EFFECTIVENESS ASSESSMENT OF MATERNITY WAITING HOMES IN INCREASING COVERAGE OF INSTITUTIONAL DELIVERIES USING GEOGRAPHICAL INFORMATION SYSTEMS IN SIX DISTRICTS OF CABO DELGADO PROVINCE (MOZAMBIQUE)

by

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For the pleasure of learning and finding answers

Student number: 40852636

I declare that the **EFFECTIVENESS ASSESSMENT OF MATERNAL WAITING HOMES IN INCREASING COVERAGE OF INSTITUTIONAL DELIVERIES USING GEOGRAPHICAL INFORMATION SYSTEMS IN SIX DISTRICTS OF CABO DELGADO PROVINCE (MOZAMBIQUE)** is my own work and that all the sources that I have used or quoted have been indicated and acknowledged by means of complete references and that this work has not been submitted before for any other degree at any other institution.

....   30 / 11 / 2010

Ivan Zahinos Ruiz   Date

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ABSTRACT

Mozambique is in the process of setting up maternity waiting homes (MWHs) in an attempt to improve access of women living in remote areas. It is expected that MWHs will increase institutional deliveries and consequently, decrease maternal mortality caused by the delay in reaching obstetric care. However, no evidence for this assumption has been found in the literature. The objective of this research was, using Geographical Information Systems (GIS), to assess the impact of MWHs in increasing institutional deliveries coverage. GIS technology is a valuable methodology to analyse access, especially in contexts where official records are weak. An ecological study, using a sample of 28 health facilities, was conducted in six districts in northern Mozambique. The findings suggest that MWHs could contribute to increasing institutional deliveries coverage in a range of 4% to 2 %. However, they do not appear to increase access of women living in remote areas.

KEY CONCEPTS

Institutional deliveries; Maternal mortality; Three delays; Geographical Information Systems (GIS); Maternal Waiting Homes (MWHs).

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LIST OF ACRONYMS

- BOC – Basic Obstetric Care
- CAD – Computer-aided design
- COC – Comprehensive Obstetric Care
- DBMS – Data Based Management System
- EOC – Emergency Obstetric Care
- GIS – Geographic Information System
- GPS – Global Positioning System
- HIS – Health Information System
- INE – Instituto Nacional de Estatística
- MCH – Mother and Child Health
- MDG -Millennium Development Goals
- MISAU – Ministry of Health
- MWHs – Maternity Waiting Homes
- NGO – Non Governmental Organizations
- NHS – National Health System
- PAF matrix – Performance Assessment Framework matrix
- PMTCT – Preventing Mother to Child Transmission.
- SIT – Sexual Infection Transmission
- SWAP – Sector Wide Approach
- TBA – Traditional Birth Attendance
- UNDP – United Nation Development Program
- UN – United Nations
- UNFPA – United Nations Population Fund
- UNICEF – United Nation Children's Fund
- UTM – Universal Transverse Mercator
- WHO – World Health Organization

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CHAPTER 1 – ORIENTATION TO THE STUDY

1.1 INTRODUCTION

Chapter 1 provides both an overview and an introduction to the study. In the course of this section is presented the background information about the research problem, providing information about the source of the problem. Later in the section, the research purpose is introduced, as an area of concern where there is a gap in the knowledge base of Public Health theory and practice.

Within this context, in the course of the study's orientations, are presented the research objectives and hypothesis that have been stated in this research. In addition, this section also introduces the main aspects related to the significance of this research, highlighting the contributions that it could provide to public health. The foundations and scope of the study are also presented in order to establish a clear framework of reference to understand the research.

Finally, in chapter 1, is also briefly introduced the research design and method that has been implemented in this study.

1.2 BACKGROUND INFORMATION ABOUT THE RESEARCH PROBLEM

1.2.1 The source of the research problem.

In 2005 (last worldwide review) more than 536.000 women, 99 % living in developing countries, died around the world due to causes related to pregnancy and childbirth (UNICEF, 2008a:5). More than a half of these deaths were registered in Africa, where maternal mortality continues to be one of the main challenges in public health.

According to the WHO, in Mozambique, maternal mortality has decreased from 1,600 deaths per 100,000 live births in 1990 to 520 deaths per 100,000 live births in 2005 (WHO,2010a:26). However, the Ministry of Health of Mozambique and the National Statistics Institute indicate that in 2003, maternal mortality was 408 per 100,000 live births (INE e MISAU, 2003: 129). Although the WHO estimates are more recent, in this research we used the data provided by the INE as they are based on national information. Nevertheless, the ratio is still high and the reduction of this statistic is one of the priorities of the health sector in Mozambique (MISAU, 2008a:36).

The causes of maternal mortality are well known and have been documented and classified during the last decades. Almost three-quarters of the deaths are a consequence of direct obstetrics complications such as eclampsia, sepsis and others. However, the National Health Systems (NHS) of the majority of developing countries fail in bringing skilled attendance to pregnant women in need, because of the multiple and, most of the time, insurmountable barriers that limit access (geographical, social, cultural, economical, etc). Obstetric complications may be irreversible if the NHS does not have the capacity to provide care in time. This literature review concludes that one of the main factors that contribute to maternal mortality is the distance and subsequent delay in treatment of childbirth complications (UNICEF, 2008a:5).

Several maternal health studies have shown that strengthening the continuum of care, from proper pregnancy management, antenatal care and institutional delivery to post partum (with the capacity to provide life-saving obstetric care, when necessary) considerably reduces maternal mortality (WHO, 1996:1; UNICEF, 2008a:5). Institutional deliveries can be defined as any delivery that take place in a modern health facility and medically trained professionals such as medical doctors, nurses and midwife/auxiliary midwife assisted (Nketiah-Amponsah and Sagoe-Moses, 2009: 469-482). The literature shows that, in countries where maternal health is successfully improved, maternal mortality decreased if institutional deliveries increased significantly (UNFPA, 2010; UNICEF, 2008a:14; Talamanca, 1996:1384).

Three options have been identified to improved access to obstetric care: (1) to establish an effective transport network in order to ensure rapid transportation of patients with complications to a qualified health facility; (2) decentralization of health services in order to provide obstetric care by setting up health facilities near the communities and (3) to ensure that pregnant women (with special focus of those with high risk conditions) wait for delivery near a health facility with obstetric care services (UNICEF, 2008a: 12-14).

Most of NHSs in developing countries have limited capacity to expand the health services network or to ensure a proper referral system based on an effective transport system; therefore maternity waiting homes (MHW) have been promoted as an alternative to improve maternal health. A MWH is a facility built near a Hospital or Health Centre that provides maternal health care services (antenatal care, skilled births attendants and emergency obstetric care). MWHs may also offer women with health education about pregnancy, giving birth and infant care (Lonkhuijzen *et al*, 2009:3). The aim of MWHs is to improve the access of pregnant women to quality and in-time maternal health care services, especially for those high-risk pregnancy or women that live in remote areas. It is assumed that MWHs contribute to increasing the proportion of institutional deliveries, and by this increase, to reducing maternal mortality.

In 2009, the Ministry of Health of Mozambique officially launched its strategy of Maternity Waiting homes (MISAU, 2009a) as part of a greater strategy to improve safe Motherhood. In Mozambique, MWHs are mainly located near health facilities of primary level (type I and type II). National indicators indicate that, in 2009, 90 % of Health Facilities located in district capitals have MHWs (MISAU, 2009b). Although the emphasis of the Ministry of Health of Mozambique is the promotion of this strategy, a review of the literature shows that information concerning MWHs activities, location, characteristics, etc. are limited and in, most areas, nonexistent (MISAU, 2009c: 105-111). This factor limits the possibility of studying the impact of this strategy.

1.2.2 Background to the research problem

The concept of homes for women with high-risk pregnancies and also women with economic and social problems has a long history. In Europe, several volunteers and charity organizations made available refuge for pregnant women in order to reduce abortion and infanticide. More specifically, in Northern Europe, waiting homes were built near hospitals to help women living in distant geographical areas with limited access to obstetric care. For example, in Finland where there are remote communities with access difficulties and few obstetric services, nurses' facilities serve as "patient hotels" with the same aim (WHO,1996:2).

During the second half of the 20th Century the strategy of MWHs has been promoted in several developing countries to bring women near health facilities, increase institutional deliveries and, as a result, decrease maternal mortality. But as Talamanca noted (1996: 1382) unfortunately, most of the experiences have not been documented properly, making it difficult to assess the effectiveness of this service.

However, in the last two decades, several retrospectives population cohort studies and qualitative studies have been done in order to assess the effectiveness of MHWs in decreasing maternal deaths and stillbirths. Lonkhuijzen *et al*. (2009) have systematized a comprehensive review of research aimed at assessing MWHs for improving maternal and neonatal outcomes in low-resource countries.

Experiences from different countries (Cuba, Honduras, Malawi, Nigeria, Papua New Guinea, Zimbabwe and Zambia) have been detailed. The review warns that conclusions that arose from these studies should be interpreted with caution as all the available data consist of retrospective cohort studies with significant potential for bias. Qualitative studies also have been used to assess the impact of MWHs. Wilson *et al* (1997:165-172) described a negative experience of MWHs impact in increasing maternal health care services due to the lack of community members involvement in maternal health care services. Also Shrestha *et al* (2007) described the failure experience of MWHs in Nepal for the same reason. These experiences reveal the huge number of factors that can influence the effectiveness of MWHs. Mann *et al* (2006:32-38) undertook an equity analysis in order to assess maternal mortality causes in Malawi. They indicate the low utilization of MWHs in Malawi due to the associated costs of having delivery outside the community.

Evaluating the effectiveness of MWHs in reducing the maternal mortality ratio could be difficult as several confounders can influence the final outcome. For example, an increase in the use of maternities with MHW could increase institutional mortality. In any case, as it has been introduced before, one of the assumptions of MHWs is that this service will increase the access of pregnant women that live in remote areas, and consequently, will increase institutional deliveries coverage. However, there is limited information from around the world, and particularly none from Mozambique, that assess the impact of MHWs in increasing geographical coverage of health facilities.

1.3 RESEARCH PROBLEM

The research problem can be summarized as follows: There is no information available in Mozambique concerning the effectiveness of MHW in increasing coverage of institutional deliveries.

This lack of information could promote a strategy that has not been tested and has no evidence of impact. In addition, it is important to promote research that contributes to knowledge of the impact of MWHs.

1.4 AIM OF THE STUDY

1.4.1 Research purpose and objectives.

The research purpose of the study focuses on evaluating the effectiveness of MHWs in increasing coverage of institutional deliveries. The assessment will be carried out using Geographical Information Systems (GIS) technology and analysis in six districts of Cabo Delgado Province (Mozambique).

The objectives of the research can be summarized as follows:

(1) Determine and represent the number and location of the MWHs in the health facilities of the six districts under study, and creating two groups of health facilities under study: those with MWHs and those without this service.

(2) Determine and represent the institutional deliveries coverage of the health facilities under study using GIS technology and the available data from the health information system of the health provincial board of Cabo Delgado.

(3) Compare and analyze the coverage of the two groups under study allowing us to determine if there is a relationship between the presence of MWHs and institutional deliveries coverage.

(4) Implement an across-time analysis in order to study if the setting up of MWHs has induced variations in the number of institutional deliveries.

(5) Contribute to the existing knowledge about the potential applications of GIS technology in the public health domain.

1.4.2 Research hypothesis

The research purpose of the study has been tested by a principal hypothesis:

✓ Hypothesis$_1$: health facilities type II with MWHs have better coverage of institutional deliveries than those without MWHs.

For this purpose, the following null hypothesis has been stated:

✓ Null Hypothesis$_1$: there is no significant difference between the coverage of institutional deliveries in Health Facilities type II with MWHs and without.

It was considered that a time series analysis might reduce some of the socioeconomic confounders that are a potential problem in this type of research design (Bonita *et al*l, 2006:42). This analysis has allowed us to discover institutional deliveries patterns and assess whether the set up of MWH services has induced changes in institutional deliveries. A secondary hypothesis has been tested in order to exclude potential confounders and contribute to assess the effectiveness of MHWs:

✓ Hypothesis$_2$: Across time analyses shows that MWHs services increase institutional deliveries in health facilities.

1.5 SIGNIFICANCE OF THE STUDY

This study has contributed to assessing the effectiveness of MWHs in increasing the reach of health facilities and thus the access of women to health care services. This information is critical within the scope of maternal health policies to influence strategies as to the promotion of MWH services.

In addition this study has contributed to studying the potential application of GIS in public health. By geo-referencing the population and mapping health facilities it is possible to study the use of maternal health care services, particularly the coverage of institutional deliveries. GIS analysis could be useful to design a health development plan to encourage pregnant women to deliver at the NHS health facilities and promoting the use of MWHs (Leewannapasai *et al*, 2009).

1.6 DEFINITIONS OF TERMS

- Three Delays: A model used by maternal health experts to classify the underlying causes of maternal mortality: (1) Delay in deciding to seek medical care; (2) delay in reaching appropriate care and (3) delay in receiving care at health facilities (UNFPA, 2010).
- Geographical Information Systems (GIS): A computer based information system used to digitally represent and analyze the geographic features present on the Earth' surface and the events (non-spatial attributes linked to the geography under study) taking place on it (Gisdevelopment, 2010).
- Maternal Waiting Homes: Facilities where pregnant women can wait and receive supervision during the last week of pregnancy. Usually used by women whose homes are in remote and inaccessible rural areas (Talamanca, 1996: 1382)
- Institutional Deliveries: Deliveries accounted for in a modern health facility (public or private) with maternal health care services, and assisted by medically trained professionals such as medical doctors, nurses and midwife/auxiliary midwife (Nketiah-Amponsah and Sagoe-Moses, 2009:469-482)
- Maternal Mortality: The death of a woman while pregnant or within 42 day of termination of pregnancy, irrespective of the duration and site of the pregnancy, from any cause related to or aggravated by the pregnancy or its management but not from accidental or incidental causes (WHO *et al*., 2005:4).

1.7 FOUNDATIONS OF THE STUDY: THE THREE DELAYS MODEL

Numerous factors contribute to maternal mortality. Still, the interval between the beginning of an obstetric complication and its result is one of the most critical aspects. The “Three Delays” model (Thaddeus and Deborah, 1994) proposes that pregnancy-related mortality is mainly affect by delays in: (1) Delay in the decision to seek care or deciding to seek appropriate medical help for an obstetric emergency; (2) delay in arrival at a health facility or reaching an appropriate obstetric facility, and; (3) delay in the provision of adequate care or receiving adequate care when a facility is reached.

The present study is based on the “three delay” assumptions and the promotion of new technologies, particularly GIS, as a useful and valuable tool to assess the impact of health strategies (WHO, 2010b).

1.8 RESEARCH DESIGN

In Mozambique, until today, registers used in MWHs are practically non-existent. One of the reasons that contribute to this weak registration is the fact that official MWHs guidelines have just been launched. This lack of official records of the activities implemented by MWHs (for example, number of women attended, origin of pregnant women and length of stay) has strongly determined the research design proposed in the present study.

It is difficult to study individually (using subjects, elements) with the available data if health facilities with MWHs have wider institutional deliveries coverage that those centres without MWHs. One of the few approaches to studying coverage consists of defining clusters of population according to the distance of these populations from a health facility. This group of population can be used to estimate annual deliveries and compare with registered institutional deliveries, determining institutional delivery coverage.

In this context, the current research is based on a *quantitative paradigm*, as was an objective, formal and systematic process that uses numerical data in order to obtain information about the effectiveness of the MWHs in a determined geographical region under study (Burns and Grove, 2005:23).

In this study, the researcher did not intent to change the course of events, just to gather data in relation to a phenomenon of interest. Consequently, it should be defined as an *observational study* in which the researcher measures, records, counts, observes or classifies events (Stommel and Wills, 2004:118).Essential elements for good reporting of observational studies was considered according to the STROBE statement (Von Elm et al, 2007:806-808). More details in chapter 3.

An *ecological or correlational* research design has been considered as the most suitable research design, as the units of analysis are groups of people rather than individuals (Bonita, Beaglehole and Kjellström, 2006:40). This ecological study attempts to study if there is a relationship between the presence of a MWH (exposure) and better institutional deliveries coverage in a group of health facilities. The research did not just try to study the impact of MWHs on health facilities, but also tries to evaluate whether health facilities with MWHs have improved their area of influence over the population.

The study has been based on the analysis of the relationship between population distance to a health facility and institutional deliveries coverage comparing two groups of health facilities, with and without MHWs. Three variables have been studied: (a) Institutional deliveries coverage; (b) distance of the population to the health facility, and; (c) presence of a MWH.

1.9 RESEARCH METHODS

1.9.1 Sample selection, inclusion and exclusion criteria of the sample.

The sample under study is composed of health facilities of the National Health System. The selection of the health facilities under study has been one of the key aspects of the research method. The crucial aspect has been to select a type of health facility that gives attention, initially, to its direct population. According to the characterization of the Ministry of Health of Mozambique, these health facilities are type II.

With the aim to assess the effectiveness of MWHs in increasing institutional deliveries coverage, the next *sampling criterion has* been defined:

✓ Inclusion criteria:

❖ Functional health facilities managed by the Ministry of Health (providing health care during the 6 months previous to data collection).

❖ Health facilities that offer maternal health care, including Basic Obstetric Care (this exclude health post).

❖ Health facilities pertaining to primary health network (this excludes tertiary and secondary health facilities as provincial and rural hospitals).

❖ Health facilities that will not receive obstetrics reference from other health facilities.

✓ Exclusion criteria:

❖ Health facilities that started their activities during the last six months previous to data collection.

❖ Health facilities pertaining to secondary or tertiary health network.

❖ Health facilities without maternal health care services.

❖ Health facilities that receive obstetrics reference from inferior levels.

According to the exposed criteria, the sample was focused on health facilities type II (however, exceptions was done in the case of health facilities type I that function as a type II). Considering these aspects, the sample was composed by 28 health facilities

1.9.2 Data Collection

The present research is based on a quantitative structured data collection approach. The main advantage of structured data collection approaches lies in their ability to summarize, compare and generalize results (Harrell *et al*, 2009: 8-10).

Secondary data sources have been and are the most predominant type of data collection used in the research. The following *secondary sources* were obtained and analyzed:

(1) **Geo-referenced population and geo-referenced location of health facilities of Cabo Delgado Province**. This information was obtained from the Geographical Information Systems (GIS) data base from the Provincial Government of Cabo Delgado, Health Provincial and Agriculture Board.

(2) **Institutional Deliveries** from the Health Information System of Cabo Delgado Province, by district, health facility and form 1994 to 2009.

(3) **Population 1997 and 2007 Census.** The data of the population Census was obtained from the National Institute of Statistics of Mozambique (INE, 2009). Population was projected, based on population growing (considering 1997 and 2007 Census).

Although to a lesser extent, *primary data* were also obtained and, in fact, they were very important for the study purpose. The lack of records concerning MWHs in Mozambique was a key determinant in requiring the collection of primary data. **MWHs locations and year of set up** were not registered in any document of the Health Provincial Board of Cabo Delgado. The researcher obtained data about the number, location and year of set up of the MWHs located in the district under study. This information was obtained through *interviews* with the district health director and *direct observation*. A *structured questionnaire* was provided to the Health Provincial Board in order to obtain information about MWHs location and year of set up. The questionnaire required confirmation of the information obtained through *direct observation* of the health facilities type II pertaining to the district under study.

1.9.3 Data analysis

Descriptive statistics have been used to analyze the data:

(1) *Institutional deliveries coverage by health facility* and by area of influence (8, 10, 12 and 14 km) has been determined.

(2) *Institutional deliveries coverage of the health facilities with MWHs, without MWHs and the whole sample by area of influence (8, 10, 12 and 14 km)*.

(3) Time-series analysis of the institutional deliveries trends of the 28 health facilities under study, using data (when available) from 1994 to 2009, in order to detect if implementation of MWHs influences changes in institutional deliveries.

Inferential statistics were used to analyze if there are statistically significant differences between the institutional deliveries coverage in the group of health facilities with MWHs and the group without the service. In order to determine this aspect, *a Chi-square test for a 2x2 by using a continuity correction*, also named Yate's continuity correction, was used (Kirkwood and Sterne, 2006:166-168).

1.10 SCOPE OF THE STUDY

The study is framed into two main areas of knowledge:

(1) First, the study is related to maternal health care. The research proposes to contribute to existing knowledge about best practices and strategies to reduce the high rates maternal mortality existing in developing countries, specifically in Mozambique.

(2) Secondly, the research seeks to contribute to the study of the potential use of Geographical Information Systems technology in Public Health.

1.11 STRUCTURE OF THE DISSERTATION

The report of the research is presented in the following format:

- In Chapter 1, Orientation to the Study, an overview of the study is presented. This chapter serves also as an introduction to the content that is widely presented in further chapters.
- Chapter 2, focuses on a Literature Review of Maternity Waiting Homes experiences, assessments, and other relevant information about this service. In addition a revision of Geographical Information Systems is outlined, highlighting the main applications in Public Health.
- Chapter 3 presents the research design and method of implementation.
- Chapter 4 focuses on the analysis, presentation and description of the research findings.
- Finally, Chapter 5 describes the main conclusions and recommendations.

1.12 CONCLUSION

In chapter 1, maternal mortality in Mozambique is briefly described, highlighting the indicators that remain high and the difficulties that developing countries experience in reducing this rate. One of the principal factors contributing to maternal mortality is the delay in reaching proper health care. In fact, the “three delays” has been widely used to characterize the main causes that contribute to maternal mortality. In this context, this model has been introduced as a foundation of the study.

MWHs have been promoted in several countries, including Mozambique, in order to reduce maternal mortality by increasing the proportion of institutional deliveries. However, few studies around the world have been carried out with the aim of assessing this strategy, hardly any of them to assess effectiveness in contributing to increased institutional deliveries, and no known studies of any type on MWHs have been carried out in Mozambique.

Within this context, the research purpose was to assess the impact of MWHs in increasing institutional deliveries by studying a sample of health facilities, and comparing two groups of facilities: those with MWHs and those without MWHs. A quantitative, observational ecological design study has been used to assess the impact of the MWHs.

Chapter 1 also includes the main aspects of the research methods, focusing on the sample selection, data collection and data analysis used in this study.

