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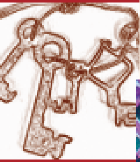

les *Clefs* pour

LES COLLECTIONS DU CEPED

Analysing Fertility from Demographic Surveillance System Data

Valérie DELAUNAY
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Application to the Niakhar site, Senegal

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CEPED brings together the Institut National d'Études Démographiques (INED), the Institut de Recherche pour le Développement (IRD) and the Demography department of the University Paris 5. Its purpose is to enhance scientific collaboration between Northern and Southern research teams concerning population and development.

CEPED provides support to research networks through research promotion, training, expertise and documentation services in four areas of research. Coordinated by experienced researchers, its activities are structured around working groups whose role is to organize training sessions, workshops, seminars and international conferences.

- Reproductive health
- Society, family and gender
- Settlement patterns, urbanisation, mobility and environment
- Methodology: data collection and analysis.

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The aim of CEPED's activities in the field of methodology (Field IV, *Methodology: data collection and analysis*) is to support and stimulate thinking and discussion about concepts, observation systems and analysis tools.

The coordinators of Field IV are Éva Lelièvre and Valérie Golaz (INED).

Activities in this Field involve setting up and evaluating analysis tools. The aim is to promote reflection on and development of specific new or alternative methods for better exploiting the wide range of existing sources.

This work takes a variety of forms: discussion groups, seminars, training support activities, consultancy and the publication of handbooks in the series entitled *les Clefs pour* (*Keys to*).

The *les Clefs pour* series in *les Collections du CEPED*

This series, launched under the responsibility of the coordinators of Field IV *Methodology: data collecting and analysis*, is intended to disseminate research methods and practices to researchers, field practitioners and students with an interest in population issues.

The Methodology series is a response to practical demand by researchers facing the specific constraints of their fields and needing to adapt tools and concepts, make best use of the available data, address the limitations and potential of specific data collections and above all innovate and use to best advantage advances made in different situations.

These constraints call for precise solutions, methodological innovations and conceptual discussions whose dissemination helps to advance concepts and methods more rapidly.

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Contents

Introduction

Small-scale systems for collecting prospective demographic data have been set up in many developing countries. These demographic surveillance systems (DSSs) have now formed a network, called Indepth[1], to exchange ideas on methodology and scientific issues and to facilitate comparative approaches.

DSSs constitute a particular method of data gathering which lends itself to specific analyses. This method is mainly used to collect data on health issues (clinical and therapeutic trials), under research programmes that usually finance the data gathering. While some aspects of the data are fully exploited by closely targeted research projects, there are shortcomings in the analysis of the demographic phenomena, which is not always performed as effectively as the data would allow. The Indepth network's work in compiling a monograph on mortality trends at 22 sites (Indepth, 2003) is impressive, as is the creation of two model life tables (mortality) for Africa based on data from African sites, (Indepth, 2004). Both these publications, to be followed by a third one on causes of death, show the full value of the comparative approach. It is now important to extend this approach to other demographic phenomena such as fertility and migration.

The purpose of this handbook is to offer a standardised analysis of fertility that can be replicated more or less completely using data from the various existing DSSs. It is a methodological document, designed to contribute to better use of DSS data and to facilitate comparative analysis of different DSSs. It describes the particularities of this type of data and presents some of its particular analytical procedures.

Part One describes the characteristics of a DSS. Part Two proposes a standardisation of the concepts and indicators. Parts 3 to 6 describe the analytical procedures. These are applied here to fertility, but can be extrapolated for analysing other phenomena. They are derived from what is called cross-sectional demographic analysis, as opposed to longitudinal analysis. Cross-sectional analysis concerns a defined time interval whereas longitudinal analysis involves monitoring records in the form of reproductive history, marital history, residential history etc.

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[1] International Network of field sites with continuous Demographic Evaluation of Populations and Their Health in developing countries: www.indepth-network.org

The procedures described are then illustrated in Part 7 with an analysis of data from the demographic surveillance system in Niakhar, Senegal.

The main calculations are programmed using the Foxpro or Stata software packages. They are shown in the annexes. To use them on different databases, they must be adapted to the structure of the data.

1. What is a Demographic Surveillance System?

1.1. Definition

A Demographic Surveillance System (DSS)[2] is a system of exhaustive surveys that can be used to monitor trends in a geographically circumscribed population. This population is defined using certain rules of residence, and individuals' life events during the period(s) they stay in the survey area are recorded (the minimum data being births, deaths and migrations). Events are recorded by multi-round surveys with variable intervals between rounds, and in some cases by specific additional surveys. Data are recorded on an individual basis but sometimes per household or per residential unit.

This system provides a longitudinal monitoring of the population by continuous recording of events over a certain length of time. In this way it provides a geographical and temporal observation window. More than a cohort study, this kind of system offers exhaustive monitoring of the population in a given geographical area.

A DSS is characterised by certain criteria:

- The boundaries of the survey area

Usually, the boundaries of the survey area are those of an administrative area (district, department, rural community etc.), or neighbourhood boundaries for DSSs in urban areas. The survey area may be a single geographical area or may include several.

A survey area's boundaries may change over time owing to scientific or financial constraints.

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[2] These systems have sometimes been called "observatories", but this terminology has been abandoned owing to progress in research ethics: one cannot observe danger situations without intervening. The Indepth network's term Demographic Surveillance System (*Système de surveillance demographique* in French) is open to criticism for its policing connotations. All French-speaking sites have now adopted the term '*système de suivi démographique*' (demographic monitoring system).

- Start of observation

This is the date when the monitoring is set up and the measuring of demographic phenomena begins.

- Rules of residence

These define an individual's residence status, i.e. the conditions under which an individual is regarded as resident in the survey area and those under which they are considered to have out-migrated.

- Survey interval

This is the length of time between survey rounds. It generally varies between three months and one year. It may sometimes be shorter, depending on the needs of the research programme. The survey interval may change over time, even in the same DSS, and this can impact on the accuracy of the information gathered.

- Field procedures

Setting up a DSS requires first of all an initial baseline survey to identify individuals, record their socio-demographic characteristics (in varying degrees of detail) and sometimes record their birth data, marital data and even residential data.

Thereafter, at each update round, new residents are recorded along with all the events that have occurred since the last round.

Each individual is given an identifier and is allocated to a household (unit of production and consumption) and a residential unit.

1.2. DSSs around the world

The first demographic surveillance system was set up in the 1950s in Zambia (in Gwembe – Gwembe Tonga Research Project, 2003). This was followed in the 1960s by DSSs in Senegal (Niakhar – Garenne and Cantrelle, 1997; Delaunay, 2002; Delaunay *et al*., 2003) and in Bangladesh (Matlab – Aziz and Mosley, 1997; Razzaque and Streatfield, 2003).

The number of demographic surveillance sites remained small for a number of years, both because of their cost and because they are not representative. Numbers have increased considerably since the 1980s, to address the needs for better knowledge of the health of local communities and for more precise data on demographic levels and trends, since civil registration data are incomplete (Pison, 2003).

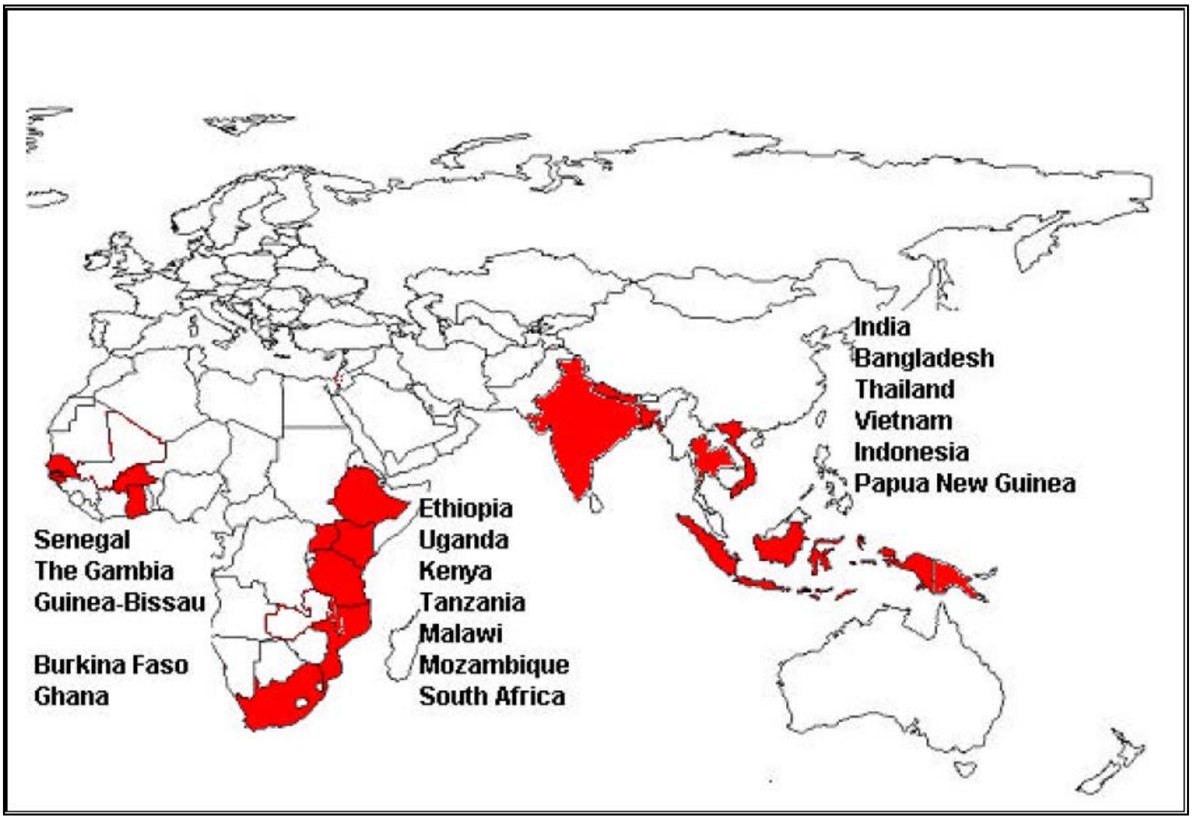
Many demographic surveillance sites today are connected with health programmes or clinical and therapeutic trials, and also provide epidemiological monitoring.

Indepth, formed in 1998 with 17 member sites, was declared an International NGO in 1999. The network now has 37 sites in 18 countries. Twenty-six of these are in Africa, nine in Asia, one in Oceania and one in Central America (Table 1)[3].

The network's member sites vary in size from 7500 people in Mlomp, Senegal, to 220,000 people in Matlab, Bangladesh. The average is 67,000 people. The sites are relatively recent: nine of them have been running for less than five years, but more than half are over ten years old (Table 1).

All DSSs record vital events (births and deaths) and migrations. These data are often supplemented by a variety of databases giving information on the economic and social situation of the communities studied. Some sites record fuller information on deaths so that probable cause of death can be established; a 'verbal autopsy' questionnaire is often used for this purpose[4]. Many sites record marriages and divorces. Depending on the research focus of the site, other events may be recorded, such as changes in household head, formation and dissolution of the household, or children's school attendance (Sankoh *et al.*, 2004).

Map 1 – Countries where the Indepth network has member DSSs (May 2004)



Source: Sankoh *et al.*, 2004

[3] www.indepth-network.org consulted on 6/02/2006.

[4] These are questionnaires administered by enumerators, tracking the history of the illness and/or the circumstances that led to the death, generally an algorithm of questions on the precise symptoms from which doctors can attribute a probable cause of death (Gray *et al*., 1990; Snow and Marsh, 1992).

Table 1 – Demographic surveillance sites in the Indepth network, January 2006

Site	Country	Year	Population monitored in 2002	Frequency (months)	Duration of monitoring (years)
East Africa					
Ethiopia	Butajira	1987	40	nd	19
Kenya	Kinsumu	2001	135	4	5
Kenya	Nairobi	2000	60	4	6
Kenya	Kilifi	2005	nd	nd	1
Uganda	Rakai	1988	42	10	18
Uganda	Iganga/Mayuga	2004	62	4	2
Tanzania	Ifakara	1996	60	4	10
Tanzania	Magu	1994	28	4	12
Tanzania	Rufiji	1998	85	4	8
Southern Africa					
South Africa	ACDIS/Hlabisa	2000	85	4	6
South Africa	Agincourt	1992	67	12	12
South Africa	Dikgale	1995	8	12	11
Malawi	Karonga	2002	20	nd	4
Mozambique	Manhiça	1996	36	4	10
West Africa					
Burkina Faso	Nouna	1992	55	3	14
Burkina Faso	Ouagadougou	2002	nd	nd	4
Burkina Faso	Oubritenga	1993	100	12	13
Burkina Faso	Sapone	2005	nd	nd	nd
The Gambia	Farafeni	1981	16	3	25
The Gambia	Kintampo	2003	145	nd	3
The Gambia	Navrango	1993	141	3	13
The Gambia	Dodowa	2005	nd	nd	2
Guinea Bissau	Bandim	1978	100	3	28
Senegal	Bandafassi	1970	10.5	12	36
Senegal	Mlomp	1985	7.5	12	21
Senegal	Niakhar	1962	30	3	44
Asia					
Bangladesh	HSID (ORP)	1982	127	3	24
Bangladesh	Matlab	1966	220	1	40
Bangladesh	Watch	1995	90	nd	11
India	Ballabgarh	1965	77.5	1/2	41
India	Vadu	2003	nd	nd	3
Indonesia	Purworejo	2003	50	3	3
Thailand	Kanchanaburi	1999	45	12	7
Vietnam	FilaBavi	1999	52	3	7
Vietnam	Chililab	2003	64 (pilot: 9.5)	3	3
Oceania					
Papua New Guinea	Wosera	1990	12	1/2	16
Central America					
Nicaragua	Leon	2004	nd	nd	2
nd: no data					
Source: www.indepth-network.org					

1.3. DSS outputs

1.3.1. In terms of data

- Data quality

Demographic surveillance systems generally provide very high quality data for several reasons:

a) the more frequent the survey rounds, the more exact the dates attributed to the events recorded at each round;

b) frequent visits reduce the likelihood of events being left out, especially with events that are easily forgotten (or are not talked about) such as infant deaths, stillbirths and abortions/miscarriages. The records need to rely on respondents' memories only over the short period since the last round;

c) false declarations are minimised by consistency tests, which can be performed in the field at the time of the survey (surveys are generally conducted on the basis of the information already recorded). For example, a woman who is pregnant at one round will be asked after a certain number of months what the outcome of her pregnancy was: live birth, stillbirth, spontaneous or deliberate abortion, or infant death;

d) multiple rounds make it possible to check or add to information at a later round. It is often when the data are analysed that missing data or inconsistencies are revealed. Going back at the next round, the data can be added to or corrected.

