 3 Firewood 4 Charcoal 5 Solar 6 Other 9	Electricity 1 Pressure lamp 2 Lantern 3 Tin lamp 4 Fuel wood 5 Solar 6 Other 9	Radio 1 Television video 2 Refrigerator 3 Car 4 Bicycle 5 Boat 6 Donkey/cart 7

LOCATION OF HOUSEHOLD AND MARKING HOUSEHOLD NUMBER ON THE DOOR

1. Place the GPS about 2 metres in front the door to main dwelling unit and record reading: GPS

   Reading: North__________ East______________

2. Mark the household number on the door of the main dwelling unit PSRI/LAB/: ☐☐☐☐☐☐☐

3. Household code
   - 0 Existing at time of enumeration
   - 1 New through marriage
   - 2 Through in-migration
   - 3 Out-migration outside Island
   - 4 Migration within Island

DATE OF LISTING/CREATION OF HH ☐☐ ☐☐ ☐☐☐☐

Day Month Year