CHAPTER 2 – A LITERATURE REVIEW OF MATERNITY WAITING HOMES AND APPLICATIONS OF GEOGRAPHIC INFORMATION SYSTEMS IN PUBLIC HEALTH

2.1 INTRODUCTION

Chapter 2 describes some of the trends in maternal mortality in Africa, with special focus on Mozambique and Cabo Delgado Province, including details of the causes of maternal mortality and the strategies promoted by the Ministry of Health of Mozambique to ensure safe motherhood. The three delays model is used as a suitable foundation framework to describe the main barriers to access and obtaining skilled obstetric care. Afterwards, MWHs are described, offering a brief historical review and analysing the main characteristics that can improve the chances of success of this services. This review is based on existing information of MWHs experiences from around the world, including available data from Mozambique. Finally, this chapter presents some of the main features of GIS, applications and functionality, in order to show the potential of this tool for public health purposes, with special focus on the assessment of health care access.

2.2. MATERNAL MORTALITY

2.2.1 Maternal mortality in Africa.

According to the most recent UN estimates, in 2005 more than 536,000 women died around the world form causes related to pregnancy and childbearing (UNICEF, 2008a:5). The Africa region, with more than half of the deaths, is the area that registers the highest risk of maternal mortality with 900 maternal deaths per 100,000 live births, significantly more than the 27 per 100,000 in Europe in the same period of time. In fact, the lifetime risk of maternal death for a mother living in a developing country is more than 300 times more than a woman living in an industrialized region (WHO, 2010a:14-15). This difference between developing countries and the industrialized world is called the "*greatest health divide in the world*".

Deeper analysis of this indicator shows that in the Africa region, during the period from 1990 to 2005, there was stagnation and even a potential increase in maternal mortality. This situation demonstrates the potential difficulty in attaining an annual reduction of 5,5 % necessary to achieve Millennium Development Goal 5 (MDG 5). This MDG aims to improve maternal health, in addition to other strategies, by reducing the maternal mortality ratio by three quarters, between 1990 and 2015 (UNICEF, 2008a:3).

2.2.2 Maternal mortality in Mozambique.

Maternal mortality rates in Mozambique have been gradually reduced from 1.600 deaths per 100.000 live births in the beginning of the 90s to 408 deaths per 100.000 live births in 2005 (MISAU and INE, 2003: 129). The Ministry of Health of Mozambique predicts it will reduce the maternal mortality ratio to 250 deaths per 100.000 live births in 2015, in order to achieve MDG5. According to the 2008 Report on the Millennium Development Goals (2007:34), it is a target that can potentially be achieved.

MISAU and key health sector actors (official donors, UN agencies, NGOs, others) established a Performance Assessment Framework (PAF) in order to evaluate progress of key health indicators (MISAU, 2009b: 1-3). According to health goals established by the Ministry of Health, the PAF matrix defines maternal mortality ratio as a key indicator, and also details five process indicators, namely: (1) proportion of institutional deliveries, (2) percentage of head district with maternity home, (3) number of Health Facilities per 500.000 population with Basic Obstetrical Services, (4) percentage of contraceptive coverage with modern methods and (5) percentage of pregnant women assisting to antenatal check-up receiving at least two doses of Preventive Intermittent Malaria Treatment (PIT). The baseline in 2005, target for 2009 and indicators achieved in 2009 are showed below:

Key Process Indicator	Baseline 2005	Target 2009	Achieved 2009
Proportion of assisted deliveries per Health practitioners.	49 %	60 %	55 %
Percentage of head districts with Maternity ward.	15 %	NA%	40,8 %
Number of Health Unities for 500.000 population With Basic Obstetrical Services	1,23	2,74	5,9
% of contraceptive coverage by using modern methods	5 %	13,5 %	13,9 %
% of pregnant women assisting to antenatal check-up receiving at least two doses of Preventive Intermittent Malaria Treatment (PIT).	0 %	50 %	51 %

Adapted from PAF Matrix (MISAU, 2009b)

Table 2.1. Key Process Indicators to assess the reduction of maternal mortality rates.

These results show the difficulties of NHS in increasing institutional deliveries, within the context of notable improvements in all the other four areas. Even where there is an increase in the number of MWHs located at head districts, it seems that the availability of this service does not influence considerably the percentage of institutional deliveries coverage.

2.2.3 Maternal mortality in Cabo Delgado Province.

In 2003, the Health and Demographic Survey (INE, 2003:125) estimated that maternal mortality in Cabo Delgado province was 450 per 100,000 live births, considerable more than 10 % above the national average of 408 per 100,000 live births. Unfortunately, at this time, there is still no later followup edition of the survey. However, the Strategic Health Plan of Cabo Delgado province provides information (DPS de Cabo Delgado, 2008) about other relevant maternal health indicators from 2003 to 2007. In this period, the Provincial Health Board reports an increase from 29,5 % to 47,5 % in the percentage of institutional deliveries, an increase of 50 % in the number of MWHs in head district health facilities and a reduction of the institutional maternal mortality rate from 450 per 100,00 in 2003 to 242 in 2007.

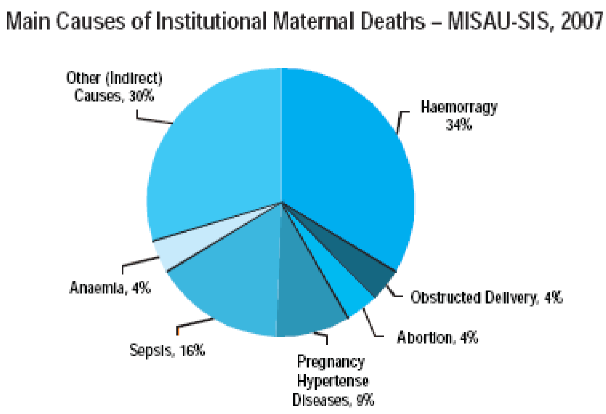
In 2008, the National Statistics Institute published a new edition of the Multiple Indicator Cluster Survey that collected data from nearly 14,000 households across the 11 provinces of the country, including relevant information about assistance during delivery and other key indicators related to maternal health. The survey (INE, 2008:12-13) indicates that 42,6 % of women were attended by midwifes at delivery. The percentage is just slightly higher than the 39,4 % of women that give birth attended by a friend or relative. In this context, just 1.0% were attended by a doctor. These data contrast with Maputo city, where 91,5 % of women were attended by skilled staff. This comparison reveals the huge differences in access to basic obstetric care between rural and urban areas in Mozambique.

As described above, maternal mortality is a combination of multiple biological and social factors, usually integrally interrelated. In order to analyze the relevant factor influencing Mozambican maternal mortality rates, a brief analysis of the causes of maternal mortality is reviewed below, emphasizing the main factors described on MDG Reports, the Strategic Plan of the Health Sector in Mozambique, and other relevant national and international sources such as UNICEF in the Maternal and Newborn Health Report 2009 (UNICEF, 2008a:2-24).

2.2.4 Relevant factors determining maternal mortality in Mozambique.

The first set of causes are described as *direct causes*. Direct causes, also named immediate medical causes, are those maternal deaths (maternal deaths mostly occur from the third trimester to the first week after birth) related to obstetric complications – including post-partum haemorrhage, eclampsia, infections, and prolonged or obstructed labour. It also includes complication following abortion. The information concerning maternal mortality direct causes comes mostly from institutional deliveries, due to lack of information from home based deliveries.

Intra-hospital maternal mortality represents an indicator of quality in relation to pregnancy and delivery health care. Routine reports detailed in the MDG 2008 report of the Mozambican Government (MPD,2007:35) report that the Intra-hospital Maternal Mortality Ratio per 100.000 live births has decreased from 234/100.000 live births in 1993 to 163/100.000 live in 2007 although there was an increase to 185/100.000 in 2006. The Ministry of Health (MISAU, 2007a: 2-6) reported an intra-hospital Maternal Mortality ratio of 198/100.000 live births in 2008. The main obstetric complications in Mozambique are: haemorrhage (34 % of deaths), sepsis (16 % of institutional maternal deaths), pregnancy hypertensive diseases (9 %), obstructed delivery (4 %), and institutional abortion (4%). According to the Reproductive Sexual National Policy of the Ministry of Health (MISAU, 2007a:2), unsafe abortions constituted 11 % of maternal deaths in 2003. Analysis of these data should be done carefully as underreporting and misreporting is usual within the Health Information System, especially with maternal mortality data.

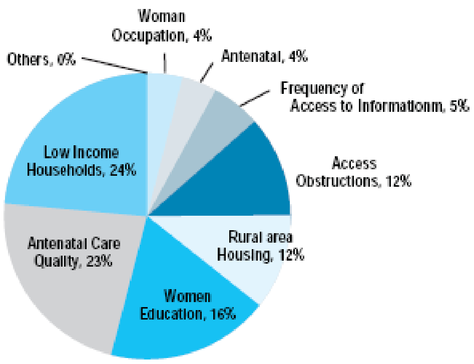


MDG 2008 Report (MDP,2008:36)

Figure 2.1. Main Causes of Institutional Maternal Deaths.

The second set of maternal mortality causes, *indirect causes*, includes factors that contribute to a mother's risk of dying, that are exacerbated by pregnancy. In developing countries with a weak health information system and a weak diagnosis capacity, as in Mozambique, it is difficult to attribute these causes to pregnancy. On the other hand, analysis of indirect causes is extremely relevant to maternal health policies and the design of strategies. The main indirect causes of maternal mortality in Mozambique are related to HIV/AIDS, malaria, nutritional aspects (with special relevance to maternal anaemia), and low access to basic health care support, and more specifically, to quality antenatal care and support (MISAU, 2008a:21-23). MDG 2008 report (MDP, 2007:36) shows that 34 % of institutional maternal deaths are related to indirect causes, including a 4 % of anaemia.

According to UNICEF (2007a:12-13), worldwide antenatal care coverage from 2000-2007 with at least one visit was 85 %, whereas only 53 % of pregnant women realized at least four antenatal visits. In Mozambique, according to the 2008 MDG reports (MDP, 2007:36), there are several factors that have been recognized as potential causes in obtaining proper delivery care and support by a qualified practitioner. Social and economic issues, including low income households (24 %), rural area housing (12 %), access obstructions (12 %) and women's education (16 %) that includes also cultural and anthropological aspects, are the most significant factors. Aspects related to lack of antenatal care quality, or poor support, contributes to 23 % the inequalities in deliveries.



Source: (MDG, 2008: 36-37)

Figure 2.2. Factors that contribute to inequalities having deliveries attended by skilled staff.

Within these categories lie several explanations that explain why access to obstetric care remains, in most cases, unachievable: *basic or structural causes* include relevant aspects such as health education, knowledge, inadequate maternal health practices and care seeking, poor environmental health facilities, inadequate health-care services and limited access to maternity services (including limited access to skilled health workers) (UNICEF, 2007a: 15-24). As Talamanca suggests (1996:1381), these factors highlight the inability of the health national system to set up effective family planning programmes, to increase access to qualified health care and the failure to provide obstetric care when and where it is needed.

Maternal mortality rates measure the risk of a mother dying during pregnancy, during delivery or in the weeks following delivery (within 42 days), and the number of pregnancies that a woman has already experienced. In this context, family planning policies and promotion are crucial contributors to decreasing the maternal mortality indicator. In relation to family planning in Mozambique, the total prevalence rate of contraception has increased from 6% to 17% (MPD, 2008:32). The rate of contraception through modern methods was 14.2 % in 2003 and did not decrease in 2007. The level of unsatisfied demand for Family Planning Services was 53% in 2003 (MISAU, 2008a:1-2). These indicators show a significantly low use of family planning services.

Infrastructures, services and human resources determine which health services can be offered. Mozambique has an inadequate health network and health coverage and, especially, inadequate maternal health care services. The Strategic Health National Plan (MISAU, 2008a:22-23) indicates that only 50 % of the population has access to acceptable health services. Furthermore 30 % of the population has limited access to health services. According to national statistics presented by MISAU (2008a: 23) Mozambique has one primary level health unit for every 17.000 inhabitants, and one secondary level health facility for every 501.000 inhabitants.

In addition, transport for referral and emergency response (including public transport) is another major factor influencing maternal mortality rates. The system responsible for availability monitoring established by MISAU (2007b:86) indicates that in 2007 just 14,5 % of the health units had access to an ambulance. The lack of appropriate public transport affects the entire continuum of fundamental care needs during the pregnancy cycle: antenatal, deliveries and post natal consults.

Another relevant basic cause that affects and limits access to quality maternal health care services is the crisis of the health workforce that faces Mozambique. Mozambican health workforce indicators are among the worst in the world. According to the Ministry of health, the shortage of health workers is actually the single greatest barrier to fully attain MDG goals (MISAU, 2008b:1). The main health workforce indicators show that in 2006 total health workers (doctors, nurses and midwives) per 1.000 populations was 1,26, the number of doctors per 1.000 populations was 0.043, the number of nurses per 1.000 populations was 0.21, and the number of skilled birth attendants per 1.000 population was 0.14. According to WHO recommendations (MISAU, 2008b: 3), in order to achieve the health MDGs, a minimum density of 2,3 health workers per 1.000 population is needed. Mozambique falls a long way short of desirable numbers.

Finally, we can describe *underlying causes* that prevent the utilization of potential resources in the scope of maternal health services. Underlying factors do not affect exclusively maternal mortality rates, but interaction between them can reduce access of women to quality maternal health care. It is absolutely necessary to analyze these factors in order to establish correct, safe motherhood programs and strategies (UNICEF, 2007a:15-20).

Poverty is one of the key factors that affect maternal mortality. According to a UNDP report (UNDP, 2008:240), 74,2 % of the Mozambican population lives on less that 2 $ per day. Women tend to live in an even more negative situation, as indicated by the Gini Index which measures inequalities between men and women. Gini Index (1 means total gender equality and 0 total gender inequality) in Mozambique is 0.373 showing a high degree of gender inequity (UNDP, 2008:329). Educational indices also demonstrate inequality between women and men. The combined gross enrolment ratio for primary, secondary and tertiary education in 2005 for males was 58 % against 48 % for females. The adult literacy rate from 1995 to 2005 (% aged 15 and older) was 54,8 % for males and 25,0 % for females (UNDP, 2008: 329). In conclusion, poverty, education and gender inequities are underlying factors that contribute to the high maternal mortality indices.

In conclusion, the literature review indicates multiples causes that affect maternal mortality rates in Mozambique. Before going into detail of proposed strategies to reduce maternal mortality, we review the "Three Delays" model as a theoretical framework that analyses and explains the main barriers that women face to obtain in-time quality obstetric care.

2.3 THE THREE DELAYS MODEL

As described above, numerous factors contribute to maternal mortality. However, the interval between the beginning of obstetric complication and its conclusion is one of the most critical aspects. The "Three Delays" model (Thaddeus and Deborah, 1994) proposes that pregnancy-related mortality is mainly affect by delays in: (1) delay in the decision to seek care, which means delay deciding to seek appropriate medical help for an obstetric emergency; (2) delay in arrival at a health facility, therefore delay reaching an appropriate obstetric services and (3) on behalf the health system, delay in the provision of adequate care when it is reached.

Source: adapted from Taddeus and Deborah (1994)

Figure 2.3. The three delays.

The first delay stems from a failure to recognize danger signs. This is usually a result of the absence of skilled birth attendants. It may also stem from reluctance within the family or community to send (or allow) women to attend health facilities due to financial or cultural limitations. The second delay is caused by a lack of access to a health facility, a lack of available transport or a lack of knowledge of the existing services. The third delay relates to difficulties in the referral facility (including inadequate equipment or a lack of trained personnel, emergency medicines or blood).

All countries that have reduced maternal mortality have done it through a dramatic increase in hospital deliveries. Therefore, maternal mortality reduction programmes should give priority to the availability, accessibility and quality of obstetric facilities (UNFPA, 2010). It can be said that the first delay is related to the procurement of services, whereas the second and the third are related to the offer of services. Strategies to improve maternal health care should contemplate both, offer and demand, due to the multiple origins of causes. However, distance and cost are major obstacles in reaching appropriate obstetric facilities. As a result, the governments of most developing countries are mainly trying to increase access and reduce the second delay. Maternity waiting homes are one of the strategies most recommended as they are designed to reduce the gap between the community and the health system. MHWs try to reduce delays in treatment by moving women at risk into MWHs located near hospitals. MHWs therefore contribute especially to reducing the second delay of the “three delays” model.

Before going into detail of the description of MWHs service (experiences and main service characteristics), a brief review of the safe motherhood strategies promoted in Mozambique is presented.

2.4 SAFE MOTHERHOOD INTERVENTIONS IN MOZAMBIQUE

Improving maternal health is one of the most highly prioritized strategies of the Ministry of Health of Mozambique. Several national and provincial documents testify to the focus on ensuring safe motherhood (MISAU, 2008a; MDP,2008). The strategies proposed can be classified according to the three delays model, described above.

2.4.1 Interventions to reduce the first delay: community level.

An increase in services offered both in terms of quantity and quality should have a positive impact on the reduction of maternal mortality rates. However, several studies and practical experiences show that in order to significantly reduce maternal mortality rates, it is absolutely necessary to strengthen the health education of the population, with special emphasis on women (UNPFA, 2010; UNICEF 2008a). It is necessary to improve the knowledge and life skills of pregnant women and families on the danger signs of maternal and newborn health and about the characteristics of referral systems. Furthermore, information, education and communication strategies of health promotion and health services should be established from health facilities, communities, schools, and other information centres.

But expanding service delivery may not be enough if women and girls are deprived access to essential services because of cultural, social, or other well-known barriers. In this context, providing a supportive social context for the rights of women and girls is also critical to reducing maternal mortality and morbidity. According to Yamin (2005:5), reproductive and sexual rights have played a significant role in the incorporation of human rights into public health work. Furthermore, the woman's rights approach implies a multi-sector and long-term intervention. The enhancement of woman's rights could be considered as among the most difficult of interventions in countries like Mozambique, due to, in addition to other relevant factors, the low index of women education and literacy. Other major contributory factors include inertia and continuity of traditional gender, family relationships and constructions of sexuality. It is essential to provide services at key points in the life cycle, through integration of dynamic health systems which consider health care aspects of home, community, outreach and facility-based care (UNICEF, 2008a:27) .

Even considering the importance of supporting women rights, it is necessary to be realistic and to measure the real impact and limitations of the policies and strategies promoted by health systems. Several authors (eg Yamin, 2005:9) state that it is necessary to accept the limitations of health systems in addressing women's needs before establishing priorities. This literature review highlights the need to focus on quality and increase institutional delivery coverage as the key priority in the short term.

2.4.2 Interventions to reduce the second delay: reaching obstetric care.

The second strategy includes a set of activities seeking the improvement of health coverage, and more specifically maternal and reproductive services coverage. This strategy seeks to reduce the second delay in order to offer in-time obstetric care when necessary. Within this aim, the health strategic plan 2007-2012 (MISAU, 2008a:36-38) establishes the target of increasing institutional deliveries from 48 % (2004), to 56 % (2010) and 66 % (2015). Several international studies note that an increase in institutional deliveries is directly related to a decrease in maternal mortality (Talamanca, 1996). In order to achieve this rise in institutional deliveries, it is estimated that it is needed to expand the health network, by 2025, by one rural health facility per 10.000 population (of type II which includes maternal health services). There is currently a deficit of approximately 750 rural health facilities. The health facility should be equipped with one ancillary worker, one medical agent, and one maternal and child health (MCH) nurse. In addition it is necessary to establish one district hospital with surgical capacity (two rooms) per district.

Maternity waiting homes are considered indispensable in the scope of safe motherhood. The existence of maternity wards inside health units allow mothers to wait in a safe environment. The plan of the Ministry of health plans to achieve at least 65 % of head districts health units with maternity wards (MISAU, 2008a:38). The increase of access to health services should link households and communities, and also health facilities of the primary level with hospitals or another secondary facility. It is a key objective to improve and strengthen the referral system by organizing correct communications (radio communications), available ambulances fleets, and protocols for transfers.

2.4.3 Interventions to reduce the third delay: obtaining valuable obstetric care.

The third set of strategies seeks to improve the capacity of the system to provide valuable obstetric care inside the health facilities of the National Health System. It is directly related to access of the population to skilled health staff – a doctor, nurse or midwife – at delivery. This access will minimize maternal deaths related to direct causes, and also indirect causes. Skilled health personnel are associated with an improvement of diagnostic capacity and treatment of obstetrics complications. According to UNICEF (2008a:16-18) skilled health professionals throughout pregnancy, birth, post-partum and neonatal care are among the most vital elements in reducing maternal mortality rates. The National Human Resources Plan of the Ministry of Health was launched in November of 2008 (MISAU, 2008b). The plan seeks an increase in the total number of health workers from 25,683 (1.26 per 1,000 population) to 45,904 (1.87 per 1,000 population). This increase is still below the 2.3 per 1,000 populations proposed by WHO, but it is considered that it could be a realistic and efficient target increase considering the current critical situation. The plan details the aim of increasing by 141 % the number of health workers directly involved in clinical tasks (from 1.896 to 4.572), concretely a 119 % of doctors and 68 % of nurses. These forecasts expect to achieve an increase of the number of trained birth attendants per 1,000 population from 0,14 (2006) to 0,20 (2015).

Through skilled health professionals and also the improvement of the quantity and quality of health facilities, Mozambique (MISAU,2008b:38) expects to expand the programs of Basic Obstetric Care (BOC), Comprehensive Obstetric Care (COC) and Emergency Obstetric Care (EOC). It is planned to expand the COC from the current 0,95/500.000 populations to 1,1/500.000 population in 2010. EOC is expected to expand from 1,23/500.000 population in 2003 to 3,0/500.000 population in 2010 and 4,0/500.000 population in 2010. Finally it is expected to improve the coverage of treated complicated obstetric care in health units with ECO from 16% in 2001 to 30 % in 2010, and to decrease the deaths caused by direct obstetric complications from 2,3 % in 2001 to 1,5 % in 2010.

Ensuring quality antennal care providing a comprehensive package of health and nutrition services is another key strategy to improving safe motherhood. A post-natal visit for every mother and newborn as soon as possible after delivery, ideally within 24 hours, with additional visits towards the end of the first week at four to six weeks (UNICEF, 2007a:18). Post-natal care urgently needs to be expanded during this period (24-28 hours after delivery). In this context, the Ministry of health expects to increase the post-natal coverage from 56 % registered in 2003 to 80 % in 2015 (MISAU, 2008a:38).