- Possibilities for more thorough exploration

Some atypical events or behaviours need to be addressed in a more thorough and qualitative way. The population file makes it easy to find the individuals concerned, so at a later round they can be asked more precise questions, or special interviews can be designed and organised to address that subject. For example, if researchers want to focus on sterility problems, it is easy to select childless women of a certain age and ask them what they think the likely causes of their sterility are. Again, to study neonatal mortality, mothers whose newborns have died can be identified and interviewed. There are many fields of study that are worth an in-depth qualitative examination to achieve a better understanding of the phenomenon. This is one of the major advantages of a DSS.

1.3.2. In terms of results

- Measuring change

By recording data continuously, changes in the nature and intensity of the phenomena can be measured. Indicators of levels of different demographic phenomena can be calculated by year to show annual fluctuations and longer-term trends, which is particularly important for analysing population dynamics (Delaunay, 2002).

- Establishing temporal order

With exact dates one can establish a chronology of the events recorded, even when they follow each other closely. This is particularly useful when an event is qualified in relation to another event (births are qualified according to their relation to a marriage event: they may be premarital or marital, for example).

- Causal interpretations

It is also temporal order that makes it possible to establish causal relations between events. A causal relation is necessarily defined in time, by observing the successive occurrence of two events, the earlier one being the cause, the later one the effect.

The degree of precision in recording the chronology of events is therefore crucial. With continuous, precise observation of individuals it is possible to analyse causal relations (e.g. the effect of a pregnancy on the weaning of the previous child or vice versa, or the impact of migration on health and fertility behaviour).

1.4. The limits of DSSs

While DSSs have many advantages, they also have some limitations.

1.4.1. In terms of data

- Observation is limited to a specific window in time and space.

Individuals are observed in a given area and over a given period of time. No data are gathered on their vital events before they come into the survey area or during any periods they spend outside it. To make up for this, some sites use retrospective surveys to fill out respondents' marital and reproductive histories. Once an individual leaves the survey area, no further event in their lives is recorded.

Because of the difficulty of monitoring mobile individuals, the DSS system is not well suited for use in areas of high population turnover.

- Effect of continuous presence

Certain biases can be linked to the repetition of the survey rounds over time and the almost permanent presence of a team of data collectors. It is not easy to measure the magnitude of these biases.

- Direct or indirect observation

While most sites base data gathering on direct interviews in households, a few[5] use key informants. This has the advantage of reducing data collection costs but is obviously more susceptible to biases in reporting (under-declaring, poor dating).

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[5] This method was used experimentally in the 1970s but is now increasingly abandoned.

1.4.2. In terms of results

- Variations in interval between rounds

Changes in the frequency of survey rounds during the follow-up period (frequency depends on funds and on the goals of ongoing programmes) can have a direct impact of the levels of the indicators measured. Frequent visits produce more exact dates and less under-declaring of some events (births quickly followed by infant deaths, for example).

- Variation in residence rules

Changes in the definition of residence and rules on migration can lead to an artificial break in the data series. Any such change has an impact on the calculation of the population at risk, which is the denominator for the rate.

- Sites are too diverse for easy comparison

Every site has a particular history. It has been set up for a specific project which has modelled the data collection characteristics. The interval between rounds is variable, the historical scope is never the same, populations differ in size, residence rules differ. All these differences can limit the possibilities for comparative analysis, and this must be taken into account.

1.5. Particularities of DSS data

1.5.1. Minimum data

Individuals resident within the demographic surveillance area at the time of the baseline survey are given an identifier (often a number made up of different zones from which their address can be found: village number + compound number + individual's number, for example). Their sex is recorded and their date of birth estimated.

After that, the minimum record required for a Demographic Surveillance System is that of entries into and exits from the survey area, which makes it possible to establish the size of the resident population at any moment during the follow-up period. Entries include births and in-migrations, exits include deaths and out-migrations. New entrants are given an identifier according to the rules of the database and the date of the event is recorded. Births are linked to the mother's identifier. Exits are linked to the identifier of the individual who leaves or dies, and the date of exit is recorded.

These minimum data, the record of entries and exits, provide a general measure of mortality, fertility and migration.

By calculating person-years lived in the area (see below) a close analysis can be made of the resident population, and crude rates of mortality, birth and migration (i.e. the ratio of the number of events to the total population) can also be calculated.

Mortality can also be analysed by age and sex from these minimum data. The precise date of death is known and the birth date can be subtracted to give age at death; sex is also known. The data also give precise denominators (in person-years) for calculating rates.

As regards fertility, the age-specific fertility rate can be calculated from the minimum data, and the mother's age at the time of the birth can be deduced from the difference between her birth date and the baby's.

1.5.2. Additional data

However, additional information is needed to answer the various research questions that justify this type of observation. The type of information depends on the particular research programmes that are using the DSS in question.

Some additional information concerning vital events can be collected. When a birth is recorded, the father's identifier or the childbirth conditions (place, assistance, cost etc.) can be recorded. Sometimes deaths are documented more precisely by recording the circumstances surrounding the death, the history of the illness and the medical treatment protocol. The questionnaire used for this is called a 'verbal autopsy' (Gray *et al*, 1990; Snow and Marsch, 1992). Its purpose is to establish the likely cause of death. Migrations records may include the place of destination or provenance and the reason for the move.

To take account of the social and economic background, individual characteristics such as religious affiliation, educational level and occupation may be recorded, as may household characteristics such as sanitary equipment and farm implements.

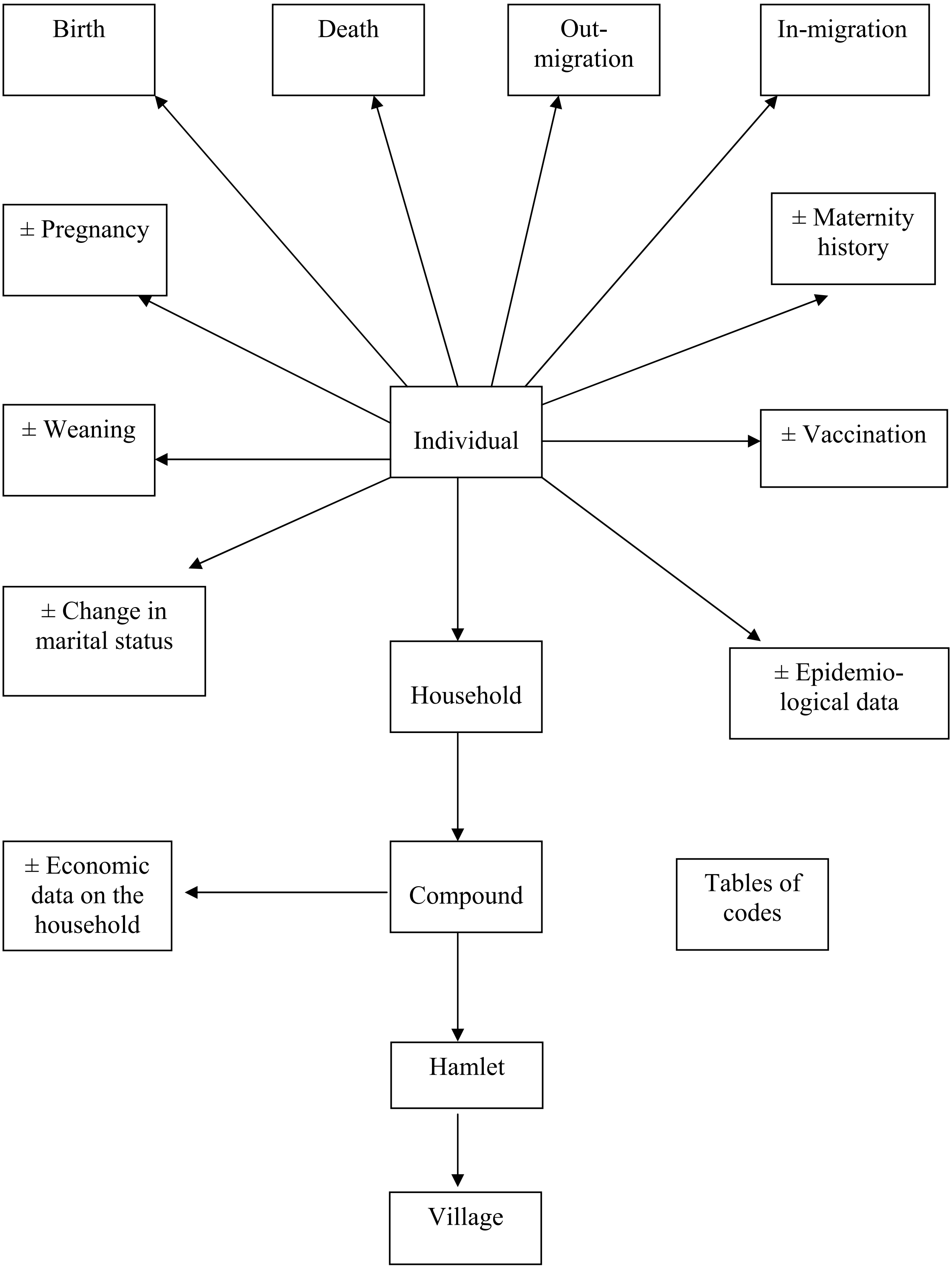
Individuals' behaviour can be better understood if their histories are known. Any study looking at healthcare behaviour (prevention or use of available care), patterns of migration, education, farming practices etc. needs to gather information about the past, prior to the window of observation. This may mean recording data on individuals' residential, reproductive, marital, occupational and educational histories, their history of contraceptive use, etc. − information that makes it possible to track past events and follow the subsequent history using the data collection system.

1.6. Organisation of the data

DSSs are monitoring systems that gather data on a prospective basis, using the principle of frequent update rounds. Survey rounds can also be used to gather retrospective information for a specific study.

Today, *prospective* data are usually organised in the form of relational databases. These have a table for each event recorded, and these tables are organised around a central table representing the individual's different periods of residence in the survey area. The link between the different tables is the individual's identifier (Figure 1).

Figure 1 – Organisation of a database



The databases are processed using a database management software package such as Dbase, VisualFoxpro, Access or SQL, and some use an application specially developed for this type of data (HRS2[6]).

1.7. Use of GISs

More and more DSSs are using geographical information systems (GISs) to display the various indicators on maps and to provide for spatial analysis of the data.

The principle used is to represent the data on different layers on a blank map: administrative boundaries, road networks, geographical coordinates of social and collective facilities, geographical coordinates of housing units, etc. With a GIS, facilities can be accurately located and distances and routes calculated for the purposes of spatial analysis. This is useful for

- measuring the accessibility of services;
- estimating the catchment area of an infrastructure;
- determining the spatial organisation of phenomena studied, such as the modes of propagation of an epidemic;
- analysing interactions between different places studies, etc.

[6] Household Register System (Phillips *et al.*, 2000).

2. Fertility indicators and how they are measured

Various indicators can be used to measure a population's fertility level. The most rudimentary is the *crude birth rate*, which is calculated by relating the number of recorded births to the mean population of the area over the same period, regardless of age and sex. This indicator has the advantage of requiring little information, just annual births and mean annual population size. But it is not very satisfactory from an analytical standpoint because many people included in the denominator (men, older women, children) are not contributing to births. This means that it is highly sensitive to the age and sex structure of the population. The crude birth rate is nonetheless widely used for estimating a population's growth potential.

A second, less widely used indicator is the *general fertility rate*. This is the ratio of births to the mean number of women of childbearing age over the same period. Unless the age and sex structure of the population undergoes a major disruption at some point in time, the general fertility rate and crude birth rate should follow the same trend.

The most commonly used indicator is still the average number of children per woman. This is called *completed fertility* and is the most accurate measure of fertility. It is measured in terms of the number of times women have actually given birth in their lifetime, so to obtain it a generation has to have reached the end of their childbearing years (age 54 to 59). It is usually obtained by tracing women's reproductive histories retrospectively. However, the situation it reflects is a past situation. To characterise the contemporary fertility rate, demographers take a cross-sectional approach which enables them to observe the current fertility levels of different generations of women. The resulting indicator represents the completed fertility of a hypothetical generation that combines the fertility levels of women of all age groups at a given time. This is the *total fertility rate* (*TFR*).

Before examining in greater detail how these indicators are calculated, it will help to consider the different events involved in the reproduction process, how concepts are defined and the rules for recording events.

We will not here discuss the complete reproductive histories that some DSSs record, and which allow a longitudinal analysis of fertility. However, this is a very useful approach if the necessary data are available.

Nor will we discuss the application of event history analysis methods to demographic surveillance data, which also requires a reconstitution of individual reproductive histories. This is the subject of a separate CEPED publication in the same series (Bringé and Laurent, 2005).

2.1. Direct events: pregnancies, births, abortions and still-births

Although births are among the vital events recorded by all DSSs, this is not the case of pregnancies, deliberate and spontaneous abortions or still-births.