Basic preventive and curative interventions include immunization against neonatal tetanus for pregnant women, routine immunization, distribution of insecticide treated mosquito nets and oral rehydration salts, among others. Within this context, the Ministry of health forecasts a reduction of 60 % in the current lethal index of deaths by malaria in pregnant women, to reinforce the availability of personnel and collective measures against malaria (treated mosquito nets, pulverizations, etc) and to increase the ratio of pregnant women attending antenatal check-up and receiving at least two doses of Preventive Intermittent Malaria Treatment (PIT) from an actual of 37,2 % to 55 % in 2012 (MISAU,2008a:38-40).

Preventing mother-to-child transmission (PMTCT) of HIV and offering antiretroviral treatment for women in need is also a key activity considering the high levels of HIV prevalence, mainly focused in the south and central region of the country. The Ministry of Health plans to expand to 95 % the PMTCT services in 2015 (MISAU, 2008a:38-40). Other STI control (with special incidence to syphilis) is strongly promoted by the national health system, seeking to achieve treatment for the current 60 % of patients, to 85 % in 2010 and finally 95 % in 2015 (MISAU, 2008a:38-40).

Considering the high fertility rates of Mozambique and its combination with low access to basic maternal health care, promoting access to family planning services appears as a key strategy to decrease maternal mortality. In this context the Ministry of Health launched in 2007 the National Strategy for Sexual and Reproductive Health which declares targets and activities looking for, within other key aspects, to promote access to family planning services (MISAU, 2007a). The Ministry of Health is committed to improve the contraceptive coverage from 14 % registered in 2003, to 24 % in 2010 and 34 % in 2015 (MISAU, 2009b:39).

The explicit recognition of the three delays that contribute to maternal deaths makes it clear that, to prevent maternal deaths, interventions must operate on one or more of the identified steps. Literature review (Loukhujesen *et al*, 2009) emphasizes the interventions to reduce the delay between the onset of serious complications of pregnancy and the arrival of the patient at hospital. Within this context, maternity waiting homes appear as a valuable options intended to minimize this risk. In addition, MWHs appear as a cost-effective strategy in developing countries intended to increase institutional deliveries and by this intervention, reduce maternal mortality.

2.5 MATERNITY WAITING HOMES

Maternity waiting homes are considered a valuable strategy in developing countries to reduce the gap between communities and the National Health System. As it has been described before, the Ministry of Health of Mozambique prioritized the set up of this service (as in other regions of the world) as a sustainable strategy to improve institutional deliveries especially in rural areas (MISAU, 2009a).

In the section, below, the concept of MWHs is described and several experiences around the world are detailed in order to explain the crucial aspects and functioning factors that influence the success of MWHs services. In addition, the MWH strategy recently launched in Mozambique is analyzed, providing the outcomes of an assessment realized by the MISAU in order to characterize the performance of this service.

2.5.1 Description and purpose of MWHs

A MWH is a facility located near a Hospital or Health Facility that provides maternal health care services (antenatal care, skilled births attendants and emergency obstetric care). Women may stay in the MWH at the end of their pregnancy and await labour. Once labour begins, pregnant women can move to the health facility ensuring that the birth is assisted by a skilled birth attendant (Lonkhuijzen *et al*, 2009:3). In some cases, MWHs seek not just to decrease maternal mortality but to improve maternal and neonatal health. In these cases, MWHs place special emphasis on education and counselling regarding pregnancy, delivery and care of the newborn and family.

Initially, MWHs were mainly intended for women with high-risk pregnancies (major obstetric abnormalities) living in remote and sometimes inaccessible areas. Progressively in developing countries, the concept of high-risk has been expanded including all women living in rural areas (and even sometimes urban areas), those expecting their first delivery, women with multiple births, young pregnant women and also older pregnant women, or those with identified problems such as high blood pressure, and other conditions. There are experiences in countries that also promote the use of MWHs in case of social exclusion, violence at home, etc. In conclusion, in most developing countries, the admission criteria are very wide, considering definitively that all willing women are allowed to use this service with the aim to ensure that institutional deliveries is increased (WHO,1996:2).

In this literature review, we define two identifiable sets of publications concerning MWHs. The first group attempts to describe the experience of MWHs illustrating their main characteristics, liaisons with community, internal management, etc. The second group of publications attempts to assess the effectiveness of MWHs in reducing maternal mortality.

2.5.2 A review of MWHs experiences

The concept of homes for women with high-risk pregnancies and also women with economic and social problems has a long history. In Europe, several volunteers and charity organizations made available refuge for pregnant women in order to avoid abortion and infanticide. More specifically, in Northern Europe, waiting homes were built near hospitals to help women living in distant geographical areas that had limited access to obstetric care. For example, in Finland where there are remote communities with access difficulties and few obstetric services, nurses' facilities serve as "patient hotels" with the same aim (WHO,1996:2).

During the second half of the 20th Century the strategy of MWHs has been promoted in several developing countries to bring women near health facilities, in order to increase institutional deliveries and, as a result, decrease maternal mortality. But as Talamanca notes (1996: 1382), unfortunately most of the experiences have been not documented properly, making it particularly difficult to assess the effectiveness of these services.

In her article *"Maternal Mortality and the Problem of Accessibility to Obstetric Care: The strategy of Maternity Waiting Homes"* (Talamanca, 1996) describes the experiences of several authors illustrating MWHs operating in Africa since the nineteen fifties, in particular in Uganda, Nigeria, Malawi and Ethiopia. The general perception of the report's authors is that MWHs have reduced stillbirth and also institutional maternal deaths. However, the methodological approach used to confirm this information is not provided.

In 1996, the WHO published a report titled *"Maternity Waiting Homes: A review of experiences"* in the scope of the Safe Motherhood initiatives launched in

1987 by three UN Agencies in Nairobi. The report details some examples of MWHs from Africa, South Africa and the Caribbean still running when the document was published. As in the case of Talamanca, the review focused on three particular examples: Ethiopia, Cuba and Nicaragua (WHO,1996:2-4; Talamanca: 1996:1382-1384).

In *Ethiopia*, a “Tukul” (the name by which a MWH is known in this country) was built in 1976 attached to Attat Hospital, a 55-bed rural community-based hospital in the centre of the country. The Hospital, 17 km from the nearest town, had a catchment area that contains 300 000 people. The admission criteria of the “Tukul” focused on women identified as being at high-risk, indentified by traditional birth attendants (TBAs) and community health workers selected by community committees. The facility was built in the style of a local house, costing US$ 1000 (labour and most of the materials were provided by village communities), with a total of 15 beds. Women supply their own food. The average length of stay was 15 days, and during this stay the women attend the antenatal clinic located at Attaat Hospital. In addition, a nurse visits the “Tukul” once a day.
The records indicated that in 1987, 151 women, the majority at high risk, were admitted in the “Tukul”. The hospital registered 13 maternal deaths, not one of which was of a woman who first entered the “Tukul”.

The Cuban experience is particularly interesting because of the comprehensive register of MWH services. Maternal mortality in the Caribbean country decreased, between 1962 and 1989, from 118 to 29 per 100,000. In this period, institutional delivery experienced a considerable increase from 63 % to 99 %. It is considered that the set up of MWHs that increased from 22 in 1970 to 148, in 1989 contributed significantly to these improvements. The MWHs network in Cuba is completely integrated within the National Health System. Referrals to MWHs are done by the family physician that provides prenatal care to pregnant women. All MWHs are built attached to a local hospital or within a reasonable distance. A particular characteristic of the Cuban experiences is the availability of national health workers in MWHs, with an average of 0.8 full time health workers (nurses, auxiliaries and labourers) per bed. In addition, the staff also sometimes includes one or more full-time physicians or midwives. Medical care includes daily vital signs and blood pressure measurements done by a nurse, as well as at least one obstetric check-up twice a week by the physician. All the activities required to maintain the infrastructure in a good condition, including day activities such as cooking and cleaning are carried out by labourers. Educational and health promotion activities are offered to women staying in the MWHs.

Each women staying at a MWH has a complete record with relevant background, laboratory test, completed clinical data and other important information. This record accompanies the patient to the health facility at delivery. Finally, another evidence of the sound and systematized system is that the MWHs networks submit a report of their activities every 3 months to the Ministry of Health. In addition, the Cuban experience is characterized by a community service aspect. Several groups based at community level support the MWH (agriculture cooperatives, women's organization, and others).

By 1990, there were 150 maternity homes distributed throughout the Island, with a total of 2365 beds. In 1989, nearly 30 % of all deliveries used MWHs. Although MWHs have been assessed positively, empirically, there is no definitive evaluation of the impact. However, it is widely considered that they have undoubtedly contributed to raising the rate of institutional deliveries in Cuba (WHO,1996:2-4; Talamanca: 1996:1382-1384).

In *Nicaragua*, the first "Casa Materna" (Maternity House) was built in 1987 as an initiative of the Nicaraguan Women's Organization with initial support and Swedish Cooperation and the Nicaraguan Government. The "Casa Materna" had a special focus, besides the aim to reduce maternal and neonatal mortality, on women education and family planning. As evidence of these two objectives, the facility has two centres: the Centre for High Risk Pregnancies and the Continuing Education Centre. Women at high risk are identified by local authorities in their communities. Women come approximately one week before delivery and, after delivery, stay for four to six days receiving information and health advices about newborn care. There was no cost for any services at the "Casa Materna". No workers received salaries. The facility had twenty beds, and when WHO report was published, none of the mothers at the "Casa Materna" had died due to childbirth-related illness. The Director of the facility expressed that the main challenges to maintaining the service are the financial sustainability and the lack of financing.

Talamanca (1996:1384) described another relevant experience of MWHs in *Colombia*, where in 1986 was instituted a "Casa Hogar" near the city of Cali. Women were referred by a health team or health promoter. MWH was built, following a local style with three bedrooms, by the community with local contributions, and in this case was located 1 km from the local hospital. Women paid a small fee to stay. Permanent staffs included two health promoters (salaries paid by the government) and, in addition, weekly hospital staff provide health care to users. The facility adopted an "open house" policy and all women were accepted. Health education was a key component of the "Casa Hogar" (with participation of teachers, educational programmes, etc). This experience is a clear practice of community intervention.

In *Ghana*, Wilson *et al* (1997: 5165-5172) detailed the process of setting up of a MWH in the Nsawam district, after conducting preliminary studies and focus groups that identified distance as a major barrier to institutional deliveries. A ward was completely renovated (with eight beds) with government and cooperation funding, and was inaugurated in 1994. Posterior evaluation revealed that in one year just one woman attended and spent only one night. Focus group discussion with community members and hospital staff revealed that the associated cost of using the facility, distress at being away from home, distance from the hospital, lack of health staff, a deserted environment and lack of perceived need were the reasons for poor utilization.

More recent experiences have also been described. Friederike Amani Paul (UNFPA, 2007) provides some details about a “Chigonella” (meaning those waiting for delivery), a Maternity Waiting Home at the Dodoma regional Hospital running since 1992 in *Tanzania*. The publication highlights the importance of MWHs for high-risk women, specially primigravidas and older pregnant women. In addition, the author emphasizes the desperate situation of the facility and other MWHs around the country due to saturation of the services. MWHs, initially designed to accommodate 15 women are lodging 50 to 80 pregnant women. This indicator shows considerable utilization of the services.

In *Honduras*, MWHs were introduced as part of a strategy to improve maternal health. TBA were trained in order to increase referrals and also to raise the identification of high-risk pregnant women. A study showed that hospitals with a MWHs compared to hospitals without MWHs registered more women who were older than 34 or had more than 4 deliveries. In this sense, the study suggested that MWHs contributed to identifying women with high-risk pregnancies and encouraged them to use MWHs and use health facilities to give birth (Lonkhuijzen *et al*, 2009:4).

Eckermann and Deodato (2008) described the experience of Maternity Waiting homes in *Laos*, operationalized by the Silk Homes project in the South of the Country. Silk Homes are described as multi-function centres that provide information, education and safe delivery. The project, funded by the Italian Cooperation, plans to build 17 MWHs, one in each district of three provinces. The innovative nature of this project resides in the fact that it seeks to integrate various health programmes with economic interventions and small Income Generating Activities (IGA), micro credits, linking elaborated products by pregnant women with local markets. It is an integral approach that aimed to overcome women’s resistance to using MWHs by providing an additional value based on education and micro-economic opportunities. It is important also to emphasize that this project also includes the provision of economic (10,000 Kip/day per women) incentives and other non-economic supplies (rice, oil, clothing and household items) in order to ensure women's adherence. The Assessment of Skilled Birth Attendance in Lao PDR launched in 2008 (MOH and FNUAP, 2008) provided some information about the outcomes of some of the MWHs that were opened. The main concern of health officers was the sustainability of the program.

Other factors besides sustainability can lead MWH services to fail. In 2007, Shrestha *et al*. described the failure experience of MWHs in *Nepal*, where out of the 27 MWHs available not a single one had been utilized by pregnant women. The cross-sectional study was based on 18 pregnant women and 14 health workers interviews and focus groups. After the analysis of data, the authors conclude that many women were unaware of the service and that the community was not involve in the establishment of the MWHs, highlighting the need for information dissemination and promotional activities to increase the utilization of MWHs.

UNICEF describes the promotion of a MWH set up in *Afghanistan* in 2008. A 17-bed facility became fully operational in 2008 located near Kandahar hospital. The facility had a female medical team in order to conform to local customs. No information about usage is provided (UNICEF,2010),

These are some of the experiences that the literature offers about MWHs around the world. The second set of articles, described below, detail other experiences that try to assess the impact of MWHs from a more scientific approach, using quantitative and in some cases qualitative approaches. However, few official guidelines regarding the development of Maternity Waiting homes are available. The experiences, described above, indicate a wide variety of services. In order to contribute to the theory of the MWH strategy and before elaborating the details with this second set of articles, a brief summary of the critical elements of a maternity waiting home are described, with special emphasis on the strategy launched by the Ministry of Health of Mozambique in 2009.

2.5.3 Key elements of MWHs management and functioning

Initial guidelines regarding MWHs were published by WHO in 1996 in the document “Maternity Waiting Homes: a Review of Experiences” (WHO, 1996). These guidelines highlighted the importance of considering MWHs as a part of the continuum of maternal care, and not just as a facility that exists in a vacuum. In fact, the experiences detailed at that time, focused on several aspects that suggest that crucial aspects affecting the success of MWHs, occur outside the facility. According to the WHO (1996:7), MWHs should be understood as part of a complex chain of factors affecting maternal health status.

Considering the WHO guidelines and also lessons from empirical experiences, figure 2.4 shows the key elements affecting the level of success of MWHs reducing maternal (and neonatal mortality).

Related to the high-risk selection there are three approaches: (i) a high-risk medical approach to identifying pregnancies likely to develop complications and refer these to a MWH; (ii) a high-risk multifactor approach that promotes a broader concept based on a combination of distance, socioeconomic and medical risk factors, and; (iii) an open access approach that understands MWHs as a proxy for institutional deliveries. In order to define the best approach it is indispensable to assess the capacity of the NHS to correctly identify high risk cases and, secondly, if the health system is able to provide care to the identified women. This analysis should be locally evaluated and depend on available resources.

Figure 2.4: Crucial aspects influencing a MWH.

Referring women to MWHs is a key factor, especially in developing countries. To involve the community and TBAs appears as the best solution if antenatal care visits present a low rate. However, in countries where the continuity of care is more stable, the involvement of health services is crucial for referring. As has been noted before, in systems in which the family physician has a relevant role, the involvement of this person appears as the best option.

The whole purpose of MWHs is to provide women (especially those with obstetric risk) access to qualified obstetric care. In this sense, MWHs can be set up near a health facility with Basic Obstetric Care or a health facility with Complete Obstetric care (operating theatre). In the first case, it is indispensable to ensure rapid transferral for complicated situations. However, in developing countries this is also a problem. The options depend on the local situation regarding the resources and on the characteristics of the community.

Related to this point, it is crucial to analyse the human resources available in the health facility. Again, the capacity of the National Health System will be a determinant, though obviously skilled staff is strongly recommended. The presence of an obstetric specialist in each MWHs is strongly recommended. In any case, in countries where human resources are scarce and no specialists are available in each facility, it is important to reinforce the visits to the MWHs, establishing, at least, periodical daily rounds in order to detect complications.

The maintenance of the MWHs is a critical issue. The literature review indicates several experiences where lack of maintenance is identified as a factor that limits the success of the strategy (Mann *et al*, 2006). Several options can be implemented, however, if the health system is sufficiently strong. It is recommended that the maintenance of the service is assumed by the state in order to ensure long-term continuity. Others options focus on self-maintenance by women users, or community involvement. On the other hand, other experiences try to generate income, by small economic activities, in order to guarantee funds. Most of the cases promote a mix of these options in order to ensure community involvement. No information about success in self-maintenance has been found.

Clinical records and other relevant information should be collected in MWHs in order to evaluate the services. It is strongly recommended, that MWHs registers, data and indicators should be incorporated into the routine health information system. However, with special incidence in developing countries, records are non-existent making proper assessments difficult.

The location of women in MWHs is an important opportunity to promote educational activities with a focus on maternal and neonatal care, family planning, STIs and HIV, and other critical health conditions. Community health workers can play a relevant role; however clinical staff involvement is also suggested.

Several studies (Wilson el at, 1997; Talamanca,1996; Eckerman and Deodato, 2008) identify the associated cost for women using MWHs as the main barrier to access. This critical point can be overcome by promoting economic incentives for users, but this may seriously hamper sustainability. In some cases it is allowed that women may stay with their family in the facility, however this approach may also lead to complications. The associated cost is the most complicated and crucial aspect, and definitively is intrinsically linked to the economic and social status of women in developing countries.

Finally, MWHs success will depend on community involvement, support, approval and cultural acceptance. It is necessary to adapt cultural aspects, such as the sex of those responsible for carrying out visits (in most developing countries it is recommended that these are women and not men), or the promotion of some cultural practices and traditions, such as to bless the facility according to local beliefs, and other strategies to increase population acceptance of the service.

2.5.4 MWHs strategy in Mozambique

Although there are records that prove the existence of MWHs before, the official strategy of Maternity Waiting Homes was launched by the Ministry of Health in 2009 (MISAU, 2009a). In fact, the national assessment of Maternal and neo-natal health needs (MISAU, 2009c:105-111), characterized and assessed some aspects of the MWHs performance in Mozambique, before the strategy was officially launched.

The strategy defines the strategy to properly manage MWHs in the Mozambican context, highlighting the following aspects:

(1) Related to construction:

   a. Location of the building: inside the Health Facility area in order to ensure control by women and supervision by health staff.

b. Type of construction: low cost facility with similar characteristics to local infrastructure, where possible, improved construction (brick buildings are recommended in order to ensure sustainability), however also be aware of maintenance costs.
c. Responsible for construction: District Health Boards Budget should ensure materials, or if not possible, NGO contributions and community should ensure the work. In the cases of MWHs located in Rural Hospitals, the whole construction is the responsibility of the District Boards.
d. Maintenance: shared responsibility between community, health district Board, Health Facility and Local Governments.

(2) Equipment of MWHs:

a. Bed, mattress, pillow and mosquito net should be the responsibility of the Ministry of Health (Health District Boards).
b. Table, chairs, closets and other complementary furniture should be provided by the Provincial and district government, community and NGOs.

(3) Management and functioning responsibility:

a. The strategy promotes a participatory process with the involvement of multiples actors, namely: Provincial Government, District Health Board, the Health Facility where the MWH is located, NGOs, community organizations, families and pregnant women.
    i. Responsibility of the Provincial Government: advocacy and political leadership to ensure effective support to MWHs setup.
    ii. Responsibility of Health District Board: To indicate a focal point responsible for MWH management; to ensure that no illegal payments are tolerated and monitoring of MWH performance.

iii. Responsibility of Health Facility: to ensure obstetric care for pregnant women; to ensure available staff to attend pregnant women staying at MWHs at night (feminine staff); staff assessment regarding support to users; cleaning of MWH, bathrooms and facility surroundings; equilibrated alimentation for pregnant women; to ensure that educational health activities are performed as well as supervision and monitoring.

iv. Responsibility of the community: to indicate a focal point co-responsible of the MWHs activities: co-responsible for maintenance; to encourage pregnant women to use MWHs (especially those with high-risk or with access limitations); to establish gardens, plantations of trees and to promote Income Generation Activities to support MWHs sustainability.

(4) Users criteria's:

a. Women identified as having high-risk pregnancies (special attention to antecedents)
b. Women that live in remote areas or areas with access limitations.

(5) MWHs Offered services:

a. Maternal Health Care with a weekly antenatal visit in the health facility, and daily, health staff should visit the MWH in order to monitor and assess pregnancies.
b. Preventive activities: multiple informative and counselling activities should be performed regularly concerning: neonatal care, post-partum care, HIV and AIDS prevention, etc.
c. Recreational and productive activities.

(6) Monitoring and assessment of MWHs services (including food provision to users)

a. Register book for all users indicating relevant aspects such as origin, reason for coming, diagnostic, etc.
b. Monthly and quarterly activity reports should be elaborated by the health facility and sent to district and provincial board.
c. Assessment services should be done by: (i) regular supervision visits by district and provincial boards and (ii) quarterly should be done a joint assessment by health facility, community district and provincial board.

In 2009 the Ministry of Health of Mozambique published a Maternal and Neonatal Health needs assessment. This assessment includes a characterization of the Maternity Waiting Homes by the study of a sample of 114 MWHs and an interview of 332 pregnant women that were using the service (MISAU, 2009c:105-111). The results show that:

(1) 55,26 % of MWHs were located in the head district health facility whereas 44,73 % were located in peripheral health facilities around the district.
(2) MWHs have a mean capacity to lodge 11 women, however at the time of the survey there was, on average, three women using the service.
(3) Relating to the type of construction, 77,5% of the visited MWHs had just a room (without additional spaces), 50,86% were build with bricks and in the periphery the most prevalent material was local with 43,48% (for more detail see pictures in chapter 5).
(4) Just 33 % of MWHs visited had electricity, whereas 46 % were illuminated by oil lamps.
(5) 72% of MWHs had no canalised water and 33 % of MWHs located in health facilities type II (periphery) had no bathroom.
(6) 62,5% of the visited MWHs had no beds.