2.1.1. Definitions of concepts

A *pregnancy* is difficult to record, especially in societies where the custom is not to take notice of them until they are visible. Pregnancies are generally declared late and some remain undeclared. It is also a problem for the interviewer to determine the date when the pregnancy began. Such data cannot easily be made use of.

Pregnancies are generally recorded in order to improve data collection. By recording pregnancies one can make sure their outcome is correctly recorded. Spontaneous or deliberate abortions and still-births, and even early neo-natal mortality, are often under-declared (Mazuy and Lelièvre, 2005), and the longer the time gap between the event and the survey round, the more likely they are to be undeclared. Where pregnancies are recorded, the system can be alerted when a recorded pregnancy is not followed by a recorded outcome within a consistent time interval (under 7, 8 or 9 months depending on the system).

A birth is generally given a very precise definition that distinguishes it from a still-birth or abortion: if the baby gives a sign of life (breathing, crying) this is considered a *live birth* even if the baby lives only a few minutes. If it shows no sign of life but was a viable fœtus (over 6 months or 180 days of pregnancy) it is classed as a *stillbirth*. If not viable by the same definition it is an *abortion*. Abortion is taken in its clinical meaning, i.e. whether spontaneous (miscarriage) or deliberate. Although these distinctions are clear from the theoretical standpoint, they are difficult to establish in practice; the interviewer cannot easily distinguish between a stillbirth and an abortion, or between deliberate and spontaneous abortion − this latter distinction requires a special approach, studying the local terminology and making a qualitative study of local practices, etc.

The child's *birth order* and the mother's *parity* are calculated purely on the basis of the mother's live births, including those outside the marriage. This is an essentially biological measurement.

2.1.2. Data recording

Pregnancy records cannot reasonably be analysed because the events involved are under-reported. Early abortion (spontaneous or deliberate) is especially likely to be under-reported. Unless the woman declares it, the interviewer and even the woman's contact circle will be unaware of it.

The events that can be recorded, measured and used to produce indicators are stillbirths and live births.

As regards measuring fertility, only live birth data are used. Stillbirths are not taken into account. Stillbirths are analysed in terms of late fœtal mortality, which will not be discussed here.

2.2. Intermediate variable: marriage

Fertility can be analysed more closely if the marital status of the mother at the time of the birth is taken into account. Marriage is regarded as generally marking the start of fertile sexual activity. Later marriage will therefore favour a drop in fertility. However, behavioural trends in many societies show a degree of dissociation between marriage and fertility (Bledsoe and Cohen, 1994; Delaunay and Guillaume, 2007). Births before marriage are on the increase, so premarital fertility is emerging in countries where formerly it did not exist. This type of fertility can be linked to a wide range of different situations, and distinctions should be made between these in any analysis.

Thus some DSSs now record marital status and any changes in marital situation that occur during the follow-up period.

2.2.1. Definitions of concepts

In many of the societies where there are DSSs, *marriage* is more like a process than an event. However, the requirements of a DSS often mean that only one step in the process is recorded. It may be the final stage, or when the marriage is recorded in the civil register if this is done. The record may also be based simply on the declarations of the individuals themselves. The type of union (monogamous or polygamous) may be recorded, as may the woman's rank in the union.

The term *never-married* is self-explanatory.

Individuals are *divorced* if they have been married, are not currently married, and their spouse was alive at the time of the separation. A polygamous man may be divorced from one wife but still married to another; in this case they are still considered to be married and only their ex-wife is considered divorced.

Individuals are *widowed* if they have been married but no longer are, their spouse having died. A polygamous man may be widowed from one wife but still married to another, in which case he is considered to be married.

2.2.2. Recording marital events

The rules for recording marital events are highly sensitive to the definition of marriage adopted; this will also determine how divorce is recorded. Widowhood presents fewer problems because it is connected with the death of an individual and this corresponds to a precise date.

The rules adopted for recording events must therefore be taken into consideration in any analysis of marital events. They vary from site to site and this must be taken into account in any comparative analysis. Marriage is an important factor for analysing fertility, because it determines the nature of the fertility: marital *versus* premarital.

3. Overall fertility

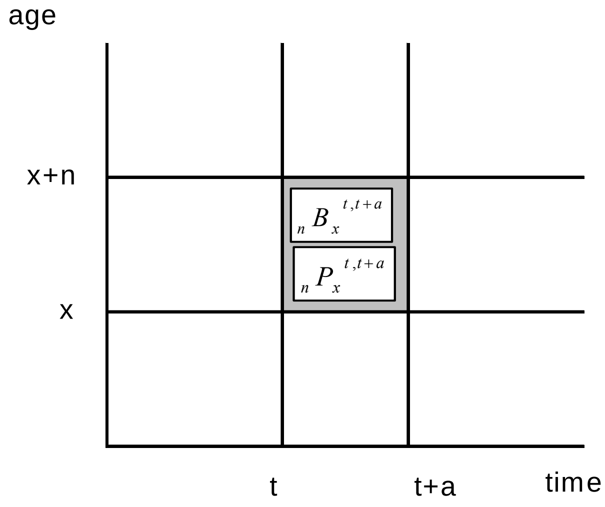
3.1. Introduction

The analyses presented here are based entirely on prospective recording and aggregate data from DSSs and not any retrospective individual data (reproductive histories) that may have been reconstituted (Bringé and Laurent, 2005).

Demographic analysis of fertility is performed by calculating indicators based on the recording of live births, the main one being the *total fertility rate (TFR)*. Other indicators concern birth interval and birth order; these are not addressed in this handbook.

The TFR is obtained by the sum of the age-specific fertility rates. It expresses the average number of children per woman and represents the number of children a woman would bear if she spent all her childbearing years living in the same conditions as pertain at the time of the observation. Age-specific fertility rates are obtained from the ratio of number of births of mothers aged x to $x+n$ to the population of women aged x to $x+n$ at risk (Figure 2). Five-year age groups are often used, in which case $n = 5$. However, any other interval may be chosen. Similarly, the calculation is made for a follow-up period from time t to time $t+a$, for which any time interval may be used.

Figure 2 – Factors for calculating age-specific fertility rate



The fertility rate between ages x and x+n is expressed by relating all births occurring between the first and last birthdays in the time interval under consideration, to the total average population of the generations concerned, including all women[7], using the following formula:

$$ {}_nF_x^{t,\ t+a} = \frac{{}_nB_x^{t,\ t+a}}{{}_nP_x^{t,\ t+a}} \qquad [1] $$

And the total fertility indicator is calculated using the following formula:

$$ TFR^{\ t,\ t+a} = \sum_{x=10}^{50} n.\ {}_nF_x^{t,\ t+a} \qquad [2] $$

where

B = number of births
P = female population
F = fertility rate
x = lower limit of age group
n = age group span
t = lower limit of period
a = length of period

[7] This rate relates events to a whole population and not to the population at risk of that type of event (Pressat, 1983).

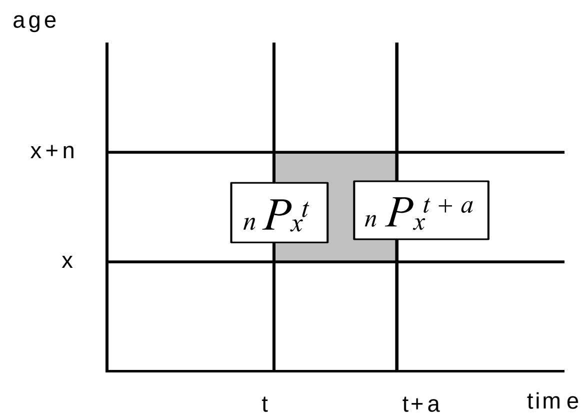
For more details on demographic analysis methods, see the basic books by Roland Pressat (1983), Christophe Vanderschrick (1995), Henri Leridon and Laurent Toulemon (1997), and Samuel Preston *et al.* (2001).

3.2. Reference population

3.2.1. Mean population

There are several ways of estimating the reference population within a given age group. The simplest is to calculate the mean population of individuals matching the required characteristics, in this case all females who were between ages x and $x+n$ between dates t and $t+a$ (Figure 3).

Figure 3 – Factors for calculating mean population



The reference population will therefore be estimated by the arithmetical mean of the populations recorded at dates t and $t+a$, using the following formula:

$$ {}_n\hat{P}_x^{t,\ t+a} = \frac{{}_nP_x^{t} + {}_nP_x^{t+a}}{2} \qquad \text{[D.1]} $$

where

P = female population
x = lower limit of age group
n = age group span
t = lower limit of period
a = length of period

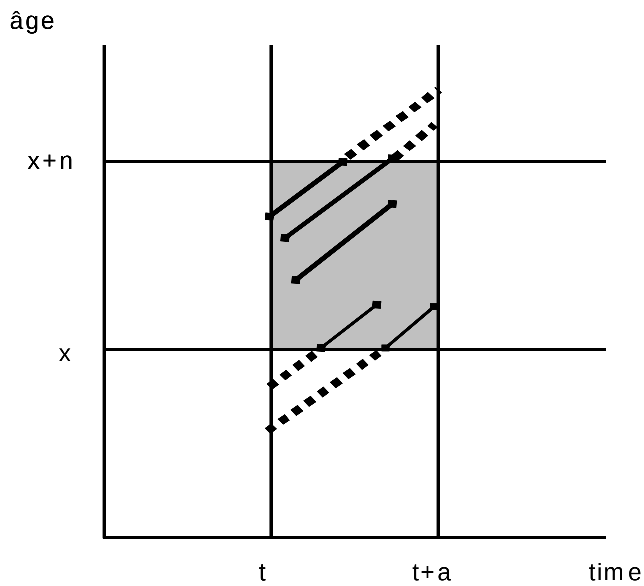
This indicator gives an estimation of the resident population over the period in question. However, it can be greatly refined if one knows the exact dates of entry to and exit from the population, which is the case with DSS data. Here the terms used are *person-years* or *person-years lived in the area*.

3.2.2. Person-years

The principle here is to calculate precisely the length of time an individual stays in the survey area, between two dates and two ages. If individuals are continuously resident between times *t* and *t+a*, they will be counted for *a* person-years; if they are resident for one year they will be counted for one person-year; if they stay only three days they will be counted for 3/365.25 person-years.

These person-years must then be divided between before and after their x^{th} birthday and between before and after their $x+n^{th}$ birthday so that they can be counted in the correct age group (Figure 4).

Figure 4 – Calculating person-years for different residential histories



This means calculating for each individual the number of years lived in the survey area during the reference period and between two birthdays.

$$ {}_n\hat{P}_x^{\,t,\ t+a} = {}_nPY_x^{\,t,\ t+a} \qquad \text{[D.2]} $$

The reference population will then be estimated from the number of years' residence in the area of women who were aged *x* to *x+n* between dates *t* and *t+a.*

3.3. Calculating fertility rates by age group and total fertility rate

To calculate fertility rates, the number of births per time interval and per maternal age group must be known. Thus, if the fertility rates are to be calculated for each year of the demographic surveillance, one must calculate the birth frequencies for each age group concerned, year by year. The number of person-years for each age group and each year of observation must also be known.

The data can then be entered on an Excel spreadsheet from which the necessary calculations can be made and the rates computed.

3.3.1. Calculating person-years

There are several ways to programme the calculation of person-years and fertility rates. Here we refer to programming under the Dbase/Foxpro environment, but it can of course be done using other languages.

The principle is to increment a counting matrix defined by age group and time period for a given population. The programme counts the exact length of time spent in the area for each age group, during the period considered and between the two birthdays that define the age group. For example, one can calculate the number of women who were living in the survey area between 1998 and 2000 and were then between their 15th and 20th birthdays, between their 20th and 25th birthdays, etc.

The programme is shown in Annex 1 (`womenpy.prg`). It uses a file called *residant* which corresponds to the table of residence periods in the survey area, consisting of one line per stay, specifying the entry and exit dates; the same individual may therefore figure on several lines if they spent more than one residence period in the area (Table 2).

Table 3 gives an example summarising the residential histories of two women. The first woman, registered as number 24,527, lives in village 17, compound 55. This woman was present for the baseline survey in 1983. She moved away (out-migration) in March 1989. She returned to her compound in May 1994, and in July 1996 moved to another compound in a neighbouring village. The second woman, registered as number 24,581, was also present for the baseline survey, and also moved away (out-migration) for a period (from May 1988 to October 1989). Then in June 1992 she moved to a neighbouring compound in the same village, but in May 2001 moved back to her original compound, where she still lives.

The programme produces a table in FoxPro format (womenpy.dbf) which gives for each year and each five-year age group[8] the number of years the women lived in the area. This table can be easily read under Excel and can be transposed to Excel format (womenpy.xls).

Table 2 – Structure of the residence periods file – example from the Niakhar DSS – file *Residant.dbf*

FIELD	CONTENT
Vil	Village number
Comp	Compound number
Id	Individual identification number
RP	Number of residence period
Sex	Sex code F = female M = male
Dob	Date of birth
Entry	Type of entry 11 = baseline survey 12 = birth 13 = immigration 62 = change of address within survey area
Daten	Date of entry
Exit	Type of exit 91 = still resident 71 = out-migration 61 = change of address within survey area 51 to 55 = death
Datex	Date of exit

Table 3 – Content of residence periods file – example from Niakhar DSS – file *Residant.dbf*

VIL	COMP	ID	RP	SEXE	DOB	ENTRY	DATEN	EXIT	DATEX
17	55	24527	1	F	01/11/1977	11	30/03/1983	71	15/03/1989
17	55	24527	2	F	01/11/1977	13	19/05/1994	61	06/07/1996
4	14	24527	3	F	01/11/1977	62	06/07/1996	91	31/12/2010
17	61	24581	1	F	29/12/1976	11	28/03/1983	71	23/05/1988
17	61	24581	2	F	29/12/1976	13	13/10/1989	61	15/06/1992
17	4	24581	3	F	29/12/1976	62	15/06/1992	61	15/05/2001
17	61	24581	4	F	29/12/1976	62	15/05/2001	91	31/12/2010

[8] Time periods and age groups can of course be altered.

3.3.2. Numbers of births

There are several ways of calculating birth numbers, using statistical software or a Dbase/Foxpro programme.

In the births table (Table 4), care must be taken to add the age of the mother at the time of the birth. There must therefore be a data field for the mother's date of birth (*mdob*).

Table 4 – Structure of births file – example from Niakhar DSS – file *Birth.dbf*

FIELD	CONTENT
Vil	Village number
Comp	Compound number
Id	Individual identification number
Idmother	Mother's individual identification number
Sex	Sex code F = female M = male
Dob	Date of birth
Mdob	Mother's date of birth

The mother's age at the time of the birth (*magebirth*) is calculated by subtracting the mother's birth date from the child's and dividing by 365.25 (i.e. the average number of days in a year):

$$magebirth = \left[\frac{(dob - mdob}{365.25} \right] \qquad [3]$$

Five-year age groups are generally used (*magebirthg*), and can be calculated as follows (int = integer part):

$$magebirthg = \text{int}\left[\frac{(dob - mdob)}{365.25 * 5} \right] \qquad [4]$$

The results are then labelled as follows:

2	10-14 yrs
3	15-19 yrs
4	20-24 yrs
5	25-29 yrs
6	30-34 yrs
7	35-39 yrs
8	40-44 yrs
9	45-49 yrs
10	50-54 yrs

Using the births table to tabulate the *magebirthg* variable against the date of the birth gives a table showing the number of births by year and by mother's age group.

Example using Stata:

```
gen magebirthg=int((dob-mdob)/365.25*5)
gen yob=year(dob)
tab magebirthg yob
```

The result produced by Stata can be copied into a text file, which can then be read under Excel.

The numbers of births can also be obtained with a Dbase/Foxpro programme. The principle is to increment a counting matrix defined by age group and time period for a given population. The programme can be used to count the number of births for each maternal age group, within the period concerned. In this way one can calculate the number of births between 1995 and 2000 to mothers aged 15 to 19, 20 to 24, etc. The programme `Birthmother.dbf` shown in Annex 2 produces a table showing the number of births by maternal age group, for each year. This table can be read by Excel and saved in .xls format, or transferred using the Stat/Transfert software.

3.3.3. Fertility rates by age group

The fertility rate for each age group is obtained using formula [1], where the reference population is estimated in person-years lived in the area (calculation [D.2]):

$$ {}_nF_x^{t,\, t+a} = \frac{{}_nB_x^{t,\, t+a}}{{}_nPY_x^{t,\, t+a}} \qquad [1.1] $$

where

B = number of births
PY = female person-years
x = lower limit of age group
n = age group span
t = lower limit of period
a = length of period

This means relating the data in table `womenpy.xls` to those in table `birthmother.xls`. This can easily be done with Excel, for example. In this way a spreadsheet can be formatted that will produce the various fertility indicators: total fertility rate, mean age at childbearing (see below).

Calculation of the rates can also be programmed. An example programme under FoxPro is shown in Annex 3.

3.3.4. Total fertility rate

The total fertility rate is obtained using formula [2], presented in section 3.1 above:

$$TFR^{\,t,\,t+a} = \sum_{x=10}^{50} n.\ {}_nF_x^{\,t,\,t+a} \qquad [2]$$

3.4. Mean age

Several indicators of mean age can be calculated (Vandeschrick, 1995).

One is the *mean age of mothers at the birth of their child*. This is the weighted mean of reproductive ages by numbers of births at corresponding ages, over a given period [*t*, *t*+*a*][9]:

$$\overline{AB} = \frac{\sum_{x=10}^{50} \bar{x}.\ {}_nB_x}{\sum_{x=10}^{50} {}_nB_x} \qquad [5]$$

where

B = number of births
x = lower limit of age group
n = age group span
$\bar{x} = \frac{2x+n}{2}$ = central age of age group

But this indicator is affected by the population's age structure and makes it more difficult to compare different populations. For example, supposing a population where the youngest women of childbearing age leave the area (e.g. because of large-scale migration), the births recorded would give a much higher mean age at the birth of the child, but this would not reflect a real change in fertility behaviour patterns.

This indicator does have the advantage that it can be calculated directly from the file of births by mean age of mothers. In this case it is calculated from the age in years (and not age groups) and is more precise.

---

[9] To simplify the notation, the mention of period has been omitted in the following formulae.

Example under Stata:

```
gen agemnaisa=int(((dob-mdob)/365.25))
tab annais, sum(agemnaisa)
```

Nonetheless, the indicator most often used is *mean age at childbearing*. This is the weighted mean of reproductive ages by fertility rates at corresponding ages:

$$\overline{AB'} = \frac{\sum_{x=10}^{50} \bar{x}\,.\, {}_nF_x}{\sum_{x=10}^{50} {}_nF_x} \qquad [6]$$

where

F = fertility rate
x = lower limit of age group
n = age group span
$\bar{x} = \frac{2x+n}{2}$ = central age of age group

This calculation method gives satisfactory results from data sets by year of age. It can be performed on age-group-specific data sets by taking the centre of the age group as the mean age. This assumes that births are evenly spread across the age group, but in fact there is a strong correlation between births and maternal age, so this can create a bias in the estimation of mean age. However, the advantage of this indicator is that it is not affected by the age structure of the population; it is therefore the one generally used to compare the fertility age structures of different populations.

3.5. The Excel spreadsheet

Once it has been set up, the principle of the Excel spreadsheet can be used to rapidly obtain fertility indicators simply by modifying the numbers of births and person-years for a new time period or for a sub-group of the population. This spreadsheet is shown in Annex 4. The advantage of the Excel spreadsheet is that one can include calculation of total fertility rate, mean age at childbearing and mean age of mothers at the birth of their child.

4. Primo-fertility

4.1. Definitions

In every society, the arrival of a first child is a mark of passage into adulthood. It gives the individual the status of ‘parent’, which entails a certain number of rights and duties in society. While social norms usually require the first child to be born in wedlock, circumstances have now changed in North and South alike. Young people’s behaviour everywhere is tending towards an increase in premarital sex, very often unprotected. Unwanted premarital pregnancies have major social and health implications. One way of partially analysing this issue is to provide indicators for first childbirth that take into account the marital situation of the mother at the time of the birth and at the time of conception.

DSS data generally provide the basis for producing *primo-fertility rates* by age group (or *first-birth rates* by age group). All that is needed is for *birth order* to be recorded. This indicator gives information on the mother’s age at her first childbirth, and trends in this indicator reveal behavioural changes. But this provides little information about the circumstances of the first childbirth. Rates of first birth at young ages may decline following a shift towards delaying marriage. In that case the trend would be an automatic result of later marriage, postponing childbirth, with first births still always occurring in wedlock. But a change in age at first birth may be unrelated to age at marriage. First birth may take place at the same age, or earlier, whereas women are marrying later. In that case the circumstances of the first birth will have changed radically, occurring out of wedlock and hence in a different social situation. Primo-fertility indicators will not show this change and it is important to recognise the limitations of such an indicator.

If the DSS records marriages, it is possible to calculate the *premarital primo-fertility rates*. This indicator will be far more informative about the changes younger generations are going through in terms of sexuality and childbearing. The minimum data required are individuals’ marital status on entry to the survey area and any changes in marital status during their stay.

4.2. Primo-fertility by age group

Age-specific primo-fertility rates are calculated in the same way as age-specific fertility rates. In this case the number of first-order births is related to the number of women at risk of bearing a first child, i.e. the number of childless women. It is calculated in person-years.

In calculating fertility rates the calculation of person-years takes into account exits by out-migration or death. But here, exits by childbirth must also be considered, since a woman who has already given birth is no longer 'at risk' of a first birth. Here the term used is person-years of childlessness. *Age-specific primo-fertility rates* are expressed as follows:

$$ {}_nF_{1x}^{\,t,\,t+a} = \frac{{}_nB_{1x}^{\,t,\,t+a}}{{}_nPYc_x^{\,t,\,t+a}} \qquad [1.2] $$

where

B_1 = number of first-order births
PYc = female person-years of childlessness
x = lower limit of age group
n = age group span
t = lower limit of period
a = length of period

4.2.1. Calculating first births

It is easy to identify first births if the DSS records birth order. If it does not, but does record women's reproductive history when they enter the survey area, births in the database can be compared with these data to deduce birth order.

Once birth order has been attributed, it is easy to break down births by mother's age group and the year of the birth (${}_nB_x^1$).

4.2.2. Calculating person-years of childlessness

This operation involves a longer file preparation phase. The table of residence periods, which includes individuals' entries and exits, is usually an integral part of the database. Here it must be linked to the information on first births (Table 5). This operation can be performed in various ways depending on the particular features of each database.

Table 5 – Structure of residence periods file taking into account exits by **first birth** – example from Niakhar DSS – file *Residpf.dbf*

FIELD	CONTENT
Vil	Village number
Comp	Compound number
Id	Individual's identification number
RP	Number of residence period in survey area
Sex	Sex code F = female M = male
Dob	Date of birth
Entry	Type of entry 11 = baseline survey 12 = birth 13 = immigration 62 = change of address within survey area 15 = entry by 'first birth'
Daten	Date of entry
Exit	Type of exit 91 = still resident 71 = out-migration 61 = change of address within survey area 51 to 55 = death 15 = exit by 'first birth'
Datex	Date of exit
Parity	Parity 0 = zero parity 1 = parity 1 or over

A file of births is required in which birth order is shown. It is important to identify first births in order to take account of women who leave the childless category due to entry into motherhood.

The two examples shown earlier need to be complemented with information on first birth. Table 6 shows that the first woman (24,527) gave birth to her first child in January 1997 and the second (24,581) in October 1995.

Once the file has been prepared, the programme described above (`womenpy.prg`) can be adapted (see variant 1 of the programme in Annex 1). To calculate person-years of childlessness, only one condition needs to be added in order to select only those residence periods during which the women is zero parity (parity=0). Parity is zero for all residence periods prior to an entry under code 15 ('first birth').

Table 6 – Content of file of residence periods taking into account exits by **first birth** – example from Niakhar DSS – file *Residpf.dbf*

VIL	COMP	ID	RP	SEX	DOB	ENTRY	DATEN	EXIT	DATEX	PARITY
17	55	24527	1	F	01/11/1977	11	30/03/1983	71	15/03/1989	0
17	55	24527	2	F	01/11/1977	13	19/05/1994	61	06/07/1996	0
4	14	24527	4	F	01/11/1977	62	06/07/1996	15	25/01/1997	0
4	14	24527	5	F	01/11/1977	15	25/01/1997	91	31/12/2010	1
17	61	24581	1	F	29/12/1976	11	28/03/1983	71	23/05/1988	0
17	61	24581	2	F	29/12/1976	13	13/10/1989	61	15/06/1992	0
17	4	24581	3	F	29/12/1976	62	15/06/1992	15	08/10/1995	0
17	4	24581	3	F	29/12/1976	15	08/10/1995	61	15/05/2001	1
17	61	24581	4	F	29/12/1976	62	15/05/2001	91	31/12/2010	1

15 being the code used for exit from and entry to residence period by first birth

4.3. Taking marital status into account

When marital status is taken into account the *premarital primo-fertility rates by age group* can be calculated. This takes into account premarital first-order births. The person-years calculated must in this case take into account not only exits by childbirth, but also exits by marriage (person-years of never-married childlessness)[10].

$$_{n}pF_{1x}^{\ t,\ t+a} = \frac{_{n}pB_{1x}^{\ t,\ t+a}}{_{n}PYnmc_{x}^{\ t,\ t+a}} \qquad [1.3]$$

where

pB_1 = number of first births occurring before marriage
PYnmc = female person-years of never-married childlessness
x = lower limit of age group
n = age group span
t = lower limit of period
a = length of period

[10] We are not here addressing the issue of 'legitimate' versus 'illegitimate' births, but the reasoning can be extended to those concepts. Illegitimate birth rates by age group can be obtained by relating births out of wedlock (regardless of birth order) to person-years of unmarried life (i.e. including never-married, divorced and widowed).

Here the approach is the reverse, preparing first of all the residence period file taking exits by first marriage into account. This reveals marital status (never-married or otherwise) at the time of first birth.

4.3.1. Calculating person-years of never-married childlessness

The file of residence periods must now be linked to information about first marriage. A file of marriages showing marriage order is therefore required. It is important to identify first marriages in order to take account of women who leave the never-married childless category due to entry into marital life (Table 7).

Our two examples need the further addition of information about first marriage. Table 8 shows that the first woman (24,527) married in April 1995, change address in July 1996 and bore her first child in January 1997. The second woman (24,581) married in February 1991, changed address in June 1992, and bore her first child in October 1995. She moved house again in May 2001.

Once the file has been prepared, the programme described above (`womenpy.prg`) can be adapted (see variant 2 of the programme in Annex 1). Only one variable needs to be added to select only those residence periods during which the woman is both never-married and childless (*parity*=0 and *matst*=S) to calculate person-years of never-married childlessness. Marital status will be coded S (single, never-married) for all residence periods before an entry coded 85.

4.3.2. Calculating premarital births

The file of residence stays put together in this way also makes it possible to count the first births (*entry*=15) by year of birth (year(*daten*)), mother's age group (int[(*daten*-*dob*)/365.25*n]) and birth status (*matst*=S or *matst*≠S). Where five-year age groups are used (as is often the case), *n* is replaced by 5.