In relation to the activities promoted by MWHs the survey indicates that 80 % of the MWHs offer food to the users. In addition the study reveals that only 38,33% of the MWHs promote educational and health promotion activities.

Finally, the study shows the result of the interview conducted with users. The key aspects identified were:

(1) 70,83 % of women interviewed expressed that there are barriers that make the use of MWHs difficult: 71,76 % indicated that difficulties taking care of children and carrying out household tasks was an important factor; 47,05% also referred to reluctance on behalf of the husband or mother in law to using MWHs; 25,88% of women referred to lack of awareness of being at risk.

(2) 53,11 % of women indicated that they were referred to the MWHs: 71,93% of those were referred by a health facility, 12,28% were attended the MWHs of their own initiative, 7,02% were referred by the traditional birth attendance and 6,68 % by relatives.

(3) The average length of stay was 12 days.

(4) 36,96 % of the women interviewed noted that they had a midwife's visit the day before the interview. 63 % indicated that they had a visit from a midwife, on average 11 days before the visit.

(5) 71,23 % of the MWHs were supported by the national health system whereas the rest were supported by NGOs or the community.

In conclusion, a literature review of the situation in Mozambique shows that the official strategy of MWHs was launched recently and, as a result, no common guidelines were used to standardize the service. In addition, the brief survey conducted by the Ministry of Health regarding MWHs characteristics and management indicated that, up until the present, most of the guidelines promoted by the official strategy are not being followed.

Finally, as mentioned above, in order to complete the literature review related to MWHs, we present a section focussing on studies that try to assess evidence of the impact of MWHs on maternal health.

2.5.5 The effectiveness of the MWHs

In the last two years, interest has increased in finding studies with the aim of assessing the effectiveness of MWHs. Several systematic searches have been carried out in order to describe the most important research that seeks to evaluate the impact of MWHs in improving maternal and also neonatal outcomes in low-resources countries. In addition, some latest research attempts to assess, in general terms, some particular features of MWHs.

Van Lonkhuijzen *et al* (2009) realized a study with the aim of assessing the effects of a MWH on maternal and perinatal health. The authors carried out a paper search strategy of all kinds of facilities designated for lodging pregnant women awaiting labour, with the aim of being assisted by skilled attendants during delivery. The selection criteria targeted randomised controlled trials, including quasi-randomised and cluster-randomised trials that compared perinatal and maternal outcome in women using a MWH and women who did not. The study did not find any randomised controlled trials or cluster-randomised trials. However, the search highlights the results from five studies that evaluated the effect of a maternity waiting home in several countries (Lonkhuijzen *et al*, 2009:3-7). Four of the studies were carried out in *Zimbabwe*. The first one, conducted by Chandramohan in 1994, assessed the outcome of delivery in 1573 women who used MWHs to 2915 women who did not. They found that (i) obstructed labour was higher among non-users (1% versus 0.006%); (ii) caesarean section was higher in users (18% to 15 %), and; (iii) that 31 % of women with high risk pregnancies had stayed in the MWH. The authors conclude that the success of MWHs depends on risk-selection, however if not managed properly, the patient load for the hospital may be counter-productive.

A second study conducted by Millard in 1991 also in *Zimbabwe* on a base of 854 births concluded that there was no significant difference in risk status, perinatal and maternal outcomes between users of MWHs and women who did no use the service.

A third study elaborated in *Zimbabwe* by Tumwine in 1996 analyzing 1053 births over 2 year period and found no significant difference in risk status or pregnancy outcome between users and non users.

While these three studies were focused on institutional deliveries, in 1998, Spans also included home births in his study of about 1041 deliveries in Zimbabwe (Lonkhuijzen *et al*, 2009:3-7). The data showed that 22% of deliveries occurred at home and 78% in hospital. Of those users of the health facility, 59 % used MWHs. The author concluded that MWHs improved access to hospital.

A fifth study was done in *Zambia*, in 2003. Van Lonkuijzen found no differences in the Maternal Mortality Ratio and Perinatal death rate between MWHs group compared to the non-MWHs.

The authors conclude that the findings of the studies reported should be interpreted with caution, as the literature describing the effect of MWHs provides limited insight into the potential benefit of these facilities (Lonkhuijzen *et al*, 2009:7).

Maternity Waiting Homes have also been assessed as part of a more integral package of strategies seeking to link families and health facilities (Lee *et al*, 2009:65-88; Bhutta *et al*, 2009:1-37). Both studies present a systematic review of interventions including community mobilization, financial incentives, emergency referral and transport systems, prenatal risk screening and finally MWH. Besides the results showed by Lonkhuijzen *et al*. described above, Lee *et al*. highlight the outcomes of two additional studies.

The first one was carried out by Poovan *et al*. in 1987 in *Ethiopia* where they evaluated the outcome for 151 women admitted to the MWH compared to women admitted from home, throughout a prospective cohort study. The assessment is based on the stillbirth rate and concludes a 90% reduction in MWH users (statistical significance of the data not provided).

The second study, a more recent one, was conducted by Guruvare in 2007 in *India* and is focused on six satellite maternity homes attached to tertiary care hospitals. The study seeks to compare pregnancy outcomes of mothers that used MWHs vs Indian national averages by a descriptive intervention design. The outcomes show that perinatal mortality rate in MWHs was 21 whereas the national average was 90.

To complete the literature review concerning MWHs assessment it is important to describe a rapid assessment of MWHs conducted in *Eritrea* in 2009 (Andemichael *et al*. 2009:18-21). The authors conducted research that contributes to the knowledge of the impact of MWHs in Eritrea, where the Ministry of Health has embarked on improving access to people in remote and inaccessible areas. The study assessed 11 MWHs in six sub-zones in Northern and Southern Red Sea Zones. The study concludes that institutional deliveries increased 48,5% in the period 2007/2008, when MWHs were introduced, compared to available data from 2006/2007. In addition the study indicated that there was no maternal death registered during the period under study. The research recommends the up scaling of the strategy because it is cost-effective.

Considering the spreading out of MWHs as strategy to improve maternal and neonatal health, the literature review shows few studies that attempt to assess the service. One of the reasons that could limit this type of research is the lack of registers used in most of the developing countries and the weaknesses of the health information systems. In Mozambique, for example, the MWHs official strategy was launched recently (2009) and, according to the reports of the Ministry of Health (MISAU, 2009c:105-111), most of MWHs until this time, have no consistent records, limiting the capacity to assess this services. In addition, registration books used in maternity services do not have information about the use of MWH making it impossible to conduct studies based on the health information system. In this sense, no information has been found about the impact of MWHs in increasing institutional deliveries in Mozambique.

Geographical Information Systems (GIS) are being used in public health studies to model where people live and the environments they experience throughout their lives. GIS emphasizes the geographical dimensions of access, and particularly is a very interesting tool to study the interaction between the population, health facilities, services offered and distance. Studies around the world show that utilization of health services decreases if distance to health facilities increases (Cromely and Mclafferty, 2003:234-235). MWHs are promoted in order to reduce this gap, and by offering a place to wait for delivery and increase utilization. Within this context, by geo-coding the population and health facilities, GIS appear to be a useful software to study access and limitations, as well as to assess the capacity of MWHs services to increase institutional deliveries.

2.6 GEOGRAPHICAL INFORMATION SYSTEM IN PUBLIC HEALTH

2.6.1 What is GIS?

In part because GIS is a contemporary, flexible, multifunction and dynamic technology, definitions of the term are considerably wide and differ depending on the scope of application of this technology. However, there is a consensus regarding key aspects that should be included in the description of GIS.

In general terms, GIS can be defined as a computer-aided database management and mapping technology with the aim of organizing and storing considerable amounts of multi-purpose information. In addition, GIS adds the dimensions of geographic analysis to information technology by supplying an interface between the data and a map (WHO, 2010).

Other definitions also include the concepts of geographical data and computer hardware and software in order to highlight the technology component that embraces GIS. As a technology, GIS depends considerably on computer hardware and other secondary equipment like scanners, plotters, printers, digitizing tablets and global positioning systems. But also, GIS is linked with other contemporary technologies, such as global positioning system (GPS) and remote sensing used to collect geographical data. Once geographical data is stored in digital form, other computer graphic software are used in order to create cartographic displays, as computer-aided design (CAD) systems (Cromley and McLafferty, 2002:15-17).

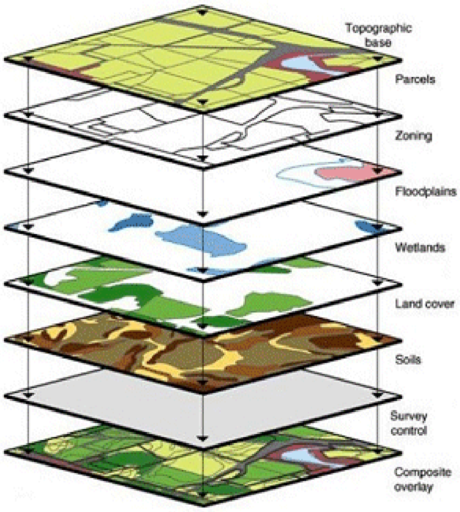
Source: www.lagic.lsu.edu/

Figure 2.5.GIS components.

GIS is a computer-based technology for integrating and analyzing geographic data, with the particularity that data composition of GIS software is not structured like a spreadsheet. Instead, positions and characteristics (features) on an earth's surface or point are stored. This allows us to analyze relationships within features, groups, etc. Summarizing, GIS technology allows us:

- ✓ To store, compute and display spatial relationships between entities, objects or points.
- ✓ To store numerous attributes of objects.
- ✓ To integrate spatial data from different sources.

GIS, as shown in figure 2.6, is a digital geographic database that registers all attributes to a common geographic reference system. With this information, a composite of two or more layers can be elaborated because the references match.



Source: http://sig-seu.blogspot.com/

Figure 2.6. Common geographic Reference System.

GIS has many functions, depending on the scope of application. However three broad categories can be emphasized (Cromley and McLafferty, 2002:19-37):

- ✓ Spatial Database Management: this function allows storing, retrieving and manipulating data in a database.
- ✓ Visualization and mapping: When the spatial database has been created and can be retrieved, the graphical display and mapping functions of GIS are especially relevant. Graphs are gradually more recognized as essential to good statistical analysis (whether the analysis is spatial or not) as visualization and mapping facilitates users to see the spatial relationships present in large and complex database, to report the results of an analysis in cartographic and other graphic displays.
- ✓ Spatial analysis: this function is related to the general ability that GIS technology possesses to manipulate data into different forms and extract supplementary meanings as outcomes. GIS spatial analysis can be classified into five forms: measurement, topological analysis, network analysis, surface analysis and statistical analysis.

2.6.2 Applications of GIS in Public Health

The application of GIS applications to public health emerged during the 1990s and consolidated in the 21st Century. Initially, in the 1970s-1980s, this application originated in developed countries, such as the USA, with particular interests in environmental health (Cromley and McLafferty, 2002:35). However, in the last two decades, with the decrease of hardware costs and the simplification of new software, GIS applications in public health have dramatically spread in developing countries as a useful technology for health services at all levels of the health systems.

GIS technology can improve the ability of practitioners, planners, and researchers to organize and link database in order to apply them in different areas.

Disease surveillance emerged as one of the key fields to be explored. This component includes determining the geographic distribution of diseases as well as analysing spatial and temporal trends. With GIS, temporal and spatial trends in disease outbreaks can be visualized by preparing maps. In addition, health mapping can be used to join different disease surveillance actions, since location is the common element among them all. Epidemiologists are able to study the spread of a disease, outbreaks by the analysis of time, location and population (WHO:2010; Al-Shorbaji:2005;2-3). GIS can be applied in the analysis of emerging and re-emerging infectious diseases, particularly those transmitted directly from person to person. It can also be applied to the study of the ecology of vector-borne disease. Finally, GIS can also be applied to study non-infectious and chronic diseases. Tanser and Le Sueur (2002: 2-4) summarized some of the applications of GIS in Africa, related to disease surveillance and disease control. Within this context, they provided detail of the application of GIS technology to understand the relationship between space and disease, with especial focus on HIV/AIDS, Malaria and TB control. Examples of models generated by GIS to recognize malaria occurrence, seasonality, transmission intensity, and other crucial factors are provided. Similar examples are presented related to HIV and TB, inclusive studies that have used GIS to assess the impact of interventions and elucidating clusters of multi-drugs resistant.

As indicated above, one of the initial points of interest and application of GIS technology was *environmental health*. Environmental health is related to the study of agents, physical, chemical or biological, that produce adverse health outcomes in humans. In this context, GIS has been used to display causes of environmental contaminants of concern for human health and to model the zones of contamination around these sources in order to map populations at risk (Cromley and McLafferty, 2002:159). Also related to this factor, it is important to note that GIS can be also useful in mapping water supply and delivery. Moreover, not only environmental health can be assessed by the use of GIS, this technology also allows us *to stratify risk factors* affecting the health status of the population.

Planning and targeting interventions can improve considerably with the use of GIS. GIS allows policy makers to easily visualize problems related to existing health and social services, determinants and also, as has been indicated above, natural environment facilitating target resources (WHO, 2010). GIS is being used in "location-allocation" decisions to generate valuable information about optimal allocation of finite resources. Health planners can use the information generated by GIS technology to determine health facility allocation, health programme offered, and other relevant aspects as human resources allocation within other issues (Tanser, 2006:116). A relevant example of the capacity of GIS in planning is detailed in the paper *"Towards evidence-based, GIS-driven national spatial health information infrastructure and surveillance services in the United Kingdom"* (Boulos, 2004). Although the experience is based on the UK situation it shows the potential applications in less developed countries. The author notes that GIS is used to inform and educate (professionals and the public); empower decision-making at all levels, including provincial and district, contribute to planning and tweaking clinically and cost-effective actions and, moreover, to predict outcomes before making financial commitments and describe priorities in a context of scarce resources.

GIS technology has also been used in monitoring, *assessment and evaluation*, not just of diseases, but also of *interventions* and programmes over time. The increasing availability of remotely sensed data sets and other digital databases helps, mainly in developing countries, to fill the gap created by the lack of reliable statistics and disease reporting. Through the use of GIS it is possible to understand the usage patterns of health services, generating useful information to assess underperforming or reduced service quality (Tanser, 2006:115).

Finally, assessment of *access to health services* emerges as one of the most important contributions of GIS in public health. Access to health facilities with delivery services, or maternity waiting homes is concerned with the ability of a population to obtain a specified set of health care services. In this context, GIS emerges as a valuable technology to provide and manage information about health service locations, measure geographical access to services and also to analyse changes in the service distribution patterns.

2.6.3 GIS, access and usage of Health Services

Cromley and McLafferty (2002:234) define access as a multidimensional concept that illustrates people’s capacity to make use of a health service when and where needed. Five important components of access are indentified: (1) *Availability* that defines the supply of services related to population needs; (2) *Accessibility* that describes geographical barriers (distance, transportation, travel time) and cost; (3) *Accommodation* that is related to services organization in order to meet users’ needs; (4) *Affordability* refers to the prices of services and (5) *Acceptability* that is linked to patient’s views of health services and interaction of the health services with users. Access is related to all these elements. However GIS is particular focused on *Geographical Accessibility*.

Literature reviews (Cromley and McLafferty, 2002; Grady and McLafferty, 2004; Richard *et al*, 1999; Tanser, 2006) show multiple applications of GIS in order to *map service location*. This is the first step allowing us to study access and health services use. Maps have the ability to display service location patterns, resident's allocation and availability. These elements permit us to visualize the spatial match between service needs and resources.

Mapping service location takes form when *health care needs* are identified. In this area, GIS technology can also provide a significant contribution. Need describes the prevalence of health conditions that should be deal with by a determined health service. Demographic, socioeconomic and health outcome indicators are used in order to estimate these needs. For example, in order to analyze needs for maternal health care services, it is necessary to consider or estimate the number of pregnant women within a population. As mentioned above, GIS technology allows visualizing needs, examining the spatial distributions of mothers, and linking with current available services.

With these two elements, service location and needs, it is possible to assess the potential access to health service, both as a forecast and also as an assessment using existent health indicators. Potential accessibility is related, in the final analysis, to the geographical match between people and basic health care services (Cromley and McLafferty, 2002:240). Potential access can be calculated by the average distance from the population in need of a service to appropriate service providers, and also, as Tanser indicates (2009:111) by determining the population that living within a specific time (one hour, two hours, etc...) of the nearest service. In both cases, GIS is ideally suited to this type of contextual analysis. Moreover, physical access to primary health care services is still a crucial aspect in most developing countries in which a considerable proportion of the population often lives in rural areas at considerable distances from basic health services.

GIS is also used to analyse and compare deviations between observed (registered) usages with the predicted population catchments. Tanser (2009:114) indicates that small deviations would indicate that facilities are evenly distributed, patients are generally using their closest facility, and attendance is positive. By the use of geographically stratified population techniques can be calculated estimation of usage indices, and also assess observed registration.

With the expansion of the Internet, GIS technology has become more accessible. Several on-line applications allow users to create maps that indicate access to maternal health services. For example, STATmapper (www.statmapper.com) allows users to create interactive maps from 54 surveys in 46 countries. Topics include maternal health and other relevant health indicators.

Research details several applications of GIS to assess the impact of health programmes or interventions. Tanser and Le Sueur (2002:6) emphasize the viability of GIS applications in Africa, focusing on the value of GIS technology for planning, monitoring and assessment of intervention strategies. The authors also highlight the importance of international projects, such as the Mapping Malaria Risk in Africa (MARA) collaboration, and the enabling applications of free software as the HealthMapper develop by WHO.

2.7 CONCLUSIONS OF THE LITERATURE REVIEW

In conclusion, the literature review shows that maternal mortality is one of the most important priorities in the Health Sector in Africa, Mozambique and Cabo Delgado Province. Several strategies have been promoted in order to decrease the high ratio. Among these, we can highlight the set up of MWHs in order to reduce the gap between communities and the obstetric care services, and increase institutional deliveries. Several countries have implemented this strategy in order to reduce maternal mortality. Few experiences have been systematized, and few studies have been done in order to assess their effectiveness in reducing maternal mortality and in increasing institutional deliveries. Although, in Mozambique, MWHs have been in service for several years and, recently, the Ministry of Health has officially launched a strategy to promote setting up this service there is, as yet, no definitive evidence that MWHs are contributing to increasing institutional deliveries. No particular assessments have been promoted in this area. Perhaps one of the main reasons to justify this lack of evaluation is the lack of official records regarding the activity of the MWH in Mozambique.

On the other hand, the literature review emphasises the dramatic increase in the usage of GIS technology in Public Health, among others, in maternal health, strategic planning, monitoring and assessment. GIS technology can also increase knowledge about determinants and barriers that limit access to health care services and assess interventions to increase this access, by mapping heath services and population needs. The literature review has shown the potential of GIS technology for evaluating maternal health strategies and promotion of MWHs.

CHAPTER 3 – RESEARCH DESIGN AND METHOD

3.1 INTRODUCTION

The main findings of the literature review indicate that in Mozambique the MWH strategy is one of the priorities of the Ministry of Health. However, considerable limitations exist regarding the availability of records regarding the activities of this service. Within this context, can be highlighted the absence of both quantitative and qualitative assessments of the impact of MWHs in increasing institutional deliveries. In addition, the literature review has noted the increasing potential of GIS technology in Public Health, as a powerful tool to assess health interventions and programs.

Considering these aspects, the research design and method proposed in this study is coherent with the research purpose: To assess the effectiveness of MHWs in increasing coverage of institutional deliveries using Geographical Information Systems (GIS) in six districts of Cabo Delgado Province (Mozambique).

Within this context, the main research paradigm is described, considering the aim of the study, but also considering the availability of MWHs data in Mozambique. In this chapter, the research method is introduced, with special attention to the sampling process, the determination of the inclusion and exclusion criteria, the data collection approach and method, the data analysis and the internal and external validity of the study.

3.2 RESEARCH DESIGN

The current research is based on a *quantitative paradigm*, as it is an objective to use a formal and systematic process that uses numerical data in order to obtain information about the effectiveness of the MWHs in a determined geographical region under study (Burns and Grove, 2005:23). Quantitative research can be used to describe variables, examine relationships among variables and also, to examine cause-and-effect interactions between variables. In this case, numerical data was provided from three main sources of Cabo Delgado Province: Provincial Health Information System, Geo-coded administrative and Geographical data and Population Census.

In this study, the researcher did not intend to change the course of events, but rather to gather data in relation to a phenomenon of interest. Consequently, it should be defined as an *observational study* in which the researcher measures, records, counts, observes or classifies events (Stommel and Wills, 2004:118). In order to ensure good reporting, the Strengthening the Reporting of Observational Studies in Epidemiology (STROBE) statement has been followed (Ven Elm *et al*, 2007:806-808). This statement defines a checklist of items that should be included in observational studies, namely: (1) Introduction: background and objectives; (2) Methods: study design, setting, participants, variables, data sources, bias, study size, quantitative variables and statistical methods; (3) Results: participants, descriptive data, outcome data and main results; (4) Discussion: key results, limitations, interpretation and generalisability. These aspects have been considered in the report of the study.

An *ecological or correlational* research design has been considered the most suitable research design, as the units of analysis were groups of people rather than individuals. The main advantages of ecological studies are based on the low time and cost required, because they use existing data. On the other hand, confounding is high and control for all the potential confounders should be used in order to exclude the possibility that other characteristics account for any relationships found (Bonita, Beaglehole and Kjellström, 2006:40).

In Mozambique, up until the time of the study, registers used in MWHs are weak, because official MWHs guidelines have only just been launched. Therefore, it is difficult to study individually (using subjects, elements) if health facilities with MWH have a broader institutional deliveries coverage than those centres without MWH. In addition, the aim of the present study is to assess the impact, on health facilities coverage, of the set up of MWH. For this reason, clusters of population have been defined according to the distance from a health facility. This group of population was used to estimate annual deliveries and compare with registered institutional deliveries, determining institutional delivery coverage. This ecological study attempts to study if there is an association between the presence of a MWH (exposure) and better institutional deliveries coverage in a group of health facilities.

The research did not just try to study the impact of MWH on health facilities, but also tries to compare if health facilities with MWH have improved their area of influence over a determined population. Consequently, the research also compared two groups, or clusters of health facilities with similar characteristics: those with MWH and those without the service. As detailed below, inferential statistics have been used in order to determine if there is a significant difference in institutional deliveries coverage between health facilities with and without MWH.