Table 7 – Structure of the residence periods file taking into account exits by **first birth** and **first marriage** – example from Niakhar DSS – file *Residpf2.dbf*

FIELD	CONTENT
Vil	Village number
Comp	Compound number
Id	Individual identification number
RP	Number of residence periods in survey area
Sex	Sex code F = female M = male
Dob	Date of birth
Entry	Type of entry 11 = baseline survey 12 = birth 13 = immigration 62 = change of address within survey area 15 = entry by 'first birth' 85 = entry by 'first marriage'
Daten	Date of entry
Exit	Type of exit 91 = still resident 71 = out-migration 61 = change of address within survey area 51 à 55 = death 15 = exit by 'first birth' 85 = exit by 'first marriage'
Datex	Date of exit
Parity	Parity 0 = zero parity 1 = parity 1 or over
Marst	Marital status S = single, never-married M = ever-married

Table 8 – Content of residence periods file taking into account exits by **first birth** and **first marriage** – example from Niakhar DSS – file *Residpf2.dbf*

VIL	COMP	ID	RP	SEX	DOB	ENTRY	DATEN	EXIT	DATEX	MARST	PARITY
17	55	24527	1	F	01/11/1977	11	30/03/1983	71	15/03/1989	S	0
17	55	24527	2	F	01/11/1977	13	19/05/1994	85	15/04/1995	S	0
17	55	24527	3	F	01/11/1977	85	15/04/1995	61	06/07/1996	M	0
4	14	24527	4	F	01/11/1977	62	06/07/1996	15	25/01/1997	M	0
4	14	24527	5	F	01/11/1977	15	25/01/1997	91	31/12/2010	M	1
17	61	24581	1	F	29/12/1976	11	28/03/1983	71	23/05/1988	S	0
17	61	24581	2	F	29/12/1976	13	13/10/1989	85	24/02/1991	S	0
17	61	24581	2	F	29/12/1976	85	24/02/1991	61	15/06/1992	M	0
17	4	24581	3	F	29/12/1976	62	15/06/1992	15	08/10/1995	M	0
17	4	24581	3	F	29/12/1976	15	08/10/1995	61	15/05/2001	M	1
17	61	24581	4	F	29/12/1976	62	15/05/2001	91	31/12/2010	M	1

85 being the code used for exit from and entry to residence by first marriage

4.4. Mean age at first birth

In the same way as for overall fertility, various indicators can be calculated in connection with mean age.

One such indicator is *mean age of mothers at the birth of their first child*. This is the weighted mean of reproductive ages by number of first-order births at corresponding ages over a given time period [t, $t{+}a$] [11] :

$$\overline{AB}_1 = \frac{\sum_{x=10}^{50} \bar{x}\,.\ {}_nB_{1\,x}}{\sum_{x=10}^{50} {}_nB_{1\,x}} \qquad [5.1]$$

where

B_1 = number first-order births
x = lower limit of age group
n = age group span
$\bar{x} = \frac{2x+n}{2}$ = central age of age group

This indicator is affected by age structure. However, the more strongly first births are concentrated within a narrow age group, the weaker this impact will be.

[11] To simplify the notation of the following formulae, mention of time interval has been omitted.

It can be calculated directly from the file of first-order births by mean age of mothers. For greater precision it will be calculated using age in years (and not age group).

Example using Stata:

```
gen agemnaisa=int(((dob-mdob)/365.25))
tab annais, sum(agemnaisa)
```

It is also possible to calculate *mean age at first childbearing*. This is the weighted mean of reproductive ages by first-order fertility rates and by corresponding age:

$$\overline{AB'}_1 = \frac{\sum_{x=10}^{50} \bar{x} \cdot {}_nF_{1\,x}}{\sum_{x=10}^{50} {}_nF_{1\,x}} \qquad [6.1]$$

where

F_1 = primo-fertility rates
x = lower limit of age group
n = age group span
$\bar{x} = \frac{2x+n}{2}$ = central age of age group

The tables produced by the programme `womenpy.prg` adapted for person-years of childlessness can be used in an Excel spreadsheet, into which the formula for calculating mean age at first childbirth can be incorporated.

4.5. Typology of first births

The precision of the dating of events recorded during the follow-up period, which is one of the main advantages of a DSS, makes it possible to classify first births in some detail. First-order births can be classified according to the mother's status at conception or at the birth.

4.5.1. Definition

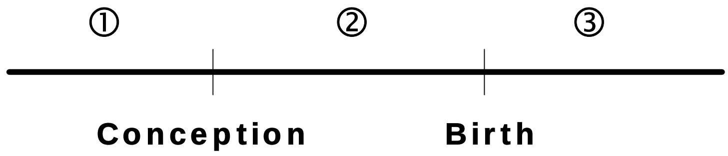
This typology is based on calculating the interval between first marriage and first birth. The date of the first birth is compared with that of the first marriage, so that:

- a negative interval means that the first birth took place before the first marriage; the term used is *premarital birth* (case 3);
- if the interval is positive but is shorter than eight months, the *conception* is considered *premarital* but is '*legitimated*' *before the birth* (case 2);

- if the interval is longer than eight months, both *conception* and *birth* are *marital*[12] (case 1).

Figure 5 illustrates the typology.

Figure 5 – Typology of first births



Marriage in ①	Marital conception Marital birth	8 months <= dob1-dom
Marriage in ②	Premarital conception Marital birth	0<= dob1-dom < 8 months
Marriage in ③	Premarital conception Premarital birth	dob1-dom < 0

Such data suffer from left censoring, unless the complete reproductive and marital histories of the women on their entry to the survey area are available (some DSSs do collect this information). If an unmarried woman moves into the survey area and gives birth to a child less that eight months later, the birth is a marital one but there is no information about the conception. This category is then a missing data item and can be taken into account only for analysing type of birth, not type of conception.

4.5.2. Preparing the files

The reasoning has been applied here to first-order births but could equally well be applied to subsequent births.

For each first birth (identified by '*entry*=15'), the mother's marital status at the time of the birth and at the presumed time of conception can be determined. To do this it must be possible to compare the date of the birth with that of the first marriage if there has been one. If this is not entered on the same line as the birth,

[12] Cases where the interval is between eight and nine months include cases of premature birth of infants conceived in marriage as well as cases of premarital conception. It is difficult to separate the two. We therefore suggest regarding these as marital conceptions to avoid the risk of overestimating the phenomenon.

programming is more difficult (though not impossible). We have therefore opted for a simpler solution, which is to make a file of first-order births and link it to the table of residence periods (*Residpf2.dbf*), as it is easy to locate first marriage in this file (date of first marriage=*daten* for *entry*=85). However, it may be that no marriage has been recorded in the database. In that case, the datum used is the woman's marital status on entry to observation field.

The programme `compbirth1.prg` shown in Annex 5 can be used to draw up this kind of typology by creating two variables, one specifying whether or not the conception is premarital, the other giving the 'type of legitimacy' of the birth.

5. Male fertility

Although male fertility has been little studied to date, it is useful to measure it in order to monitor trends and seek explanations for those trends. Some specific surveys have shown how useful such indicators can be (Donadje and Tabutin, 1994). Where male reproductive histories are recorded, the same methods of analysis can be used as for women, to calculate age-specific fertility rates and total male fertility rate.

But the way births are recorded in DSSs does not always make it possible to perform such analyses. In the first place the father's identification is not always recorded: the infant is usually attributed to its mother, and it is less common for the survey system to include a question that enables the father to be identified. In the second place, a man may be the genitor for a pregnancy not covered by the DSS in question.

Here we will examine the case of systems that do attribute births to fathers, and discuss the limitations. This section is not illustrated with examples.

5.1. Recording births with paternity

When the father of the child whose birth is being recorded is identified, the child is linked to the father's identifier number if he is resident. In this way the births recorded during a time interval can be classed by father and by certain characteristics of the father – age group in particular – in order to calculate men's age-specific fertility rates.

5.2. Biases in the evaluation of male fertility

This calculation would be correct if all births to men resident in the survey area and occurring within the survey area were recorded as such. However, men and women alike may leave the area and the possibility that men have children outside the survey area is an additional observation bias. This bias is all the greater in a polygamous population where the men may be members of two or more different households, not all of which are included in the DSS.

In this case it would be misleading to try to measure male fertility from the DSS data. In any case it is important to take a good measure of the extent of the bias, e.g. by estimating the extent of conjugality outside the survey area. This can be estimated by recording the reproductive and marital histories of a sample of men, for example.

6. Summary

The Table below summarises the various fertility indicators that can be calculated, and the variables needed to do so.

Table 9 – Indicators that can be calculated according to data available

Indicator	Event	Characteristics	Formula
Crude birth rate	Births Entries Exits	Year of entry Year of exit Years of births	*See Chapter 2*
General fertility rate	Births Entries Exits	Year of entry Year of exit Years of births Sex	*See Chapter 2*
Total fertility rate, TFR	Births Entries Exits	Date of entry Date of exit Sex Mother's date of birth Dates of births	[2]
Mean age of mothers at birth of child	Births	Mother's date of birth Dates of births	[5]
Mean age at childbearing	Births Entries Exits	Date of entry Date of exit Sex Mother's date of birth Dates of births	[6]
Primo-fertility rate	Births Entries Exits	Date of entry Date of exit Sex Mother's date of birth Dates of births Birth order	[1.2]
Mean age of mothers at birth of first child	Births	Mother's date of birth Dates of births Birth orders	[5.1]
Mean age at first childbearing	Births Entries Exits	Date of entry Date of exit Sex Mother's date of birth Dates of births Birth order	[6.1]
Premarital primo-fertility rate	Births Entries Exits Marriages	Date of entry Date of exit Sex Mother's date of birth Dates of births Birth order Marital status on entry Marriage order Parity on entry	[1.3]

7. Examples: results from Niakhar DSS data, Senegal

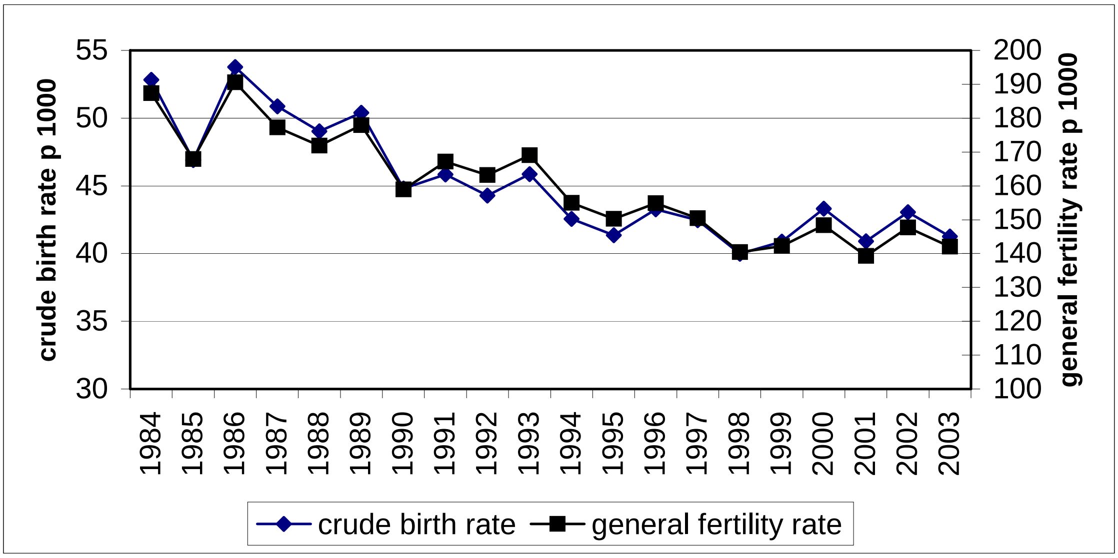
In this section, we present results from Niakhar DSS, Senegal, by way of illustration. Some of these data are available on the project's website[13]. For more information on the data collection methodology of this Demographic Surveillance System, see the website and Chapter 20 of the Indepth network's book (Indepth, 2003). This section does not claim to analyse fertility in the Niakhar DSS but simply aims to illustrate the application of the methods described.

7.1. Overall fertility trends

The crude birth rate and general fertility rate (see Chapter 2, Figure 6) show the same trend over the follow-up period, at different scales. After a period of stability until the late 1980s, both indicators fall and then stabilise again in the late 1990s. These rates correspond to a population that is just starting its fertility transition.

[13] http://www.ird.sn/activites/niakhar/indicators/index.htm

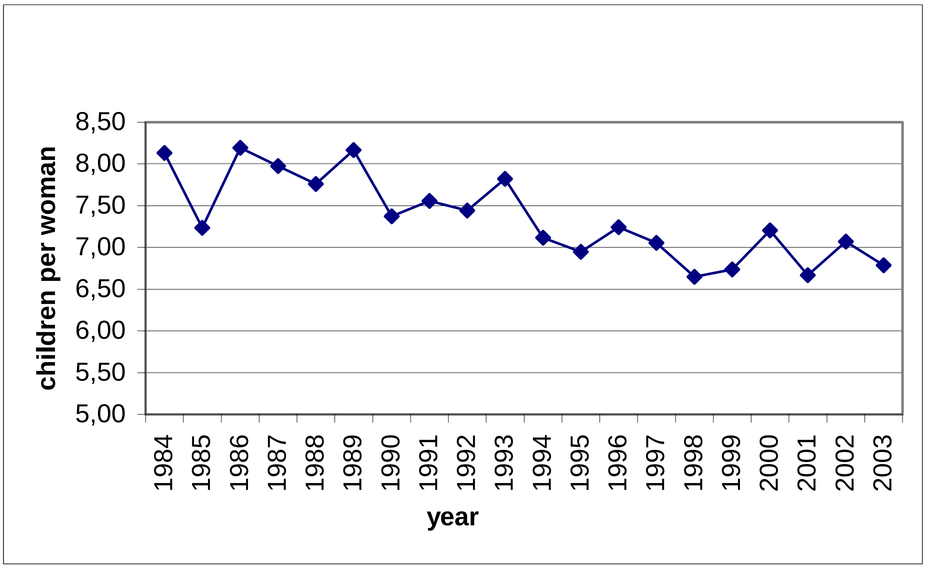
Figure 6 – Crude birth rate and general fertility rate 1984 to 2003



Source: Niakhar DSS

The fertility rate is still very high, with a total fertility rate of about 7 children per women for the most recent period (Figure 7). This indicator fell slightly over the follow-up period, from 8 children per woman in 1984 to 6.8 in 2003. By way of comparison, the total fertility rate is 5.3 for Senegal as a whole and 6.4 for all rural areas (EDS 2005, interim report).

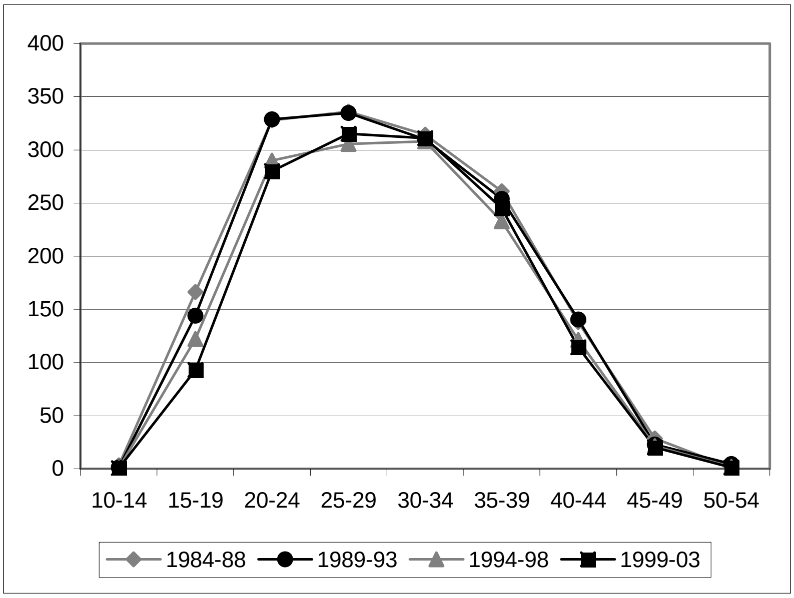
Figure 7 – Total fertility rate 1984 to 2003



Source: Niakhar DSS

The age-specific fertility rates (Figure 8) show that this decline, though perceptible at all ages, is primarily due to trends in the youngest age groups. The surveys of this population have shown that the fertility trend is mainly due to delayed first marriage (Delaunay, 1994). Marriage is still by far the most common social framework for procreation in the survey area, and women who marry later also have their first child later.

Figure 8 – Fertility rates by age group



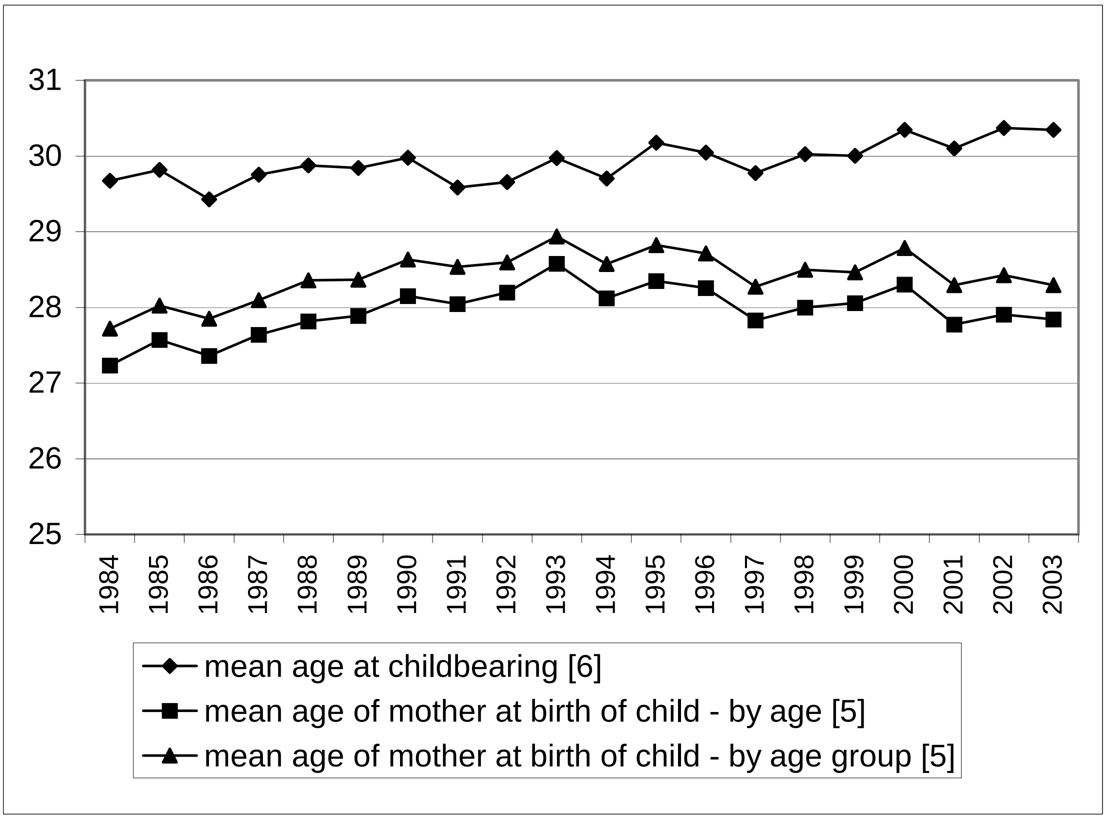
Source: Niakhar DSS

Mean age at childbearing is rising (Figure 9), reflecting the shift in the fertility age structure and the continued high fertility among older age groups.

Mean age of mothers at the birth of their child shows this upward trend over the first part of the period, but a reversal from 1994. As mentioned above, this indicator is sensitive to changes in age structure. A breakdown by age group for the two main periods (Figure 10) shows that, among the most fertile women, the proportion of younger women (age 20-24) is increasing, while that of the older age groups (ages 25-29 and 30-34) is declining. This change in structure could partly explain the alteration in the trend.

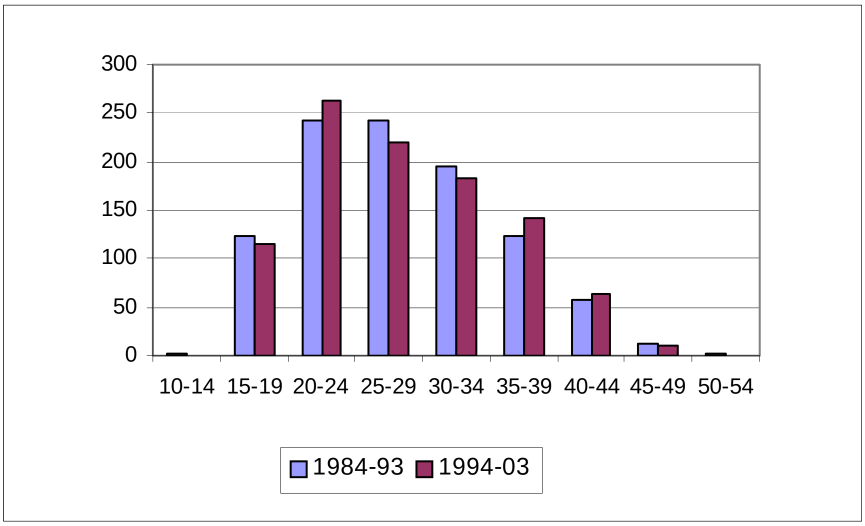
This example highlights the need for caution in interpreting the age of mothers at the birth of their child and justifies the recommendation to use instead the mean age at childbearing indicator, which is less sensitive to changes in age structure.

Figure 9 – Mean age of mothers using different calculation methods



Source: Niakhar DSS

Figure 10 – Structure of female population by age group for two periods



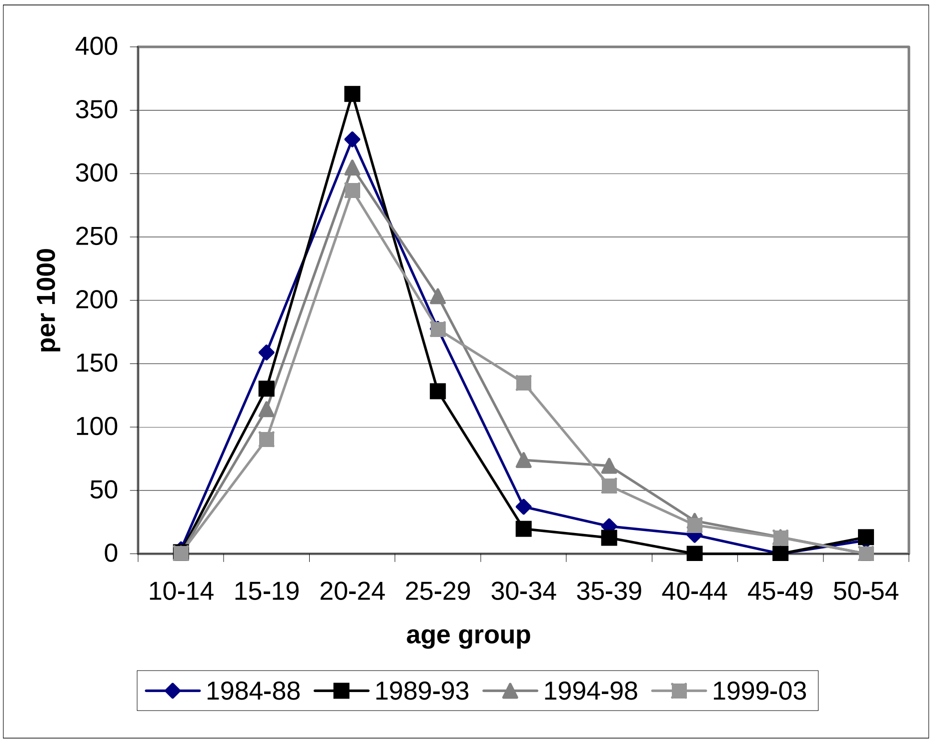
Source: Niakhar DSS

7.2. Primo-fertility

Once the marriage has been celebrated, a young woman and her circle expectantly await the arrival of a child. As all women marry (no women remain single all their lives) and do so between the ages of 19 and 20, it is no surprise to find that mothers of the first-order births recorded in Niakhar are young.

Figure 11 shows that most first births are to young women, with a sharp peak around the ages of 20-24.

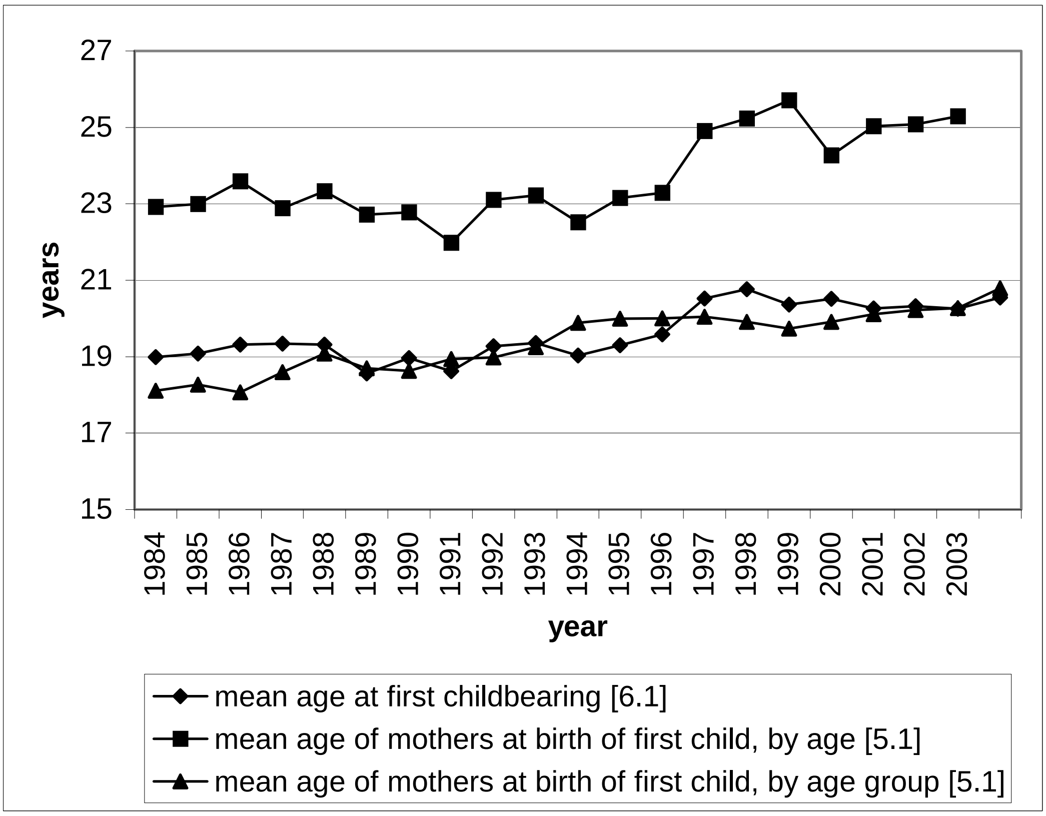
Figure 11 – Primo-fertility rates by age group



Source: Niakhar DSS

The mean age of mothers at first childbearing has risen sharply since 1990. The same trend is found with the other two indicators, which give very similar curves (Figure 12).