The main aim of correlational studies is to describe the nature of relationships, not to determine cause and effect. This design involves the systematic research of relationships between or among two or more variables (Burns and Grove, 2005:26). Three variables have been studied: (a) Institutional deliveries coverage; (b) distance of the population to the health facility and (c) presence of MWH.

Within this context, a main hypothesis has been formulated:

- $Hypothesis_1$: health facilities type II with MWH have better coverage of institutional deliveries than those without MWH.

A null hypothesis has also been formulated:

- Null $Hypothesis_1$: there is no significant difference between the coverage of institutional deliveries in Health Facilities type II with MWH and without.

In order to exclude confounders, a second hypothesis has been tested:

- Across time analyses shows that MWH services increase institutional deliveries in health facilities.

It was considered that time series may reduce some of the socioeconomic confounding that are a potential problem in this type of design (Bonita *et al*l, 2006:42). This analysis should allow us to undercover institutional deliveries patterns of selected health facilities in order to assess if the set up of MWH services have induced changes in institutional deliveries.

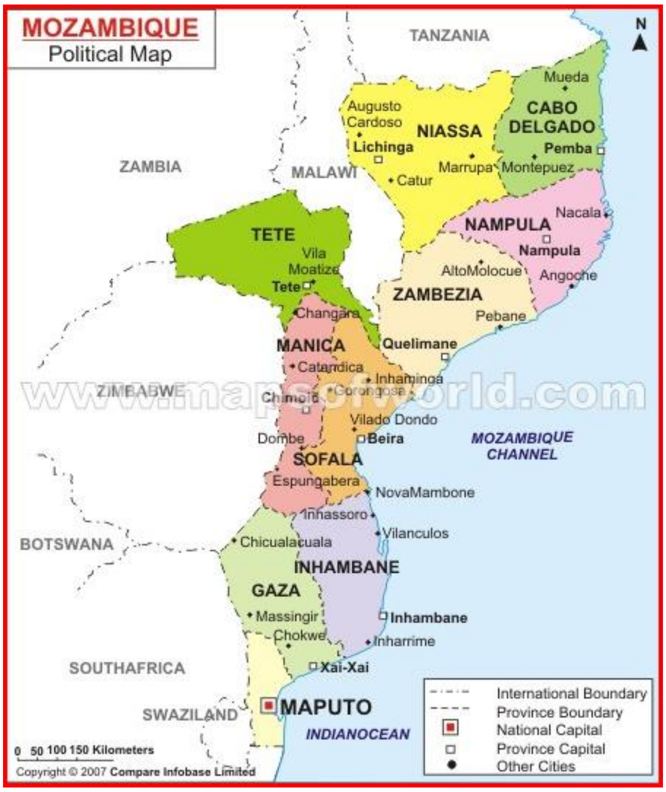
3.3 RESEARCH METHOD

3.3.1 Sampling

As Burns and Grove indicate (2005:341) sampling involves selecting a group of people, group, events, behaviours or other elements that will be under study. A sampling plan describes the crucial aspects of making the sample selections, mainly: the elements and population, the sampling criteria, the ethical issues related to sampling and finally the sample. These key aspects will be described later in this document.

3.3.1.1 Population and sampling

Elements are the individual units of a population. The *population* (in some cases named *target population*) is the entire set of elements who meet the sampling criteria, which are a list of characteristics indispensable for membership or in the population. Target population, or just population is selected from the *population universum* (Burns and Grove, 2005:342).



Source: www.mapsofworld.com

Figure 3.1. Provinces of Mozambique.

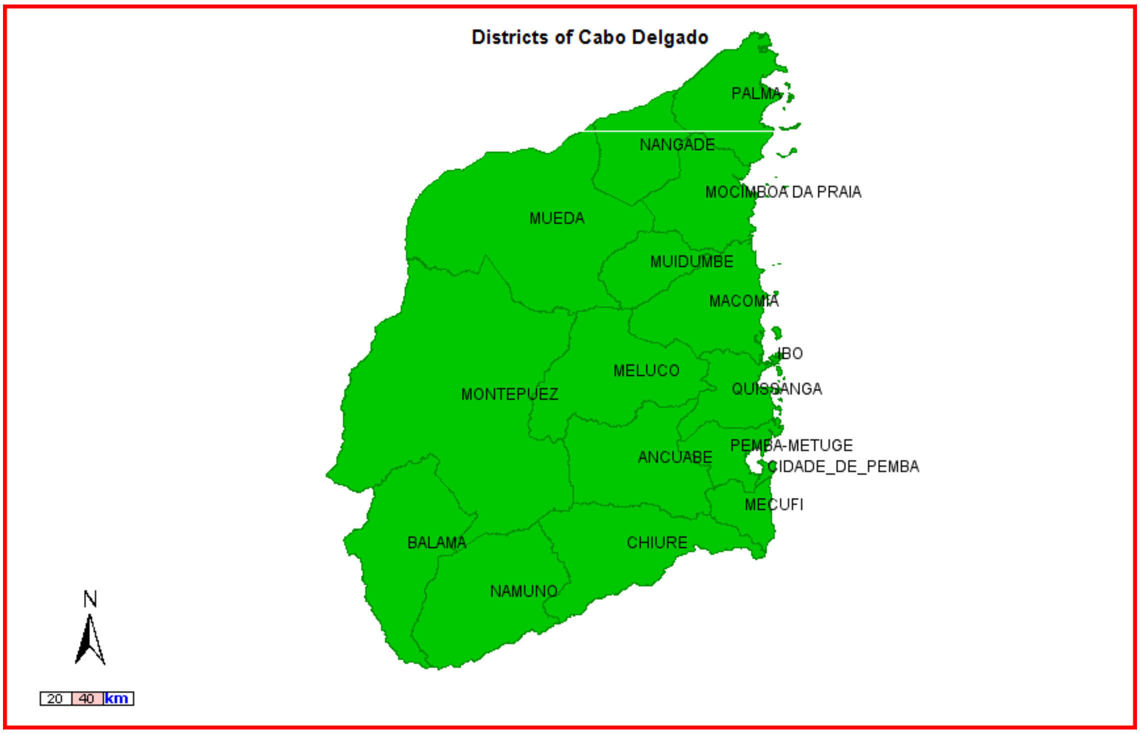


Figure 3.2. Districts of Cabo Delgado Province

This study focusses on six districts of Cabo Delgado province, namely Montepuez, Balama, Namuno, Meluco, Macomia and Ancuabe. The selection of these districts was based on two main factors: first, these six districts have the support of several NGOs, including **medicus**mundi, which have the mandate of strengthening the Health Information System. As a result, we expected a high quality of the institutional deliveries data registers. The second reason is that it was predictable that these districts have a major number of MWHs, due to the support that have received during several years from several NGOs.

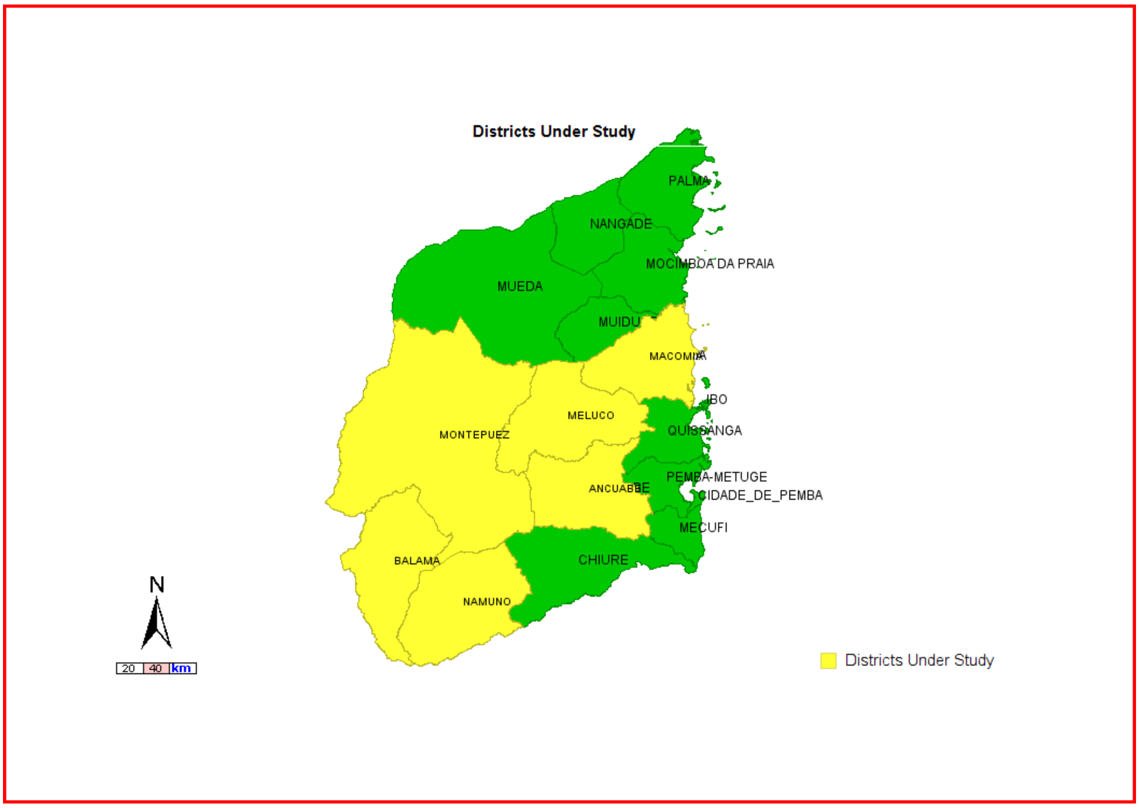


Figure 3.3. Districts under study.

In 2009, the health facilities network of the Southern and Central area of Cabo Delgado province (districts of Montepuez, Balama, Namuno, Meluco, Macomia and Ancuabe) was composed by 39 health units or elements, as individual units of the *population universum* (Burns and Grove, 2005:341), classified as:

District	Provincial Hosp.	Rural Hosp.	Urban Health Centre	Rural Type I Heath Centre	Rural Type II Heath Centre	Health Posts	Total Health Units
Montepuez	0	1	1	1	5	1	9
Balama	0	0	0	1	6	0	7
Namuno	0	0	0	1	6	0	7
Meluco	0	0	0	1	3	0	4
Macomia	0	0	0	1	5	0	6
Ancuabe	0	0	0	2	4	0	6
TOTAL	0	1	1	7	29	1	39

(DPS, 2008:18)

Table 3.1: Network health facilities in Cabo Delgado Province.

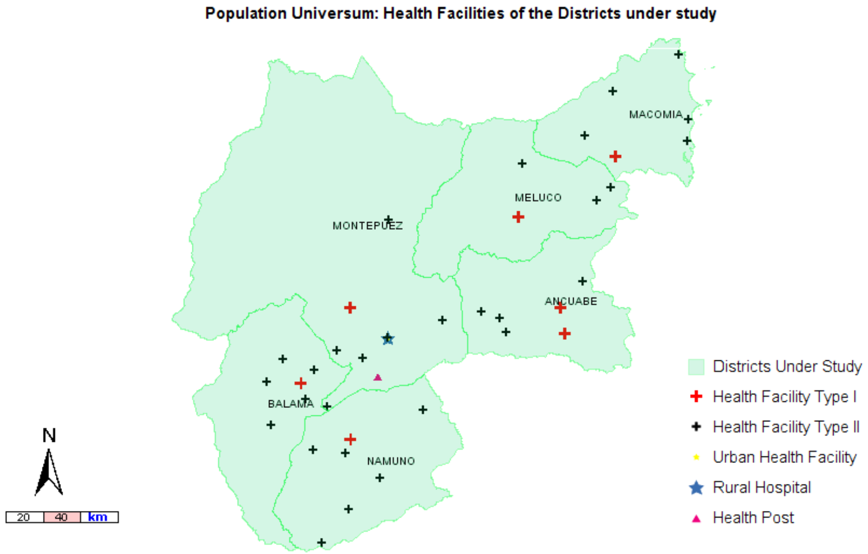


*Figure 3.4: Population Universum**

** Please note that the location of the Urban Health Facility and the Rural Hospital is the same.*

The selection of the health facilities under study was one of the key aspects of the sampling process. In 2001 the government of Mozambique launched a classification and characterization of health facilities pertaining to the National Health System (MISAU, 2001). This document establishes, among other aspects, the specific functions, criteria and mechanism for the cataloguing and description of the health facilities pertaining to the three health care levels, namely: primary, secondary and tertiary.

Based on this characterization, the crucial aspect was to select a type of health facility that, initially, did not receive obstetrics reference from any other lower level. This means that, in essence, this health facility serves its direct population. In this sense, health facility of type I attend populations with complications referred from health facilities of type II. The research methodology was based on the determination of institutional delivery coverage based on clusters of populations. In this context it is critical to work with a population that, in the first instance, goes to the most nearby health facility as its first option. This allows us (as will be detailed in chapter 4) to compare the registered institutional deliveries with the expected deliveries, considering a catchment of population that, initially, accesses the proximal health facility.

In this sense, with the aim of assessing the effectiveness of MWHs in increasing institutional deliveries coverage, the following *sampling criterion has* been defined:

- ✓ Inclusion criteria:
  - ❖ Functional health facilities managed by the Ministry of Health (providing health care during the 6 months prior to data collection).
  - ❖ Health facilities that offer maternal health care, including Basic Obstetric Care (this excludes health posts).
  - ❖ Health facilities pertaining to primary health network (this excludes tertiary and secondary health facilities as provincial and rural hospitals).
  - ❖ Health facilities that will not receive obstetrics reference from other health facilities.

- ✓ Exclusion criteria:
  - ❖ Health facilities that started their activities during the last six months prior to data collection.
  - ❖ Health facilities pertaining to secondary or tertiary health network.
  - ❖ Health facilities without maternal health care services.
  - ❖ Health facilities that receive obstetrics reference from lower levels.

3.3.1.2 Ethical issues related to sampling

The elements of the sample are health facilities pertaining to the national health system. In this sense, before starting the collection data, a request for this information was sent to the Provincial Health Board, in order to *obtain informed consent* on behalf this body. In addition, authorization was requested on behalf of the Agriculture Provincial Board to use the geo-coded data, including population location and census. Both requests for data collection and usage in order to implement the research were accepted (see annex 1 and 2).

The data used for the research were mainly, geo-referenced data (including population location and census) and institutional deliveries in the health facilities under study. In both cases, the population's clusters of pregnant women that use a health facility to deliver, were anonymous to the researcher, respecting the *Right to Autonomy and Confidentiality* (Burns and Grove, 2005:190).

3.3.1.3 Sample

According to the exposed criteria, the sample of the study was based on health facilities type II. The rest of the health facilities pertaining to the districts under study were excluded for different reasons:

- ❖ *Health posts*, the minimum instance in Mozambique of a health facility, were excluded because they did not attend deliveries, and therefore, no MWHs are set up in this type of health facility.

- *Rural Hospitals* are reference health facilities that receive referrals from different geographic locations and thus it is not possible to define directly the population of influence. In addition, they pertain to the secondary level.

- Urban Health facilities are excluded because in most cases, they have no maternity service. In this case, there is only an urban facility in the area of study, and it has no maternity service.

- Health facilities type I are excluded because, in the districts, they function as a reference centre for health facility type II. This means, that they receive women with obstetric complications from health facility type II and, for this reason, the institutional deliveries could be higher than expected. Summarizing, the population of influence is all the district population.

In conclusion, the sample was focused on health facilities type II. However, an exception was accepted in the case of the health facility type I of Mirate, in Montepuez District. Mirate, although it is a type I, functions as a type II because obstetrics complications detected in the health facilities around Mirate are referred to the rural hospital of Montepuez. Two of those health facilities type II (Metata and Hucula) did not offer delivery attendance at least during the last four year. Considering these aspects, the sample was composed by 28 health facilities, located according figure 3.5.

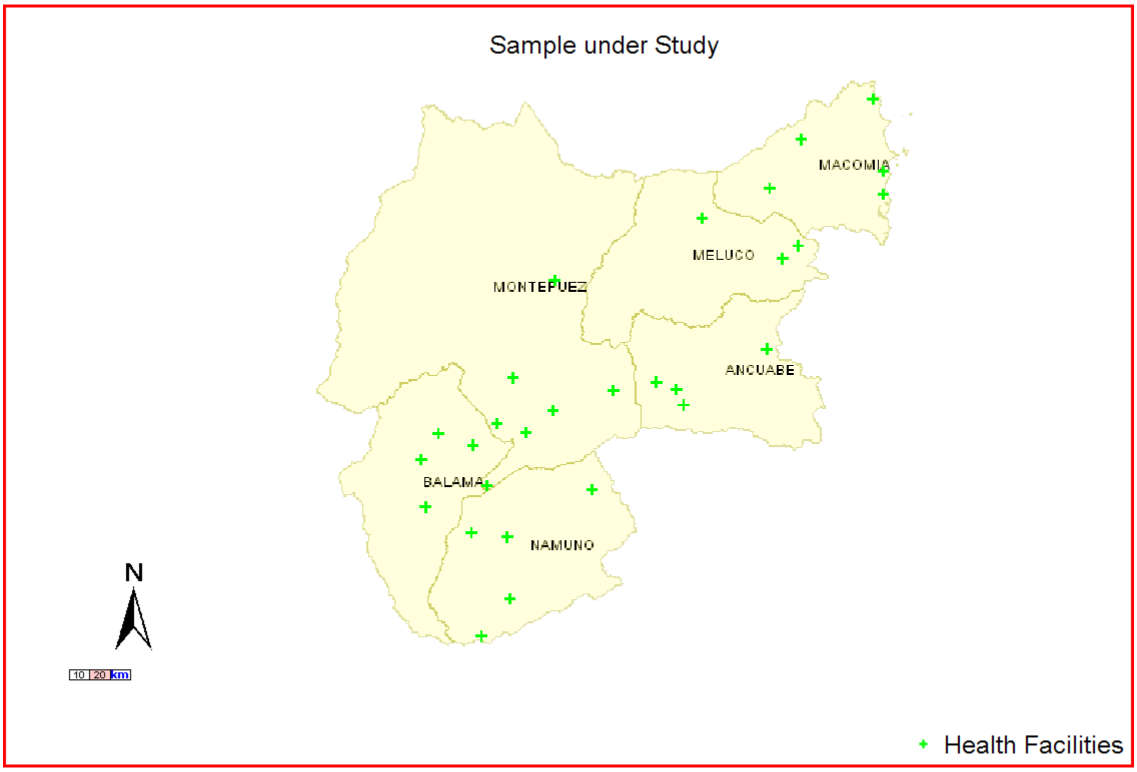


Figure 3.5. Sample under study

The MWH strategy promoted by the Ministry of Health of Mozambique (MISAU, 2009) focuses on the set up of this service at primary level, in health facilities with maternal health care services, including delivery attendance. In order to understand the sampling criteria defined to delineate the sample, the main characteristics of the health facilities pertaining to the primary level, with special focus on the health facilities type II are detailed.

Type II facilities have a population coverage estimated between 7.500 and 20.000 and an area of influence of 8 km. Related to human resources, type II facilities have an allocated staff of:

a. 1 technician of Secondary level (medical technician).
b. 1 Nurse with specialization in Maternal and Child Health (MCH).
c. 1 Labourer (cleaning)

Type II facilities offer the following services:

- ✓ Health Education, nutritional health education and social mobilization.
- ✓ Environmental actions: lavatories, etc.
- ✓ Water control.
- ✓ Neonatal and maternal health:
    a. Extended Vaccination Program
    b. Preventive 0 to 4 years.
    c. Oral rehydration.
    d. Pre-natal and Post-natal consultations.
    e. Family Planning
    f. Delivery attendance.
- ✓ Epidemiologic control of the most common diseases.
- ✓ General consultations.
- ✓ Treatments.
- ✓ First aid and small surgery.
- ✓ Distribution of essential drugs.
- ✓ Data collection and analysis of the data include in the Health Information System of the MISAU.
- ✓ Referral to higher levels.
- ✓ Resources management.

It is important to note, that the research is based on studying if MWHs are affecting the capacity of increasing the area of influence of health facilities, and therefore, to increase the institutional deliveries coverage. Within this context, the sample is composed of health facilities that satisfy the inclusion criteria. However, in order to test if institutional deliveries coverage is greater in health facilities with MWHs, it is indispensable to determine the theoretic population under influence of a determined health facility. These population, and therefore the expected and the registered deliveries (in the end, institutional deliveries coverage of the two groups of health facilities under study) will be compared, by the use of inferential statistics (more details in chapter 4).

3.3.2 Data Collection

According to Burns and Grove (2005:733) data collection consists of an accurate, systematic gathering of information significant to the study purpose or the specific objectives, questions, or hypotheses of a study. The data collection process should be consistent with the research purpose of the study, and should be defined according to the characteristics of the environment in which the study will be developed. In this important phase of the study, the researcher must be systematically implementing four key tasks: (a) selecting the subjects under study, in this case the health facilities that satisfy the sample criteria; (b) collecting data in a consistent way; (c) maintaining research controls in order to increase the validity of the study, and; (d) solving problems that threaten to put the study at risk. These aspects are detailed in the next section.

3.3.2.1 Data collection approach and method

The present research was based on a *quantitative structured* data collection approach. The main advantage of structured data collection approaches resides in their ability to summarize, compare and generalize results (Harrell *et al*l, 2009: 8-10).

Secondary data sources were the most predominant type of data collection used in the research. The main advantages of secondary sources are that; firstly they are easier and quicker to obtain than primary data and secondly, secondary data obtained from official sources are usually high quality data that have been assessed in order to reduce inconsistencies. On the other hand, the main disadvantages resides in that sometimes it may cost money to obtain and the researcher usually has to adapt the data to the purpose of the research. In addition, in some situations, there is a lack of systematized information about the process of quality verification of the data (Burns and Grove, 2005:95).

The following *secondary sources* were obtained and analyzed:

(1) Geo-referenced population and geo-referenced location of health facilities of Cabo Delgado Province. This information was obtained from the Geographical Information Systems (GIS) data base from the Provincial Government of Cabo Delgado, Health Provincial and Agriculture Board. This information includes geographical profiles, population location (latitude, longitude), population size (1997 Census) and other relevant information related to geographical features and events. The database was elaborated in 2004.

(2) Institutional Deliveries from the Health Information System of Cabo Delgado Province, by district, health facility, from 1994 to 2009.

(3) Population 1997 and 2007 Census. The data of the population Census were obtained from the National Institute of Statistics of Mozambique (INE, 1999; INE, 2007). However, the census published until the present time does not provide information of the population by community (just administrative post and locality, a higher level than communities). In this sense, population was projected, based on population growing (considering 1997 and 2007 Census). More details are provided in Chapter 4.

Although to a lesser extent, *primary data* were also obtained, and in fact, they were very important for the study purpose:

MWHs locations and year of set up were not registered in any document of the Health Provincial Board of Cabo Delgado. The researcher, with the support of the technical staff of **medicus**mundi located in Cabo Delgado Province, obtained data about the number, location and year of set up of the MWHs facilities existenting in the district under study (annexure 3). This information was obtained through *interviews* with the district health director and *direct observation*. A *structured questionnaire* was provided to the Health Provincial Board in order to obtain information about MWHs setting and year of set up. The questionnaire claimed to confirm the information obtained through *direct* *observation* of the health facilities type II pertaining to the district under study (see questionnaire in annexure 4).

3.3.2.2 Characteristics of data collection instrument

Three main sets of data can be identified, namely: (a) Geo-referenced data, (b) Population Data and (c) Health Data. In the case of the first two data sets, they were secondary data. In any case, a brief description of the data collection instruments is presented. On the other hand, health data used in this research are a blend of primary and secondary data. Description of the data collection instrument is also provided, below.

In relation to the *Geo-coded or Geo-referenced data* (secondary data), they were obtained from the Agriculture and Health Provincial Board. The geo-coded spatial database includes both location and thematic data of different attributes: administrative; agriculture, education, health, cadastre, conservation areas, weather, hydrological resources, road links and other data. This data base includes the population by community based on the 1997 Census.

In addition, the spatial database includes the relevant entities, relationships, and attributes, able to be managed by a Database Management Systems (DBMS). Relational Database Management Systems run data as a collection of tables with data relationships represented by common values in related tables. This data collection instrument allows the graphic display and mapping functions of GIS. According to Pérez (Pérez, 2010) the geo-coded database was elaborated in two phases. In 2009, GETINSA elaborated the first version within the framework of the elaboration of a broader report named *Libro Blanco de los Recursos Naturales de la Provincia de Cabo Delgado (White book of natural resources of Cabo Delgado province)*. Later, in 2001, the database was completed by the Provincial Government of Cabo Delgado and the Spanish Cooperation Agency (AECID) by the implementation of the project Sistema de

Informacion territorial de la provincial de Cabo Delgado (Territorial information system of Cabo Delgado province).

Ver atributos : cd_população_UTM

cd_população_UTM (955 elementos - 0 seleccionados)

..	FORA_DE_LI	NOME	POSTO	DISTRITO ^	TOTAL	MASCULINO	FEMININO	AGREGADOS	LATITUDE	LONGITUDE	CODIGO_CEN	TIPO	LIMITE	GID
	n	MEZA	MEZA	ANCUABE	0	0	0	0	-13,0299	39,5538		POSTO SEDE	0	19
	n	METORO	METORO	ANCUABE	5.114	0	0	0	-13,10556	38,88028	'020202019903	POSTO SEDE	0	21
	n	NANHOM...	ANCUABE	ANCUABE	551	271	280	142	-12,94917	39,86528	'020201019902	aldeia	0	38
	n	NTUTO	ANCUABE	ANCUABE	1.959	905	1.054	515	-12,87778	39,87833	'020201019903	BAIRRO	0	39
	n	NANCAPA	ANCUABE	ANCUABE	2.153	1.031	1.122	564	-12,98389	39,87778	'020201019904	aldeia	0	40
	n	MACAIA	ANCUABE	ANCUABE	1.684	827	857	460	-12,85417	39,80639	'020201019907	aldeia	0	41
	n	MBONGUE	ANCUABE	ANCUABE	3.439	1.646	1.793	865	-12,97445	39,80194	'020201019908	aldeia	0	42
	n	INGONANE	ANCUABE	ANCUABE	725	341	384	202	-12,99722	39,78667	'020201019909	POVOADO	0	43
	n	NATOVE	ANCUABE	ANCUABE	745	352	393	209	-13,02111	39,7925	'020201019910	aldeia	0	44
	n	NGEUE	ANCUABE	ANCUABE	2.595	1.296	1.299	626	-12,84945	39,96083	'020201029902	aldeia	0	45
	n	NICUITA	ANCUABE	ANCUABE	1.270	596	674	323	-12,89861	39,90361	'020201029903	aldeia	0	46
	n	NANOA	ANCUABE	ANCUABE	1.263	630	633	278	-12,91695	39,8725	'020201029904	aldeia	0	47
	n	GHIHOTE	ANCUABE	ANCUABE	1.144	536	608	310	-12,92389	39,90944	'020201029905	LOCALIDADE	0	48
	n	NACUSSA	ANCUABE	ANCUABE	1.821	899	922	481	-12,97917	39,92694	'020201029906	aldeia	0	49
	n	NONIA	ANCUABE	ANCUABE	758	355	403	204	-12,89222	39,73333	'020201039901	aldeia	0	50
	n	NAPUTA	ANCUABE	ANCUABE	1.764	857	907	489	-12,92445	39,75889	'020201039902	aldeia	0	51
	n	MAHERA	ANCUABE	ANCUABE	2.170	1.076	1.094	573	-13,025	39,6958	'020201039904	aldeia	0	52
	n	NACUALE	ANCUABE	ANCUABE	1.155	577	578	334	-12,96361	39,69889	'020201039905	LOCALIDADE	0	53
	n	MOCONE	ANCUABE	ANCUABE	379	168	211	112	-12,93333	39,675	'020201039906	aldeia	0	54
	n	ZAMBEZIA	ANCUABE	ANCUABE	256	124	132	83	-12,90028	39,68806	'020201039907	aldeia	0	55
	n	MIEGANE	ANCUABE	ANCUABE	626	289	337	178	-12,86583	39,68694	'020201039908	aldeia	0	56
	n	NGURA	ANCUABE	ANCUABE	1.471	688	783	406	-12,84167	39,64583	'020201039909	aldeia	0	57
	n	MUELA	ANCUABE	ANCUABE	224	112	112	62	-12,88167	39,64389	'020201039910	aldeia	0	58
	n	SOFALA	ANCUABE	ANCUABE	513	253	260	161	-12,9125	39,63194	'020201039911	aldeia	0	59
	n	NAMACU...	METORO	ANCUABE	87	45	42	25	-13,035	39,89028	'020202019901	aldeia	0	60
	n	MIRIANG...	METORO	ANCUABE	1.430	707	723	379	-13,05417	39,88056	'020202019902	aldeia	0	61
	n	NTIQUE	METORO	ANCUABE	1.887	886	1.001	441	-13,17139	39,86917	'020202019904	aldeia	0	62
	n	NAN'NONA	METORO	ANCUABE	3.466	1.677	1.789	952	-13,10278	39,78556	'020202019905	aldeia	0	63
	n	NCOCORA	METORO	ANCUABE	1.797	854	943	461	-13,13889	39,83056	'020202019906	aldeia	0	64
	s	NAMACU...	METORO	ANCUABE	1.565	758	807	435	-13,18611	39,8125	'020202019907	aldeia	1	65
	n	NATOCUA	METORO	ANCUABE	1.084	538	546	294	-13,02306	40,04139	'020202029902	aldeia	0	66
	n	SALAUE	METORO	ANCUABE	1.582	760	822	433	-13,1	39,97861	'020202029903	LOCALIDADE	0	67
	n	NTUTUPUE	METORO	ANCUABE	4.857	2.402	2.455	1.262	-13,13472	40,0475	'020202029904	aldeia	0	68
	n	NIPATACO	METORO	ANCUABE	1.563	801	762	356	-13,06667	40,14111	'020202029905	aldeia	0	69
	n	CHIUTE	MEZA	ANCUABE	793	393	400	241	-13,00389	39,53889	'020203019901	aldeia	0	70
	n	TEULE	MEZA	ANCUABE	1.522	703	819	428	-13,03417	39,55	'020203019902	aldeia	0	71
	n	NAMAPA	MEZA	ANCUABE	768	361	407	233	-13,03583	39,54111	'020203019903	aldeia	0	72
	n	NGECUA	MEZA	ANCUABE	391	195	196	109	-13,05	39,58333	'020203019904	aldeia	0	73
	n	NACOJA	MEZA	ANCUABE	602	294	308	162	-13,09167	39,54111	'020203019905	aldeia	0	74
	n	NECUEJA	MEZA	ANCUABE	1.083	532	551	305	-13,08694	39,465	'020203019906	aldeia	0	75
	n	N'NAUA	MEZA	ANCUABE	2.269	1.082	1.187	650	-13,09111	39,5925	'020203029901	aldeia	0	76
	n	CAMPINE	MEZA	ANCUABE	1.709	835	874	470	-13,12333	39,59028	'020203029902	LOCALIDADE	0	77
	n	NANUNE	MEZA	ANCUABE	772	378	394	234	-13,17778	39,60389	'020203029903	aldeia	0	78
	n	NACACA	MEZA	ANCUABE	1.767	860	907	480	-13,14111	39,5375	'020203029904	aldeia	0	79
	s	N'SSANJA	MEZA	ANCUABE	743	374	369	216	-12,96306	39,58333	'020203039901	aldeia	1	80
	n	NANJUA	MEZA	ANCUABE	4.702	2.279	2.423	1.297	-13,0042	39,6	'020203039902	LOCALIDADE	0	81
	n	MAREMA...	MEZA	ANCUABE	1.101	553	548	331	-13,0583	39,6333	'020203039904	aldeia	0	82
	n	MUAJA	MEZA	ANCUABE	3.264	1.512	1.752	890	-12,90889	39,47445	'020203049901	aldeia	0	83
	n	NDAUANE	MEZA	ANCUABE	96	45	51	34	-12,9417	39,5333	'020203049902	aldeia	0	84
	n	MINHUENE	MEZA	ANCUABE	2.045	958	1.087	652	-12,99945	39,46194	'020203049903	LOCALIDADE	0	85

Figure 3.6. An example of the GIS database regarding population data.

Ver atributos : Centros_saude_utm

Centros_saude_utm (103 elementos - 0 seleccionados)

NOME	POSTO	DISTRITO	TIPO_US	GID
MEZA	MEZA	ANCUABE	CSR-II	20
METORO	METORO	ANCUABE	CSR-I	22
NGEWE	ANCUABE	ANCUABE	CSR-II	38
MINHEW...	MEZA	ANCUABE	CSR-II	39
ANCUAB...	ANCUABE	ANCUABE	CSR-I	77
MARIRI	MEZA	ANCUABE	CSR-II	92
MAVALA	MAVALA	BALAMA	CSR-II	26
IMPIRI	IMPIRI	BALAMA	CSR-II	27
KUEKUE	KUEKUE	BALAMA	CSR-II	32
METATA	BALAMA	BALAMA	CSR-II	40
NTETE	BALAMA	BALAMA	CSR-II	41
BALAMA	BALAMA	BALAMA	CSR-I	80
MURRIPA	BALAMA	BALAMA	CSR-II	97
MAZEZE	MAZEZE	CHIURE	CSR-II	28
CHIÚRE-...	CHIURE ...	CHIURE	CSR-II	29
CATAPUA	CATAPUA	CHIURE	CSR-II	30
NA	OCUA	CHIURE	CSR-I	33
BILIBIZA	NAMOGE...	CHIURE	PS	42
M'MALA	CHIURE ...	CHIURE	CSR-II	67
CHIURE	CHIURE	CHIURE	CSR-I	81
NQUERETE	CHIURE	CHIURE	CSR-II	94
NAMOGE...	NAMOGE...	CHIURE	CSR-II	95
MUEGE	MAZEZE	CHIURE	CSR-II	96
QUIRIMBA	QUIRIMBA	IBO	CSR-II	13
MATEMO	IBO	IBO	CSR-II	43
IBO	IBO	IBO	CSR-I	73
QUITER...	QUITER...	MACOMIA	CSR-II	8
CHAI	CHAI	MACOMIA	CSR-II	11
MUCOJO	MUCOJO	MACOMIA	CSR-II	12
NGUIDA	MACOMIA	MACOMIA	CSR-II	44
MACOMIA	MACOMIA	MACOMIA	CSR-I	72
NAUNDE	MUCOJO	MACOMIA	CSR-II	100
MURREBUE	MURREBUE	MECUFI	CSR-II	24
MECUFI	MECUFI	MECUFI	CSR-I	79
NATUCO	MECUFI	MECUFI	CSR-II	99
MUAGUIDE	MUAGUIDE	MELUCO	CSR-II	14
MINHANHA	MELUCO	MELUCO	CSR-II	45
IMBADA	MUAGUIDE	MELUCO	CSR-II	46
MELUCO	MELUCO	MELUCO	CSR-I	75
DIACA	DIACA	MOCIMBOA ...	CSR-II	5

Figure 3.7. An example of the GIS database regarding health data.

Secondly, *population data* were obtained from the National Statistics Institute (INE, 2009) and (INE, 1999). INE provides population databases, in Excel spreadsheet format, by province, district and administrative post.

Quadro. Populaçao por sexo			
	P03 SEXO		
	Total	Homens	Mulheres
	1.606.568	777.755	828.813
Provincia de Cabo Delgado	1.606.568	777.755	828.813
Distrito de CIDADE DE PEMBA	138.716	69.936	68.780
Posto Administrativo CIDADE DE PEMBA	138.716	69.936	68.780
Localidade CIDADE DE PEMBA	138.716	69.936	68.780
Distrito de ANCUABE	107.238	51.751	55.487
Posto Administrativo ANCUABE	40.989	19.611	21.378
Localidade ANCUABE - SEDE	12.534	5.967	6.567
Localidade GIHOTE	13.258	6.358	6.900
Localidade NACUALE	15.197	7.286	7.911
Posto Administrativo METORO	37.059	18.069	18.990
Localidade METORO - SEDE	17.990	8.629	9.361
Localidade SALAUE	19.069	9.440	9.629
Posto Administrativo MEZA	29.190	14.071	15.119
Localidade MEZA-SEDE	4.359	2.119	2.240
Localidade CAMPINE	7.981	3.885	4.096
Localidade NANJUA	8.947	4.354	4.593
Localidade MINHEUENE	7.903	3.713	4.190
Distrito BALAMA	124.100	59.665	64.435
Posto Administrativo BALAMA	67.970	32.552	35.418
Localidade BALAMA - SEDE	29.439	14.200	15.239
Localidade MURIPA	16.480	7.928	8.552
Localidade NTETE	22.051	10.424	11.627
Posto Administrativo IMPIRI	19.694	9.632	10.062
Localidade NAMARA	7.830	3.835	3.995
Localidade SIVACA	11.864	5.797	6.067
Posto Administrativo KWEKWE	21.748	10.453	11.295

Figure 3.8. An example of the 2007 Census of Population published by the INE (National Statistic Institute). Source: INE (2009).

Finally, in relation to Health Data, in order to facilitate the health data collection process, just one questionnaire was used. The questionnaire was administrated to the Health Provincial Board in order to confirm both, primary (MWH location and year of set up) and secondary data (list of Health facilities and institutional deliveries data obtained from the Health Information System) (annexure 3):

(1) List of *Health Facilities* type II of the districts under study (secondary data). In fact, this information is included in the Health Network Development Plan (DPS Cabo Delgado, 2009). However this was also registered in the data collection instrument in order to confirm if during the last year some health facility was set up.

(2) Data of *institutional deliveries* by year, from 1994 to 2009 obtained from the health information system (HIS) of the Health Provincial Board (secondary data).

Data:14/7/2010, Horas: 22:08
Periódo:01/1994 a 12/2009
B-07 RESUMO DA SMI

DISTRITO DE : MONTEPUEZ

ANO	HR MONTEPUEZ	MIRATE	MAPUPULO	NAMUETO	NAMANHUMBIR	NAIROTO	NROPA	LINDE
1994	559						44	
1995	1.326						95	
1996	1.235						126	
1997	1.544	6		34	73	5	125	
1998	1.574	102		115	93		86	
1999	1.556	52	51	118	109		80	
2000	1.822	90	94	192	105	5	108	
2001	1.741	107	133	227	96		48	
2002	1.662	100	117	203	78		156	
2003	2.002	106	114	204	67		154	
2004	2.190	105	134	207	83		224	
2005	2.460	161	117	231	121	25	153	
2006	2.361	160	207	259	144		245	
2007	2.513	179	249	320	135		238	33
2008	2.979	197	301	269	192	2	199	
2009	3.081	301	561	311	238	30	400	
Total	**30.605**	**1.666**	**2.078**	**2.690**	**1.534**	**67**	**2.481**	

Figure 3.9. An example of the database obtained from the Health Information System regarding institutional deliveries. Source: DPS Cabo Delgado

(3) List of *Maternity Waiting Homes* and set up of the service (primary data). Three documents were reviewed in order to obtain this information: (1) The Service Availability Mapping (MISAU, 2007) that shows the location and service of the health facilities pertaining to the

national health network. No information is included in this document about the availability of MWH in the health facilities; (2) the Health Network Development Plan (DPS Cabo Delgado, 2009). No information is included about this service; and (3) the Maternal and Neonatal Health Needs Assessment (MISAU, 2009). Although the document includes a survey about the characteristics of the MWHs running in the country, no database is included about the localization of the MWHs around the country.

For these reasons, the location and year of set up of the MWHs in the districts under study was carries out by direct observation and verification of the information obtained with the Provincial Health Board through a questionnaire.

				MHW YEARS OF FUNCTIONING	INSTITUTIONAL DELIVERIES															
DISTRICT	HEALTH UNIT	TYPE (I/II)	MHWs (YES/NO)	(FROM/TO)	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009
BALAMA	NPIRI	II																		
	KUEKUÉ	II																		
	MAVALA	II																		
	NTETE	II																		
	MURRIPA	II																		
MONTEPUEZ	MONTEPUEZ SEDE	II																		
	MIRATE	I																		
	NAIROTO	II																		
	NAMANHUMBIRE	II																		
	NAMUETO	II																		
	NROPA	II																		
	MAPUPULO	II																		
NAMUNO	MACHOCA	II																		
	MELOCO	II																		
	NANRAPA (EP2)	II																		
	NCUMBE	II																		
	PAPAI	II																		
MACOMIA	CHAI	II																		
	INGOANE	II																		
	MUCOJO	II																		
	NAUNDE	II																		
	NGUIDA	II																		
	PIQUEUE	II																		
	QUITERAJO	II																		
MELUCO	IMBADA	II																		
	MINHANHA	II																		
	MUAGUIDE	II																		
	RAVIA	II																		
ANCUABE	MARIRI	II																		
	MINHUENE	II																		
	NACUALE	II																		
	NGEVE	II																		

Figure 3.10. Data Collection Instrument elaborated to determine the location and year of set up of the MWHs in the six districts under study. Source: own elaboration.

3.3.2.3 Data collection process

The data collection process was carries out from the 30 of July until the 15 of September of 2010. During this process the following information was collected:

3.3.2.3.1 Geo-Coded Data

The 30th of July a request for the use of Geo-coded data of Cabo Delgado Province was sent to the Health and Agriculture Provincial Board. Both authorizations were obtained (the 9th of August from the Agriculture and the 10th from the Health Board).

3.3.2.3.2 Population Data

Population data was collected from two censuses: 1997 and 2007. Both of them were obtained from the National Statistics Institute (INE, 1999) and (INE, 2007). This information was obtained in August 2010. To highlight that the geo-coded database provided by the Health Provincial Board includes the population location by community based on 1997 Census. However, the two censuses that were requested were necessary to determine population growing and thus, to obtain 2009 population projections by community.

3.3.2.3.3 MWHs location and year of set up

During the month of August we visited the districts under study in order to determine the number and location of MWHs. In October, a structured questionnaire was administrated to the Health Provincial Board in order to confirm the data. Finally, in November we visited the MWHs in order to carry out a photographic report and to obtain some information about the characteristics of the MWHs.

3.3.2.3.4 HIS data: institutional deliveries

In July the Health Provincial Board provided the institutional deliveries (1994-2009) data of the health facilities under study.

3.3.2.4 Ethical considerations related to data collection

The elements of the sample are health facilities pertaining to the national health system. In this sense, before starting the collection data, a request for this information was sent to the Provincial Health Board and the Provincial Agriculture Board, in order to *obtain informed consent* on behalf of these two bodies. The request for collection was accepted (see annexure 1).

In addition, with the aim of collaborating with the technical staff of the Health Cooperation NGO working in Cabo Delgado province, an appeal for support was requested. The request for support was accepted (see annexure 2)

The data used for the research were mainly, geo-referenced data (including population location and census) and institutional deliveries in the health facilities under study. In both cases, pregnant women that use a health facility to deliver, were anonymous to the researcher, respecting the *Right to Autonomy and Confidentiality* (Burns and Grove, 2005:190).

Finally, regarding ethical considerations, we should highlight the *Research Integrity* of the study. Practices such as fabrication, falsification, plagiarism or others that gravely impose against the ethics of the study have been totally avoided in this research. The data collection process was based on solid protocols, data collection forms and a transparent relationship with the Provincial Health Board following the norms for good science and protecting the integrity of scientific knowledge.

3.3.3 Data analysis

Descriptive statistics have been used in order to analyze the data:

(4) *Institutional deliveries coverage by health facility* and by area of influence (8,10, 12 and 14 km) have been determined by applying a proportion:

- Institutional deliveries coverage: number of deliveries attended in a health facility during a period of time / number of expected deliveries during the same period of time (using population data from National Statistics Institute Census).

$$\text{Institutional deliveries coverage of a health facility} = \frac{\text{Deliveries registered at health facility}}{\text{Expected deliveries this year within the area of influence of the health facility}}$$

Figure 3.11. Formula to determine institutional deliveries coverage.