Figure 12 – Mean age at first childbearing and at mean age at birth of first child, using different calculation methods



Source: Niakhar DSS

7.3. Premarital primo-fertility

It is useful to find out what proportion of first births take place, or are conceived, before marriage. When a never-married woman falls pregnant, sometimes the marriage takes place quickly, during the pregnancy, to correct a situation that is strongly disapproved of socially. The day of the baptism[14] is also a special moment for celebrating the union. It is the father who pays for the baptism, so acknowledging his paternity; quite often, the marriage is registered on the day of the baptism (Delaunay, 1994). It is therefore possible to distinguish between births according to whether the marriage takes place before or after the pregnancy and the birth, in this instance also distinguishing the particular case of marriages registered on the day of the baptism.

This classification of first-order births according to their timing in relation to the marriage in shown in Table 10.

[14] A child is baptised on the 7th day after the birth; during the ceremony it is given its personal name and family name, so declaring the paternity.

Table 10 – Breakdown of first-order births according to timing in relation to marriage

Status	1984-1988		1989-1993		1994-1998		1999-2003		Total	
		%		%		%		%		%
Premarital birth	137	*15.4*	121	*15.2*	200	*18.1*	200	*16.1*	658	*16.3*
Marriage the day of the baptism	16	*1.8*	24	*3.0*	48	*4.3*	27	*2.2*	115	*2.8*
Marriage during pregnancy	51	*5.7*	30	*3.8*	48	*4.3*	56	*4.5*	185	*4.5*
Total premarital conceptions	*204*	*25.6*	*175*	*23.6*	*296*	*29.0*	*283*	*24.8*	958	*25.9*
Marriage before pregnancy	593	*66.7*	565	*71.0*	723	*65.4*	858	*69.0*	2739	*67.9*
Marital birth, conception NSP	92	*10.3*	56	*7.0*	87	*7.9*	102	*8.2*	337	*8.4*
Total	889	*100.0*	796	*100.0*	1106	*100.0*	1243	*100.0*	4034	*100.0*

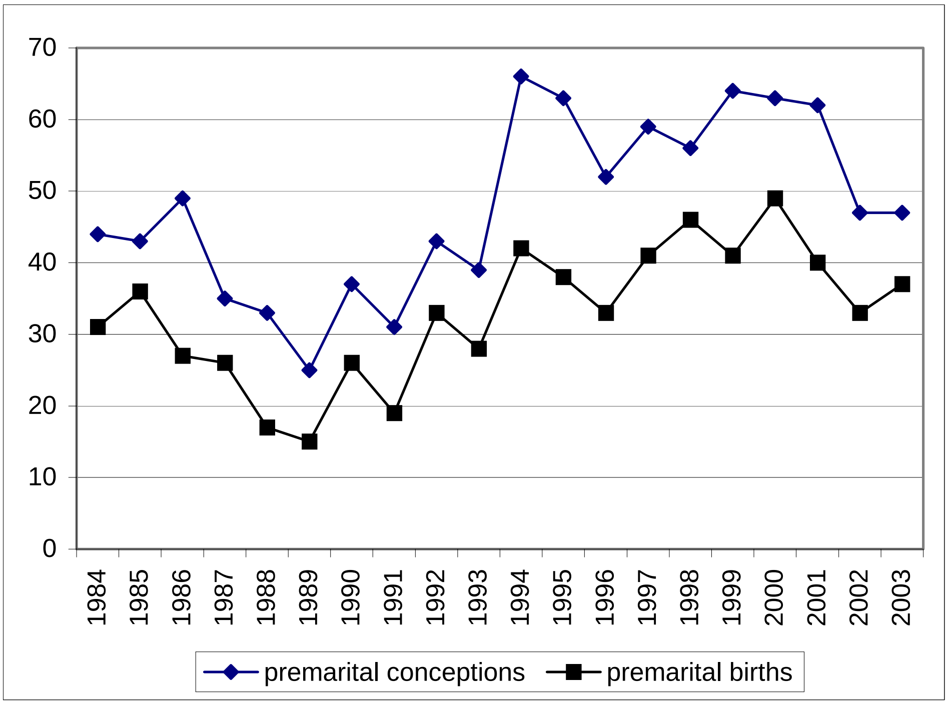
Source: Niakhar DSS

One in four of first births are conceived before first marriage and 16% of first infants are born to never-married mothers. These proportions are high for a population where social norms condemn premarital fertility (Guigou, 1992).

This phenomenon is difficult to record with retrospective surveys, owing to the difficulty of dating events precisely and the tendency to under-reporting of events that do not conform to local moral values. DSS data make it possible to establish the timing of events and reveal the extent of premarital sexual activity and fertility, which is otherwise not very visible.

First-order births taking place or conceived before marriage increased during the follow-up period in terms of absolute numbers (Figure 13).

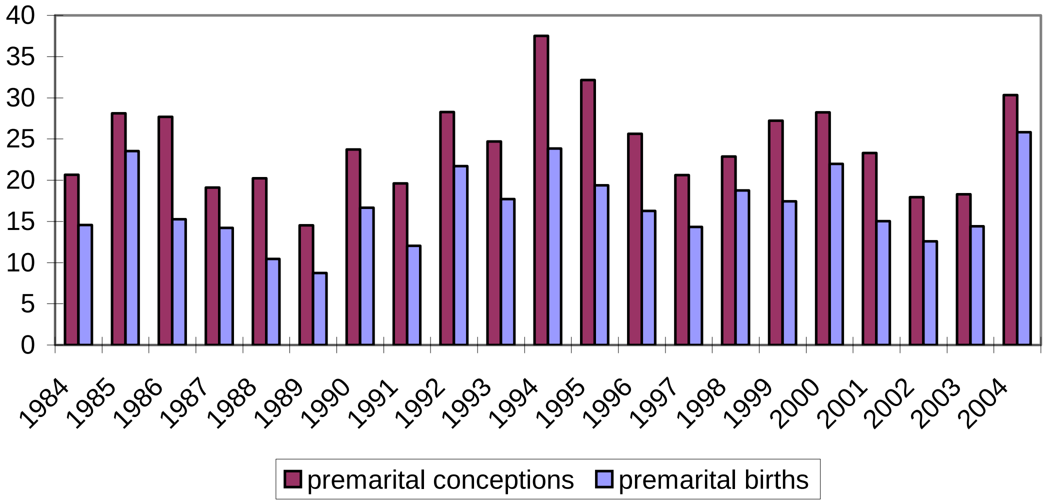
Figure 13 – Numbers of premarital conceptions and births among first-order births, 1984-2003



Source: Niakhar DSS

However, the percentage of first-order births that occur or are conceived before marriage fluctuates over the follow-up period. It would be useful to explore these fluctuations (Figure 14).

Figure 14 – Percentages of premarital conceptions and births among first-order births, 1984-2004



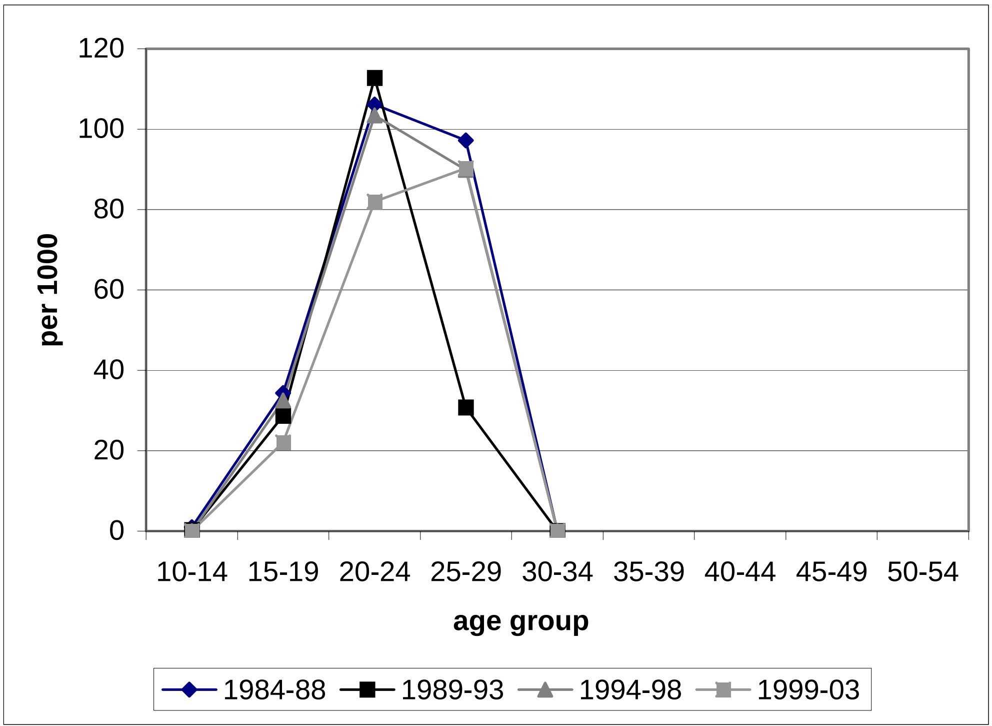
Source: Niakhar DSS

Calculating the premarital primo-fertility rates provides a better illustration of changes in the extent of the phenomenon.

Here we see that premarital primo-fertility only concern women under the age of 30, and mainly women aged 20 to 24. Birth rates, though fairly constant for the 25-29 age group, seem to decline over the later part of the follow-up period. However, the small numbers involved must be taken into account. There were only 30 premarital first-order births recorded for this age group in the entire follow-up period.

Nonetheless, this indicator, which is worth investigating further, might either reflect delayed entry into sexually active life, or improvements in contraceptive practice among the young. The level of contraceptive use has elsewhere been described as being very low (Ndiaye, 2003).

Figure 15 – Premarital primo-fertility rates by age group



Source: Niakhar DSS

Conclusion

By analysing fertility from DSS data, trends in fertility and its components during the follow-up period can be described precisely. The example examined here shows how useful it is to measure premarital fertility and produce a typology of first births. These measurement can be extended to all orders of births, and to the analysis of birth intervals.

These results concern a small population; it would be worthwhile to compare them with analysis results from other DSSs in the same country or the same region.

The study highlights the usefulness of working towards a standardized methodology for analysing fertility. This could lead to comparative analysis on a larger scale. It could be achieved through a cooperation among particular sites that have already cooperated on other issues, or by organizing a task force under the Indepth network.

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ANNEXES

Annex 1

Calculating person-years[15]

Foxpro programme

```
********************************************************************
* womenpy.prg
* female person-years
*
* female person-years of childlessness                    variant 1
*
* female person-years of never-married childlessness      variant 2
*
*This program calculate the number of person-years lived by women
*/ of childlessness (variant 1) / of never-married childlessness
* (variant 2) in the study area, each year, by age group
********************************************************************

clear
set deleted on
@ 1,2 say "womenpy.prg"
? "début  …  ",time()
?
?
set device to screen
close databases
set talk off
set path to [path]
*

declare tabwomen[21]
declare tabageg[19] && [0-0],[1-5[,[5-9[,[10-15[,[15-20[,[20-25[
...[80-85[,[85+
tabageg[1]  =  0
tabageg[2]  =  365.25
tabageg[3]  =  365.25*5
tabageg[4]  =  365.25*10
tabageg[5]  =  365.25*15
tabageg[6]  =  365.25*20
tabageg[7]  =  365.25*25
tabageg[8]  =  365.25*30
tabageg[9]  =  365.25*35
tabageg[10] =  365.25*40
tabageg[11] =  365.25*45
tabageg[12] =  365.25*50
tabageg[13] =  365.25*55
tabageg[14] =  365.25*60
tabageg[15] =  365.25*65
tabageg[16] =  365.25*70
```

[15] Modifications of variant 1 are underlined; modifications of variant 2 are framed.

```
tabageg[17] =  365.25*75
tabageg[18] =  365.25*80
tabageg[19] =  365.25*85
*
set excl on
set safety off
select b
use womenpy
zap
append blank
replace year  with "FEMALE"
append blank
replace year  with "PERSON"
append blank
replace year  with "YEARS"
```

replace year with "CHILDLESSNESS"

replace year with " NEVER-MARRIED AND CHILLESSNESS"

```
set safety on
set excl off
do while .T.
myear = str(year(date())-1,4)
if val(myear) > 1983 .and. val(myear) <= year(date())
   countyear = "1985"
   do while countyear <= myear
      nextyear = str(val(countyear)+1)
      j = 2
      do while j <= 21
          tabwomen[j]  = 0
          j = j + 1
      enddo
      sele a
      use resident  && residence period file
```

    use residpf

use residpf2

```
      tabwomen[1] = countyear

        do while .not. eof()
          @ 10,5  say " Person-years by age group "+countyear+"  in 
process..."
          @ 12,20 say " line nb "+str(recno(),7)
          date1    = ctod("01/01/&countyear")
          date2    = ctod("01/01/&nextyear")
          if daten < date2 .and. date1 < datex
             debut = max(daten,date1)
             end   = min(datex,date2)
             i = 1
             do while  i <= 19
                birthday1 = dob + tabageg[i]
                if i < 19
```

```
                  birthday2 = dob + tabageg[i+1]
               else
                  birthday2 = ctod("31/12/2010")
               endif
               if birthday1 < end .and. debut < birthday2 &&
overlaps
                  debutexpo = max(birthday1,debut)
                  endexpo   = min(birthday2,end)
                  period    = (endexpo - debutexpo)/365.25
                  if period < 0
                     ?id, recno()
                  endif
                  if sexe = "F"

                  if sexe = "F" and parity=0

                  if sexe = "F" and parity=0  and matst="C0"

                     tabwomen[i+2] = tabwomen[i+2] + period
                  endif
               endif
               i = i + 1
            enddo
         endif
         skip
      enddo
      select b
      append blank
      replace year   with tabwomen[1]
      mpop = 0
      j = 3
      do while j <= 21
         mpop = mpop + tabwomen[j]
         j = j + 1
      enddo
      replace pop     with mpop
      replace g0_0    with tabwomen[3]
      replace g1_4    with tabwomen[4]
      replace g5_9    with tabwomen[5]
      replace g10_14  with tabwomen[6]
      replace g15_19  with tabwomen[7]
      replace g20_24  with tabwomen[8]
      replace g25_29  with tabwomen[9]
      replace g30_34  with tabwomen[10]
      replace g35_39  with tabwomen[11]
      replace g40_44  with tabwomen[12]
      replace g45_49  with tabwomen[3]
      replace g50_54  with tabwomen[14]
      replace g55_59  with tabwomen[15]
      replace g60_64  with tabwomen[16]
      replace g65_69  with tabwomen[17]
      replace g70_74  with tabwomen[18]
      replace g75_79  with tabwomen[19]
      replace g80_84  with tabwomen[20]
      replace g85     with tabwomen[21]
      countyear = str((val(countyear)+1),4)
```

```
       sele a
   enddo
else
   ? chr(7),chr(7)
   ?
   ? " Year ",year,"   invalid"
   ?
   ? " enter year (4 digit) … from 1984"
   ?
   ? " or    0    to quit"
   ?
   ?
   wait
   loop
endif
exit
enddo
? "end   …  ",time()
? chr(7),chr(7)
```