(5) *Institutional deliveries coverage of the next groups of health facilities: (a) health facilities with MWH, (b) without MWH and (c) the whole sample by area of influence (8, 10, 12 and 14 km)*. Prior to the comparison of the health facilities with and without MWH, it was necessary to determine the coverage of the sample and the two groups under study. Two main approaches were studies to obtain this value:

a. Mean of Institutional deliveries coverage of: (a) all health facilities; (b) health facilities with MWH and (c) health facilities without MWH. The mean is the most commonly used measure of a central tendency. The formula for calculating the mean is as follow:

$$Mean, \bar{x} = \frac{\sum x}{n}$$

Figure 3.12. Formula to determine the Mean

b. The determination of the institutional deliveries coverage of the whole sample and the two groups of health facilities under study by using the raw data of expected and registered deliveries. Using the geo-referenced analysis it was possible to establish the expected deliveries of each health facility. By adding the total expected deliveries and, on the other hand, the registered number of health facilities with MWHs, it was possible to determine the Institutional deliveries coverage of the whole sample and the two groups under study.

$$\text{Institutional deliveries coverage of the whole sample} = \frac{\sum \text{all registered deliveries}}{\sum \text{all expected deliveries}}$$

Figure 3.13. Formula to determine Institutional deliveries coverage of the whole sample

$$\text{Institutional deliveries coverage of health facilities without MWH} = \frac{\sum \text{all registered deliveries health facilities without MWH}}{\sum \text{all expected deliveries deliveries health facilities without MWH}}$$

Figure 3.14. Formula to determine Institutional deliveries coverage of the health facilities without MWH

$$\text{Institutional deliveries coverage of health facilities with MWH} = \frac{\sum \text{all registered deliveries health facilities with MWH}}{\sum \text{all expected deliveries deliveries health facilities with MWH}}$$

Figure 3.15. Formula to determine Institutional deliveries coverage of the health facilities with MWH

Option b was considered the most suitable as the mean of the institutional deliveries coverage would be calculated by aggregating proportions. Mean, as a measure of central tendency, is affected by extreme scores in the data (outliers). It was considered that the use of the mean would distort the results. In order to avoid that, institutional deliveries coverage of the three groups (whole sample, facilities with and without MWH) were determined according to option b.

(6) Time-series analysis of the institutional deliveries trends of the 28 health facilities under study, using data (when available) from 1994 to 2009, in order to detect if the setting up of MWHs has provoked some changes in institutional deliveries.

Inferential statistics have been used to analyze whether there were statistically significant differences between institutional deliveries coverage in the group of health facilities with MWH and the group without the service. In order to determine this aspect, *a Chi-square test for a 2x2 by using a continuity correction*, also named Yate's continuity correction, was used (Kirkwood and Sterne, 2006:166-168).

The main assumptions of the Chi-Square test are (Burns and Grove, 2005: 518): (1) just one datum entry is made for each subject in the sample; (2) for each variable, the categories are mutually exclusive and exhaustive; (3) this test is distribution-free or nonparametric (no assumption has been made of a normal distribution of values in the population from which the sample was taken).

The presence of MWH services in a health facility was considered the exposure. Deliveries at health facilities were considered the outcome. A contingency table was used to record and analyze the relation between registered deliveries and expected deliveries of the two groups of population (those exposed to a health facility with MWH and those exposed to a health facility without MWH). The Chi-squared test would determine whether there is a statistically significant difference between the proportion of exposed population which had institutional deliveries, and the proportion of unexposed population which had institutional deliveries. This test provides information about how strong the relationship between the exposure and the outcome was.

	POPULATION WHO HAD INSTITUTIONAL DELIVERIES		
MWH Service	**YES**	**NO**	**TOTAL POPULATION**
A (HEALTH FACILITIES WITH MWH)			
B (HEALTH FACILITIES WITHOUT MWH)			
TOTAL POPUALTION			

Table 3.2. 2x2 table template (it was used one for each area of influence)

The formula to calculate the Chi-Squared is:

$$x^2 = \sum \cdot \frac{(|O-E|-0,5)^2}{E}, d.f$$

Figure 3.16. Formula to determine Chi-squared.

Where *O* = Observed frequency and *E*=expected frequency

In conclusion the use of the Chi-squared test for a 2x2 using a continuity correction has allowed us to test the null hypothesis of the research that stated that *there is no significant difference between the coverage of institutional deliveries in health facilities type II with MWHs and without*. On the other hand, the used of the across-time analysis has allowed us to determine if the setting up of the MWH service has increased institutional deliveries coverage in the health facilities with this service.

3.4 INTERNAL AND EXTERNAL VALIDITY OF THE STUDY

Assessing the validity of research data and also replicating the research study has been identified as critical aspects for public health practitioners' confidence in the application of research findings. Validity is a measure of the truth or accuracy of a claim that is fundamentally important throughout the research process. It is a complex idea, important not just for the researchers, but also for those who will read the report and will consider using the findings in their practice. Critical analysis becomes crucial to identify threats and establishing trustworthiness.

Validity should be considered as a transverse aspect that should be analysed throughout all the research, from the research design, to the literature review as well as the data analysis. Within this context, in this research, it is considered that the sample criteria, detailed above, should contribute to enhancing the validity of the study as the established main reasons to exclude elements of the sample, allowing us to reduce the number of confounders that can generate false results.

In addition, some particular aspects of the internal and external validity are described.

3.4.1 Internal Validity

Internal Validity, in the data collection process, refers to the extent to which a measurement instrument actually measures what it is meant to measure (Joubert and Ehrlich, 2009:117). Internal Validity is directly related to the design of the research and the quality of the data used. This will determine the extent to which the effects detected in the study are a true reflection of reality rather than being the result of the effects of extraneous variables.

As internal validity is directly related to the quality of the data, this concept has been studied considering the two main sources of data: primary and secondary data. Threats and strategies to increase the internal validity of the study have been analysed.

3.4.1.1 Internal Validity of primary data

Primary data were collected to determine the number, location and year of set up of the MWHs, as no consistent information about this information appeared in the provincial or national documents related to the availability of the infrastructures.

The information was obtained by direct observation and interviews with the District Directors (the higher health authority at district level). Later, this information was verified by the Health Provincial Board using a structured questionnaire.

The use of these different approaches of data collection increases the validity of these data. In addition, the data collection form was designed to allow ease recording of the information and to allow easy computer register.

The number and location of MWHs data have a high degree of validity because it was verified by direct observation or by an interview with the maximum authority of the health area. However, the year of set up could present a lowest degree of validity since no official records exists about the set up of these services.

3.4.1.2 Internal Validity of secondary data.

3.4.1.2.1. About the Geo-Referenced Data

Several authors have tried to define the key aspects of geo-referenced quality data; however the definition of Cromley and Mclafferty (2002:56-62) has contributed to shed light to this important aspect, characterizing five important aspects, internationally recognised, related to spatial data quality:

(1) Lineage: is the description of the source material from which the data were derived, and the methods of derivation, including all transformations involved in producing the final digital files.

As the geo-coded data used in the research are secondary sources, it is not possible to assess lineage. However, it is considered to be of higher quality because the database used for this study is used in all the research and publications from the province and, within it, can be highlighted the Health Network Development Plan (DPS Cabo Delgado, 2009) which is the document of reference in the Province in relation to the location of all the health facilities in the province. In addition, the database is also the main reference for the study of the agriculture and administrative sector, which, within other relevant information, deals with the location of all the communities of the province.

(2) Accuracy: refers, in general, to the level of error in a database.

a. Positional Accuracy: refers to the nearness of the values describing the position of a real-world object to the object's "true" position.

   It was not possible to assess Positional Accuracy for the same reasons detailed regarding lineage. However, the same assumptions about the high quality and trustworthiness of the data apply.

b. Attribute Accuracy: considers the nearness of the values describing the real-world entity in the database to the entity's "true" attribute.

   The geo-coded health database describes the type of health centre by type (health post, health facility type I, type II, Urban Health Facility, Rural Health Facility, Rural Hospital and Provincial Hospital). The attributes of the sample were checked and it was confirmed that the information registered in the database is still actualized (that means that the health facilities include in the database have the same category of the "true" attribute).

(3) Spatial dependence: is the degree to which errors are spatially systematic.

Spatial location, position in space, of the elements included in the geo-coded database was done by the use of Global Positioning Systems (GPS). GPS used a series of satellites of recognized position in space, together with satellite sensors or tracking devices positioned on the earth's surface. Very accurate coordinate locations can be computed for each sensor, by recording the positions of the satellites with multiple sensors. The output from a GPS receiver is a latitude/longitude pair describing position on the earth's surface. GPS are considered one of the most reliable instruments to determine location. In this context, spatial dependence is considered low (Cromley and McLafferty, 2002:45)

(4) Completeness: is the relationship between the objects represented in the data set and the abstract universe of all such objects. Completeness is related to two questions: (a) Are all of the relevant objects captured in the database? and (b) are all the records for an individual unit in the database complete?

In relation to the point (a), it was necessary to assess two key aspects: the existence of new health facilities and the existence of new population settings.

Related to the first aspect, the area under revision was studied and it was confirmed that no new health facilities were built since the elaboration of the database. In addition, the database was compared with the key documents of the health sector in the province confirming the validity of the information.

Related to the second aspect, it was not possible to confirm that since the elaboration of the database, year 2001 (Pérez, 2010) no new settlements have been established. However, it is important to note that the database used is the most updated data.

In relation to the point (b) it was confirmed that the records for any individual health facility were not complete. The MWH services were not detailed in the data base. For this reason it was necessary to design the questionnaire about the location of MWHs described in this section.

(5) Logical consistency: is a measure of data that considers the “structural integrity” of a database.

The logical consistency of the database was high since it responds to the key aspects that the research intends to answer. Crucial aspects were registered in a logical way: (a) geographic location of the health facilities and population; (b) attributes of these two datasets: type of health facility and census population of each community.

Once the data about the number and location of MWHs were obtained, the database was extended in order to increase this new attribute of each health facility. It is important to emphasize that this research has enriched the health database of the Provincial Health Board by the registration of the location of the MWHs.

Ver atributos : Health Facilities Sample under study

Health Facilities Sample under study (30 elementos - 0 seleccionados)

NOME	POSTO	DISTRITO	TIPO_US	MWH	GID
MEZA	MEZA	ANCUABE	CSR-II	NO	6
NGEWE	ANCUABE	ANCUABE	CSR-II	NO	17
MINHEWE...	MEZA	ANCUABE	CSR-II	NO	18
MARIRI	MEZA	ANCUABE	CSR-II	NO	27
MAVALA	MAVALA	BALAMA	CSR-II	NO	9
IMPIRI	IMPIRI	BALAMA	CSR-II	YES	10
KUEKUE	KUEKUE	BALAMA	CSR-II	NO	12
METATA	BALAMA	BALAMA	CSR-II	NO	19
NTETE	BALAMA	BALAMA	CSR-II	NO	20
MURRIPA	BALAMA	BALAMA	CSR-II	YES	28
QUITERAJO	QUITERAJO	MACOMIA	CSR-II	NO	0
CHAI	CHAI	MACOMIA	CSR-II	NO	1
MUCOJO	MUCOJO	MACOMIA	CSR-II	YES	2
NGUIDA	MACOMIA	MACOMIA	CSR-II	YES	21
NAUNDE	MUCOJO	MACOMIA	CSR-II	NO	29
MUAGUIDE	MUAGUIDE	MELUCO	CSR-II	YES	3
MINHANHA	MELUCO	MELUCO	CSR-II	NO	22
IMBADA	MUAGUIDE	MELUCO	CSR-II	NO	23
NAIROTO	NAIROTO	MONTEPUEZ	CSR-II	NO	4
MIRATE	MIRATE	MONTEPUEZ	CSR-I	YES	5
NAMANHU...	NAMANHU...	MONTEPUEZ	CSR-II	NO	7
MAPUPULO	MAPUPULO	MONTEPUEZ	CSR-II	YES	8
NROPA	MAPUPULO	MONTEPUEZ	CSR-II	NO	24
NAMUETO	MONTEPUEZ	MONTEPUEZ	CSR-II	NO	26
MELOCO	MELOCO	NAMUNO	CSR-II	NO	11
NCUMPE	N´CUMPE	NAMUNO	CSR-II	NO	13
HUCULA	HUCULA	NAMUNO	CSR-II	NO	14
MACHOCA	MACHOCA	NAMUNO	CSR-II	NO	15
PAPAI	PAPAI	NAMUNO	CSR-II	NO	16
NANRAPA ...	NAMUNO	NAMUNO	CSR-II	NO	25

Figure 3.17.Modified health database including location of MWHs.

Another relevant aspect of the Geo-referenced data validity is related to the *projections* used for mapping. According to Cromley and Mclafferty (2002:48-55) projections refer to the mathematical functions that allow to convert locations from the curved three-dimensional surface of the earth to a flat, two dimensional representation. There are several ways to project coordinates. Meridians and parallels (geographic grid) are used to reference locations on the earth's surface. Summarizing, map projection provides a method for making the transformation from three dimensions to two.

In this research, the geo-coded data were projected according to the Universal Transverse Mercator (UTM). The UTM systems coordinates (CSAT,2006) are based on a family of 120 Transverse Mercator map projects (two for each UTM zone, with one for each N/S hemisphere). UTM system divides the earth in 60 zones, each 6º wide in longitude.

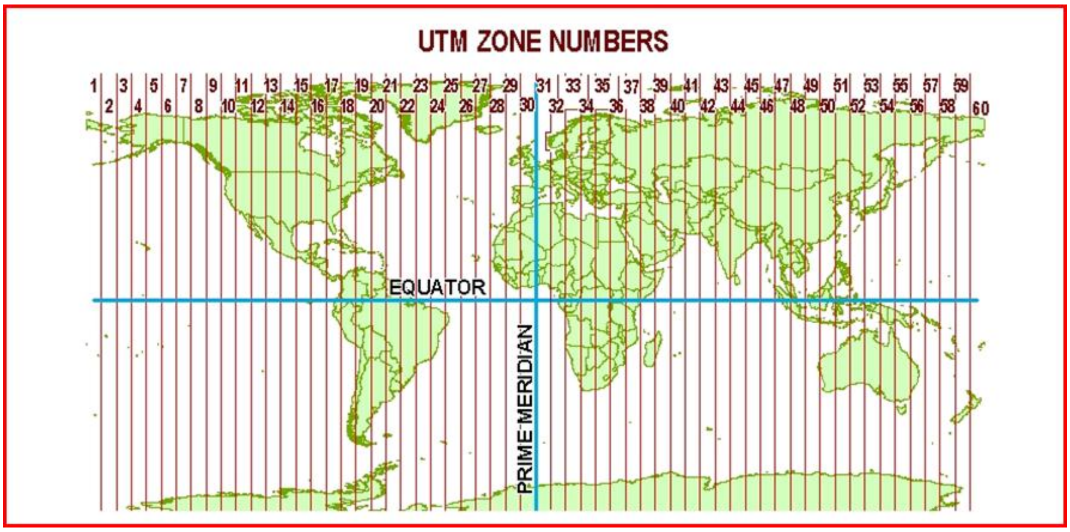


Figure 3.18. Universal Transverse Mercator (UTM) zone. Source: (CSAT,2006).

The main characteristics of UTM projections are:

(1) Numbering of zones begins at 180º and increases eastward.

(2) Each defined zone has a central meridian.

(3) X value is called the Easting has a value of 500,000 meters at the central meridian of each zone.
(4) Y value is called the Northing and has a value of 0 meters at the equator for the northern hemisphere and 100,000 meters at the equator for the southern hemisphere.

UTM is limited to the area between 84ºN and 80ºS. Beyond that, distortion increases and Universal Polar Stereographic (UPS) coordinates are used. The main advantages of UTM projections are (MapTools, 2010):

(1) A square grid that provides a constant distance relationship anywhere on the map. The UTM system allows the coordinate numbering system to be tied directly to a distance measuring system. This aspect is particularly relevant in the present research because the clusters of population that have been defined were based on the distance from a health facility.

(2) UTM system provides no negative numbers or East-West designators. This system is similar to the X,Y Cartesian coordinate and no spherical trigonometry must be applied.

(3) Coordinates are decimal based (it is not necessary to convert seconds and minutes).

(4) Coordinates are measured in metric units.

Mozambique comprises several UTM zones (figure 3.18), namely 36S and 37S, depending on the province. In this case, as the study was done in Cabo Delgado province, the most suitable zone was 37S. The used of the correct UTM zone projection to map and analyses distances enhance the internal validity of the data.

3.4.1.2.2 About the Health Information System Data.

Mozambique has a functional health information system (HIS) that reports health unit activities to district level, provincial and national level on a monthly basis. Several studies (WHO and MISAU, 2006) have been carried out about the positive and negative aspects of the HIS. However it is important to highlight that HIS data are officially recognized by the Ministry of Health and cooperation partners as common indicators of the National Health System assessment. The international NGO **medicus**mundi works in the six district of study in collaboration with the Health Provincial Board (FAMME,2007). **medicus**mundi, in addition to other activities, contributes to strengthening of the Health Information System, by promoting regular analysis and interpretation of data and ensuring effective assessment of the data.

This factor contributes to increasing the quality of HIS data, and therefore, in spite of the limitations inherent in the HIS records, the districts under study offer considerable guaranties of a better report than other districts in the Province. However, the institutional deliveries data collection from 1994-2009 showed some inconsistencies, due to the incompleteness of the records in some health facilities. This aspect negatively affected the across time analysis of the institutional deliveries trends, and also, it can affect the internal validity of the data.

Every year the Ministry of Heath of Mozambique, within the context of the SWAP collaboration with partners, presents a report of Health Data verification. The report verifies a set of indicators by comparing the data registered in the Health Information System with the registration books located in the health facilities. The last one (MISAU e parceiros de cooperação de Saúde Moçambique, 2010) analyzed the quality of data of three indicators, including the number of institutional deliveries. After implementing a survey in 14 health facilities, the report concluded that the quality of data is high with a high degree of consistency between notified and registered data.

In order to increase the consistency of HIS data, HIS data were compared with the registration books in 7 of the 30 health facilities of the sample. It was confirmed that the quality of the data was high, with more than 98,94 % of confidence (more details in chapter 4).

3.4.1.2.3 About the population Data.

The internal validity of the population data is high as the information was obtained directly from the National Statistics Institute (INE).

The data collection process aimed to obtain the most up to date census population data elaborated in 2007. The aim was to have data representative of the number and specific location of the population. Unfortunately, at the time of the research, the analyses carried out by the INE were incomplete and no information about population or community was available. The 2007 census provided data at administrative and locality level.

This fact required the elaboration of projections of populations, according to the 1997 Census and the new data of 2007. According to the population data published in 2007, the populations growth was estimated for each administrative area under study during ten years (from 1997 to 2007). The projections methodology will be detailed in chapter 4. Nevertheless, it can be considered that population data have a high degree of internal validity, as projections have been based on the last two official census published in Mozambique, considering the specific population growing in the administrative areas under study.

On the other hand, the lack of updated information about the location of communities could affect the internal validity of data regarding the location of the population. It is possible that during these 9 years (data when population was geo-referenced) some population movements have been registered. Considering that the study is based on the analysis of clusters of population around health facilities, population location is a crucial aspect for the reliability of the outcome. However, at the time of publication of the information about community's location, no other methodology could be implemented.

3.4.2 External Validity

External validity is related to the generalizability of the results beyond the sample used in the study (Burns and Grove, 2005: 736-738). External Validity is strongly related to the sampling process and the sample. To some extent, the significance of the study depends on the number and types of people and situations to which the findings can be applied.

Because of the sample limitations and the research design (ecological approach) the external validity is limited. However, it should be emphasized that the research also aims to contribute to the knowledge of the potential applications of GIS in public health. In this context, further studies based on the proposed methodology but with a larger sample can contribute to the generalizability of the results (more details in chapter 5).

3.5 CONCLUSION

The present chapter has described the main features related to the research design and method used in the research. An ecological or correlation research has been identified as the most suitable quantitative design to reach the aim of the study.

Information about the population, sampling process, sample criteria and ethical aspects related to the sampling has been illustrated. The application of the inclusion and exclusion criteria resulted in a sample based on 28 Health Facilities type II located in the six districts under study.

In addition, chapter 3 has detailed the approach of data collection, based on a quantitative structured method, and using secondary and primary data as sources of information. These different sources have been described, providing also information about the characteristics of these data collection instruments.

A brief overview of the statistical methods used, both descriptive and inferential, has been provided. More information about data analysis is offered in chapter 4.

Finally, chapter 3 has dealt with significant questions related to the internal and external validity of the research. In this context, the threats that can affect validity and also the mechanisms that have been implemented in order to increase this validity have been described.

Once the data have been collected, and validity and ethical aspects have been considered and ensured, below. Chapter 4 goes into further detail concerning the analysis, presentation and description of the research findings.

CHAPTER 4 – ANALYSIS, PRESENTATION AND DESCRIPTION OF THE RESEARCH FINDINGS

4.1 INTRODUCTION

The research purpose of the study focused on evaluating the effectiveness of MHWs in increasing coverage of institutional deliveries. This assessment was done by the use of Geographical Information Systems (GIS) in six districts of Cabo Delgado Province (Mozambique).

Chapter two presents the literature review related to the study of MWHs, concluding that no evidence of the impact in Mozambique of MWHs in increasing institutional deliveries has been found. Chapter three focusses on a description of the methodology, study design, sampling process, statistics and validity of the proposed research. In chapter three, GIS technology has been introduced highlighting how this approach can be used to answer the main hypothesis of the research. Chapter 3 also describes the availability and quality of the necessary data that have been analysed.

Within this context, and always keeping in mind the research purpose, the analysis, presentation and description of the research findings deal with key aspects related to the data management, analysis and final research results. The primary hypothesis is tested. Special attention is paid to how GIS methodology can be used to determine and show results of coverage of institutional deliveries coverage. The results of inferential statistics (*Chi-squared test with the continuity correction*) are used to determine if coverage of institutional deliveries in health facilities with MWH is greater with respect to coverage than in health facilities without that service. In addition, a secondary hypothesis is studied through an across-time analysis. Finally, a general overview of the findings is presented, summarising key conclusions.

4.2 DATA MANAGEMENT AND ANALYSIS

Data management and analysis has focused on the study of the two hypotheses that the research has stated, with a special attention to the main hypothesis and the uses of GIS technology as an innovative methodology to determine institutional deliveries coverage. In addition, in the data management and analysis section is introduced the main features of the across-time analysis.

4.2.1 Institutional Deliveries Coverage analysis using GIS

The next section explains how Geographical Information System technology can be used to determine the institutional deliveries coverage of a set of health facilities under study. Institutional deliveries coverage of the sample is calculated according to different areas of influence (8, 10, 12 and 14 km). The sequence used in order to analyse the data is explained, paying special attention to GIS applications and the software used. The analysis of data has been done by the used of KOSMO software (SAIG, 2009). KOSMO is free software with the following functions (SAIG, 2009):

(1) Storage and management of geographical information in interrelated data base management systems.