Annex 2

Calculating births

Foxpro programme

```
***********************
* BIRTHMOTHER.PRG
*
****************************
clear
set talk off
set path to [path]
? "beginning … :",time()
@ 10,10 say " Births by mother age, in process … "
@ 12,20 say " Wait ...."

* initialization of births matrix

nb = year(date()) - 1
year = str(nb,4)
nbline = nb - 1983
declare tabbirth[nbline,10]
i = 1
do while i <= nbline
   tabbirth[i,1]  = str((1983 + i),4)
   i = i + 1
enddo
*
i = 1
do while i <= nbline
    j = 2
    do while j <= 10
        tabbirth[i,j] = 0
        j = j + 1
    enddo
    i = i + 1
enddo
*o
*
* oppening of residence period file, indexed on ID
select b
use resident
index on str(id,5)+str(rp,2) to resdid
* oppening of births file
select a
use births
do while .not. eof()
    if  dob >= ctod("01/01/1984") .and. dob <= ctod("31/12/2004")
        y   = year(dob)
        lig  = y - 1983   &&    nø ligne
        select b
        seek str(a->idm,5)
```

```
        if found()
            mage = (a->dob - dob)/365.25
            col     = 0
            do case
               case mage >= 10 .and. mage < 15
                  col = 2
               case mage >= 15 .and. mage < 20
                  col = 3
               case mage >= 20 .and. mage < 25
                  col = 4
               case mage >= 25 .and. mage < 30
                  col = 5
               case mage >= 30 .and. mage < 35
                  col = 6
               case mage >= 35 .and. mage < 40
                  col = 7
               case mage >= 40 .and. mage < 45
                  col = 8
               case mage >= 45 .and. mage < 50
                  col = 9
               case mage >= 50 .and. mage < 55
                  col = 10
            endcase
            if col <> 0
               tabbirth[lig,col] = tabbirth[lig,col] + 1
            endif
        else
            ? "mother not found : idm  ",a->idm
        endif
    endif
    select a
    skip
enddo
*
*
set excl on
set safety off
sele c
use birthmother
zap
set excl off
set safety on
i = 1
append blank
replace year       with "BIRTHS"
append blank
replace year       with "/MOTHER AGE"
do while i <= nbline
    append blank
    replace year       with tabbirth[i,1]
    replace g10_14      with tabbirth[i,2]
    replace g15_19      with tabbirth[i,3]
    replace g20_24      with tabbirth[i,4]
    replace g25_29      with tabbirth[i,5]
    replace g30_34      with tabbirth[i,6]
    replace g35_39      with tabbirth[i,7]
```

```
    replace g40_44      with tabbirth[i,8]
    replace g45_49      with tabbirth[i,9]
    replace g50_54      with tabbirth[i,10]
    j = 2
    do while j <= 10
        replace total with total + tabbirth[i,j]
        j = j + 1
    enddo
    i = i + 1
enddo
set talk on
? chr(7),chr(7)
? "                   end … :",time()
?
?
return
```

Annex 3

Calculating fertility rates

Foxpro programme

```
***********************************************
* FERTIL.PRG
*
*
*
*************************************************
clear
set talk off
? "début … :",time()
@ 10,15 say " Fertility rates"
@ 12,20 say " Wait ...."
nbline = year(date()) - 1984
declare tabrates[nbline,12]
i = 1
do while i <= nbline                         && first
  tabrates[i,1] = str(year(date())-nbline+i-1)&& colomn regarding
  i = i + 1                                   && years of survey.
enddo                                         &&
*
use womenpy
loca for year = "1984"
i = 1
do while i <= nbline                       &&
    tabrates[i,2] = g10_14
    tabrates[i,3] = g15_19
    tabrates[i,4] = g20_24
    tabrates[i,5] = g25_29
    tabrates[i,6] = g30_34
    tabrates[i,7] = g35_39
    tabrates[i,8] = g40_44
    tabrates[i,9] = g45_49
    tabrates[i,10] = g50_54
    if .not. eof()
      skip
    endif                                    &&
    i = i + 1
enddo
*
use birthmother
loca for year = "1984"
i = 1
do while i <= nbline
    tabrates[i,1] = year
    tabrates[i,2] = g10_14 / tabrates[i,2]
    tabrates[i,3] = g15_19 / tabrates[i,3]
    tabrates[i,4] = g20_24 / tabrates[i,4]
    tabrates[i,5] = g25_29 / tabrates[i,5]
```

```
    tabrates[i,6] = g30_34 / tabrates[i,6]
    tabrates[i,7] = g35_39 / tabrates[i,7]
    tabrates[i,8] = g40_44 / tabrates[i,8]
    tabrates[i,9] = g45_49 / tabrates[i,9]
    tabrates[i,10] = g50_54 / tabrates[i,10]
    skip
    i = i + 1
enddo
*
*
close databases
set excl on
set safety off
use fertil
zap
set excl off
set safety on
i = 1
do while i <= nbline
    append blank
    replace year   with tabrates[i,1]
    replace g10_14  with tabrates[i,2] * 1000
    replace g15_19  with tabrates[i,3] * 1000
    replace g20_24  with tabrates[i,4] * 1000
    replace g25_29  with tabrates[i,5] * 1000
    replace g30_34  with tabrates[i,6] * 1000
    replace g35_39  with tabrates[i,7] * 1000
    replace g40_44  with tabrates[i,8] * 1000
    replace g45_49  with tabrates[i,9] * 1000
    replace g50_54  with tabrates[i,10] * 1000
    replace isf with
(g10_14+g15_19+g20_24+g25_29+g30_34+g35_39+g40_44+g45_49+g50_54)*5/1
000
    i = i + 1
enddo
set talk on
? chr(7),chr(7)
? "                   end … :",time()
return
```

Annex 4

Excel spreadsheet: fertility rates and other indicators

13		
14		
15	Person-years lived by the mothers	
16	Age group	time t
17	10-14	pa1
18	15-19	pa2
19	20-24	pa3
20	25-29	pa4
21	30-34	pa5
22	35-39	pa6
23	40-44	pa7
24	45-49	pa8
25	50-54	pa9
26		
27		
28	Fertility rates	
29	Age group	
30	10-14	=C4/C17
31	15-19	=C5/C18
32	20-24	=C6/C19
33	25-29	=C7/C20
34	30-34	=C8/C21
35	35-39	=C9/C22
36	40-44	=C10/C23
37	45-49	=C11/C24
38	50-54	=C12/C25
39		
40	Mean age at childbearing	=(12,5*C30+17,5*C31+22,5*C32+27,5*C33+32,5*C34+37,5*C35+42,5*C36+47,2*C37+52,5*C38)/somme(C30:C38)
41	Mean age of mothers at the birth of their child	=(12,5*C4+17,5+C5+22,5*C6+27,5*C7+32,5*C8+37,5*C9+42,5*C10+47,5*C11+52,5*C12)/somme(C4:C12)
42	Total fertility rate 10-54	=SOMME(C39:C47)*5
43		
44	Total fertility rate 10-49	=SOMME(C39:C46)*5
45		
46		
47		
48		

1	FIRST CHILDBIRTH	
2	No of annual first-order births by mother's age group	
3	Age group	time t
4	10-14	n1
5	15-19	n2
6	20-24	n3
7	25-29	n4
8	30-34	n5
9	35-39	n6
10	40-44	n7
11	45-49	n8
12	50-54	n9
13		
14		
15	Person-years mothers lived without children	
16	Age group	time t
17	10-14	pa1
18	15-19	pa2
19	20-24	pa3
20	25-29	pa4
21	30-34	pa5
22	35-39	pa6
23	40-44	pa7
24	45-49	pa8
25	50-54	pa9
26		
27		
28	Primo-fertility rates	
29	Age group	
30	10-14	=C4/C17
31	15-19	=C5/C18
32	20-24	=C6/C19
33	25-29	=C7/C20
34	30-34	=C8/C21
35	35-39	=C9/C22
36	40-44	=C10/C23
37	45-49	=C11/C24
38	50-54	=C12/C25
39		
40	Mean age at first childbirth	=(12,5*C30+17,5*C31+22,5*C32+27,5*C33+32,5*C34+37,5*C35+42,5*C36+47,2*C37+52,5*C38)/somme(C30:C38)
41	Mean age of mothers at birth of their first child	=(12,5*C4+17,5+C5+22,5*C6+27,5*C7+32,5*C8+37,5*C9+42,5*C10+47,5*C11+ 52,5*C12)/somme(C4:C12)
42		
43		
44		
45		
46		
47		
48		

Annex 5

Creating file *Nr1.dbf*

Structure of file *Nr1.dbf* :

Variable	Content	Type	Size
VIL	Village	N	2
CONC	Compound	N	3
ID	Identity number	N	5
SEXE	Child's sex	C	1
DOB	Date of birth	D	8
IDM	Mother's identity	N	5
RANG	Birth order	N	2
MDOB	Mother's date of birth	D	8
MATSTENTRY	Marital status at start of residence period during which the birth occurred	C	2
DATENB	Start date of residence period during which the birth occurred	D	8
FMATSTMAR	First marital status married		
DATENM	Start date of first residence period when the woman was married		
DATFMAR	Date of first marriage, if it occurred in the survey area	D	8
LEGI	Legitimacy status 1: birth before marriage 2: marriage on day of baptism 3: marriage during pregnancy 4: marriage before conception 5: marriage before birth, conception not specified	N	1
PC	Premarital conception 1: yes (legi=1,2,3) 2: no (legi=4)	N	1

Foxpro programme

```
*********
* COMPBIRTH1.prg
*********
sele a
use birth1.dbf

sele b
USE residpf2.dbf
inde on str(id,6)+str(rp,2) to residpf2
sele a
do while .not. eof()
   sele b
   seek str(a->idm,6)
   do while id=a->idm
       if a->mdob=ctod("  /  /  ")
          replace a->mdob with dob
```

```
       endif
       if matst="M"
          if a->fmatstmar=" "
             replace a->fmatstmar with matst
             replace a->datenm with daten
          endif
       endif
      if exit=85
         replace a->datfmar with datex
      endif
      if daten<=a->dob .and. datex>=a->dob
         replace a->matstentry with matst
         replace a->datenb with daten
      endif
      skip
   enddo
   skip-1
   sele a
   replace mdob with b->dob
   skip
enddo


sele a
replace legi with 1 for (dob-datfmar)<-7 .and. dtoc(datfmar)<>" "
replace legi with 2 for (dob-datfmar)>=-7 .and. (dob-datfmar)<0 .and. dtoc(datfmar)<>" "
replace legi with 3 for (dob-datfmar)>=0 .and. (dob-datfmar)<8*30.44 .and. dtoc(datfmar)<>" "
replace legi with 4 for (dob-datfmar)>=8*30.44 .and. dtoc(datfmar)<>" "
replace legi with 4 for (dob-datenb)>=8*30.44 .and. matstentry<>"C".and. legi=0
replace legi with 1 for legi=0 .and. matstentry="C"
replace legi with 4 for (dob-datenm)>=8*30.44 .and. legi=0
replace legi with 5 for legi=0 .and. matstentry="M"
replace legi with 5 for legi=0 .and. fmatstmar="M"

replace pc with 1 for legi<4 and legi>0
replace pc with 2 for legi>=4
replace pc with 9 for legi=5
```

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Cover photo

Close-up of a fine-mesh seive used for preparing
Cassava flour crackers (beijus). Basket-weave patterns. Amazonia, Brazil.

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Demographic Surveillance Systems (DSS) for longitudinal monitoring of small-area populations by continuous recording of vital events have been set up in many developing countries. DSSs are based on a data gathering method comprising an initial census of the resident population, followed by multi-round surveys covering all inhabitants of the area. They thus provide a geographical and temporal observation window on a locally circumscribed population defined using certain rules of residence. Individuals' life events during their period(s) of residence in the survey area are recorded on an individual basis (the minimum data being births, deaths and migration), but sometimes per household or per residential unit.

An international network of Demographic Surveillance Systems, called INDEPTH, has now been formed to exchange ideas on scientific issues and to facilitate comparative approaches.

The purpose of this handbook is to offer a standardised analysis of fertility that can be replicated more or less completely using data from the various existing DSSs. It is a methodological document, designed to contribute to better use of DSS data and to facilitate comparative analysis of different DSSs. It describes the particularities of this type of data and presents specific analytical procedures which can be extended to other demographic phenomena such as mortality, nuptiality, etc.

The procedures described are then illustrated with an analysis of data from the Demographic Surveillance System in Niakhar, Senegal.

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