(2) Editing, viewing and use of geographical information.

(3) Publication of Geographical Information through the use of standard protocols that allows sharing projects and knowledge.

(4) Publication of information and functionalities on the Internet and access through password.

Later, results obtained are analyzed, comparing the coverage of health facilities with and without MWH services in order to allow testing the main hypothesis of the research.

4.2.1.1 Population Analysis: projections and location.

In Mozambique the population is censused every 10 years. The last two censuses of the population were done in 1997 and 2007 respectively. The geo-coded database elaborated by the Health Provincial Board in 2001 was based on the 1997 Census.

In order to estimate the institutional deliveries coverage of each health facility, it was necessary to know the population in 2009. Note that the 2009 population was used in order to determine institutional deliveries coverage in all the health facilities of the sample, including health facilities with MWH that ended their services during the same year. It is supposed that the effects of MWH persist for a determined time. In addition, this criterion did not considerably affect the comparison between institutional deliveries coverage as the variation of population is not significant (annual increase average 2,4 %).

Population projection was estimated according to the following methodology:

(1) *Determining the annual population growth of each administrative post*: with the information provided by the Census of 1997 and 2007 it was possible to determine the exact increase of population in each administrative post. The *next example* illustrates this step:

The district of Ancuabe contains three administrative posts, namely: Ancuabe, Meza and Metoro. The 1997 and 2007 population estimates were:

DISTRICT	ADMINISTRATIVE POST	POP 1997	POP 2007
ANCUABE	ANCUABE	36.172	40.989
ANCUABE	MEZA	25.215	29.190
ANCUABE	METORO	25.856	37.059

Table 4.1. Administrative post by district: an example of Ancuabe district

With this information it was possible to estimate the annual growth of each administrative post in absolute value, percentage and the annual percentage growth:

DISTRICT	POST	POP 1997	POP 2007	NET POP INCREASE	INCREASE %	ANUAL INCREASE %
ANCUABE	ANCUABE	36.172	40.989	4.817	13,32	1,33
ANCUABE	MEZA	25.215	29.190	3.975	15,76	1,58
ANCUABE	METORO	25.856	37.059	11.203	43,33	4,33

Table 4.2. Annual growing of each administrative post: an example of Ancuabe district.

(2) *Forecasting 2009 population*: The annual increase in the population obtained can be considered to have a high degree of validity as it was based on the real population census. This increase could be used to project the 2009 population, based on 1997 population registered in the geo-coded database:

DISTRICT	POST	POP 1997	POP 2007	NET POP INCR.	INCR. %	ANUAL INCR. %	POP 2008	POP 2009
ANCUABE	ANCUABE	36.172	40.989	4.817	13,32	1,33	41.534,85	42.087,96
ANCUABE	MEZA	25.215	29.190	3.975	15,76	1,58	29.650,16	30.117,58
ANCUABE	METORO	25.856	37.059	11.203	43,33	4,33	38.664,71	40.339,99

Table 4.3. 2009 population projections: an example of Ancuabe district

(3) *Determining 2009 population by community*: The increase of population, by administrative post, can be used to project the population of 2009 of the communities pertaining to each administrative post (a total of 74 communities in the case of Ancuabe district).

Summarizing, the methodology to determine projections of 2009 population can be described by the next procedure:

$$Annual\ Population\ Increase\ 1997-2007=(Population\ 2007-Population\ 1997\ /\ Population\ 1997)*10$$

$$\Downarrow$$

$$Population\ 2008=Population\ 2007+[(Annual\ Population\ Increase\ 1997-2007*Population\ 2007)/100]$$

$$\Downarrow$$

$$Population\ 2009=Population\ 2008+[(Annual\ Population\ Increase\ 1997-2007*Population\ 2008)/100]$$

Figure 4.1. Methodology to determine population projections

This methodology was applied to all the communities pertaining to the administrative posts within each district. Finally, the population projections 2009 were actualized in the geo-coded data base.

4.2.1.2 Health facilities and MWHs location.

The geo-coded database contained information about the location of the sample (health facilities type II). Later, MWHs were also located with the information provided by the district health board, direct observation and the provincial health board.

Figure 3.12 presented before (chapter 3, page 78) showed the geo-coded database with the information of the health facilities of the sample that have a MWH. Figure 4.2 shows the location of the health facilities of the sample, indicating the location of the MWH services.

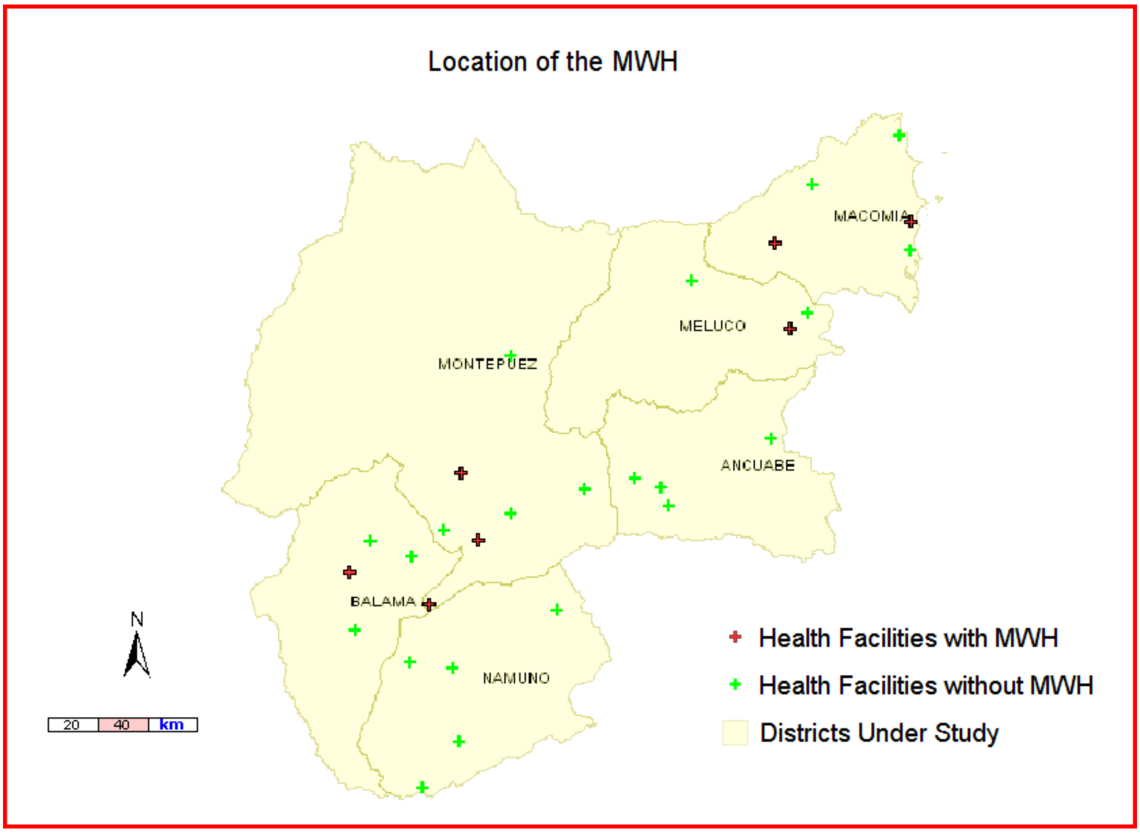


Figure 4.2. Location of the MWHs in the sample under study.

4.2.1.3 Determining health facilities influence over population: buffers and intersections.

Once the population of the districts under study was actualized according to the projections, it was localized in order to determine the exact position. Figure 4.3 shows the location of the population of the districts under study.

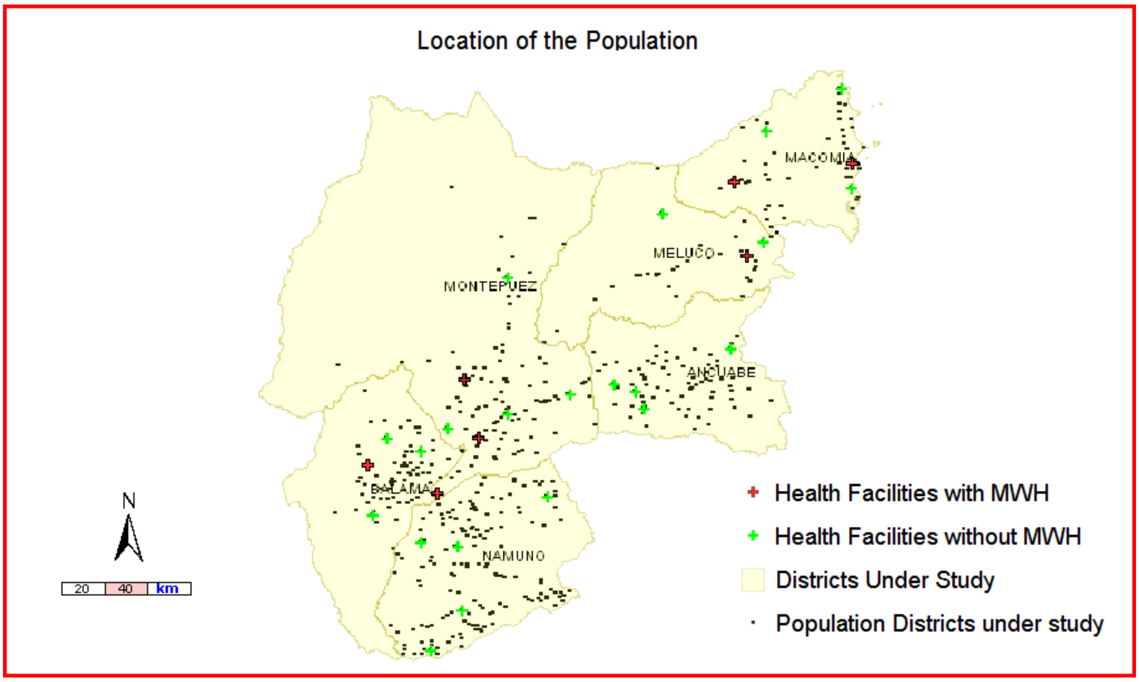


Figure 4.3. Location of the population of the districts under study.

Once health facilities were located, the *area of influence* of each health facility was determined. The KOSMO software allows one to define *buffers* of different radius of influence. Buffers of 8, 10, 12 and 14 Km were defined. The first radius was established in 8 km, as recommended by the Ministry of Health. This distance is the optimal area of influence of a health facility: 8 km (DPS Cabo Delgado, 2009:21). However, three additional buffers with an increase of 2 km were also defined in order to study the trends of institutional deliveries coverage when distance augments.

To illustrate this procedure, figure 4.4 shows the buffers of 8 km of the health facilities of Macomia District. The same procedure was applied to each facility of the sample, including both facilities with MWH and facilities without this service.

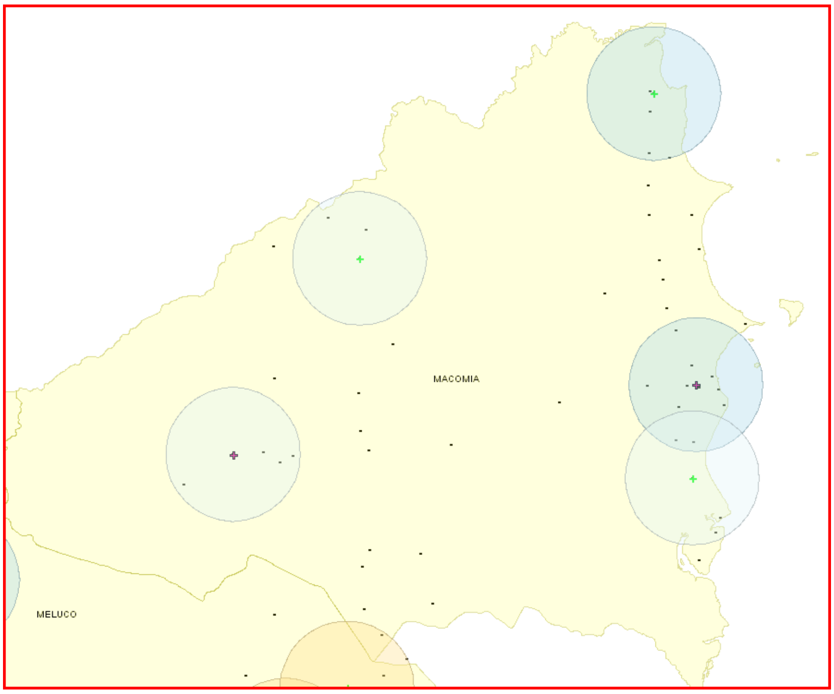


Figure 4.4. 8 km Radius buffers in health facilities of Macomia District.

As mentioned before, the KOSMO software allows us to define concentric buffers of different radios. This operation permits us to study different theoretical areas of influence of each health facility. Figure 4.5 shows the buffers of 8, 10, 12 and 14 km in health facilities of Macomia Distritc.

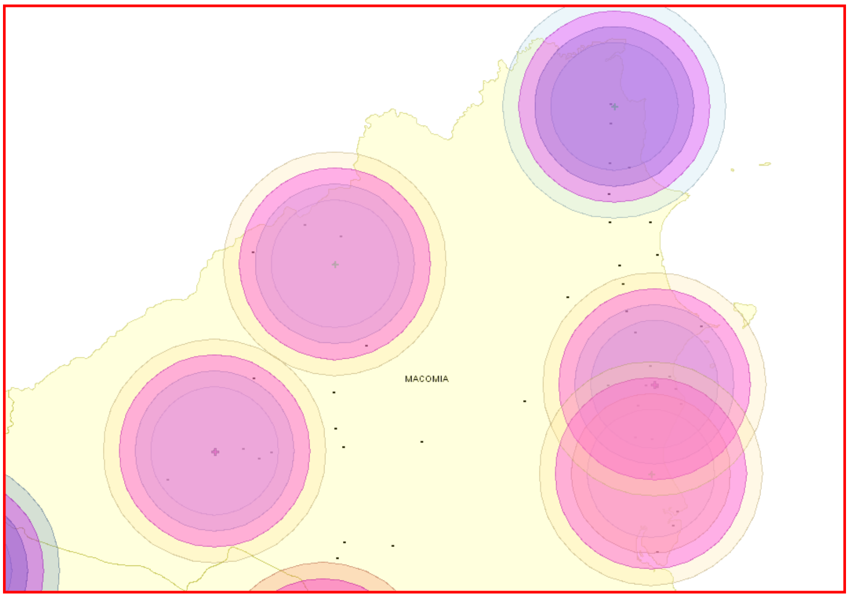


Figure 4.5. Multiple buffers (8, 10, 12 and 14 km) in health facilities of Macomia Distritc.

Following definition of the areas of influence and the location of the population it was possible to determine the population that was serviced by every buffer. The KOSMO software makes it possible to determine this operation by the use of the application *intersection*. This application determines which population attributes were inserted in each area of the buffer. Following the example of Macomia district, figure 4.6 shows the population (red points) that are serviced by an influence area of 8 km around each health facility.

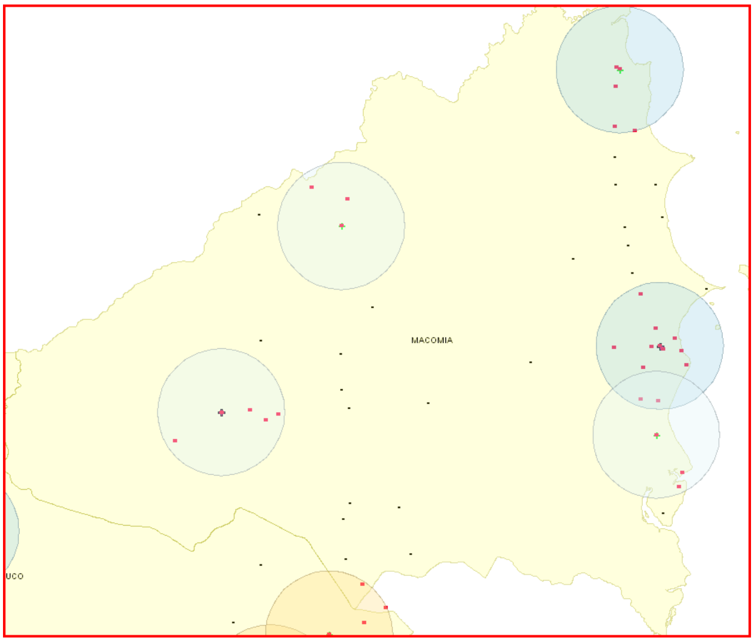


Figure 4.6. Intersection between buffer and population: population under an area of influence of 8 km in Macomia district.

This method was used with all the health facilities under study, allowing us to determine the population of influence using buffers of 8, 10, 12 and 14 km. Figure 4.7 shows an 8 km buffer in all the samples, determining the population under influence for each health facility. The same operation was done applying buffers with a higher radius.

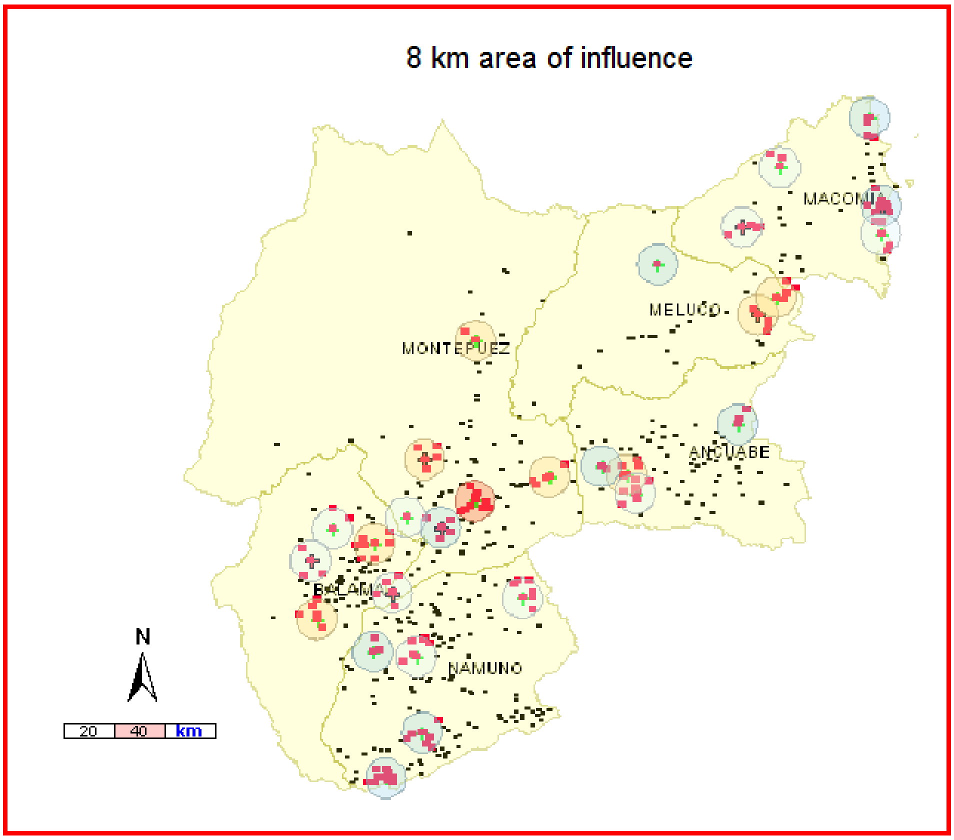


Figure 4.7. 8 km buffers and their population under influence of the entire sample.

A data based was created including the population under effect of each health facility by the different areas of influence (buffers). In summary, at this point, we knew the extent of population serviced by each facility, considering different radiuses of influence.

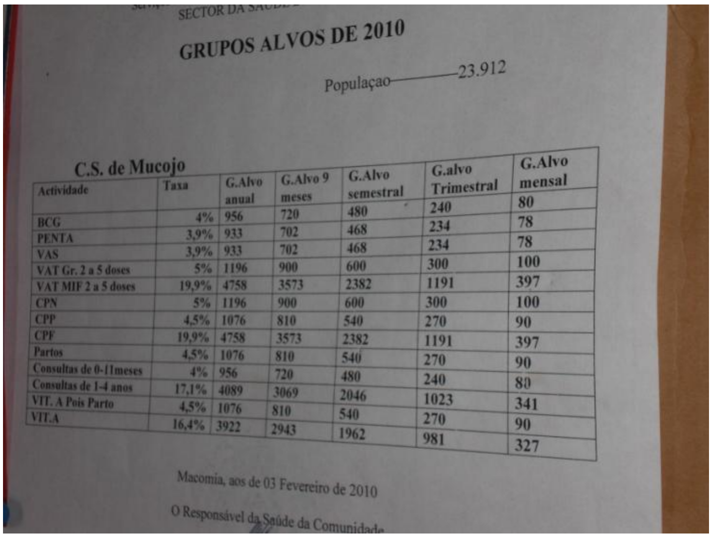
4.2.1.4 Estimating annual deliveries.

Based on the 1997 and 2007 Census, the Ministry of Health of Mozambique estimated the expected deliveries to be 4,5 % of the total population (MISAU, 2001:24). This projection is used at all levels of the National Health System, especially at health facilities level, to define targets population.

$$Expected\ Deliveries = Total\ Population\ x\ \frac{4,5}{100}$$

Figure 4.8. Formula to determine expected deliveries

Figure 4.9 shows the target population of the Mucojo Health facility (located in Macomia district) as an example of how the NHS used the formula indicated. As can be seen the total population in 2010 is 23.912 inhabitants. Institutional deliveries (Partos in Portuguese) are determined according to the formula (4,5 % of the total population). Therefore, in 2010, Mucojo expects 956 deliveries.



SECTOR DA SAÚDE

GRUPOS ALVOS DE 2010

Populaçao——23.912

C.S. de Mucojo

Actividade	Taxa	G.Alvo anual	G.Alvo 9 meses	G.Alvo semestral	G.alvo Trimestral	G.Alvo mensal
BCG	4%	956	720	480	240	80
PENTA	3,9%	933	702	468	234	78
VAS	3,9%	933	702	468	234	78
VAT Gr. 2 a 5 doses	5%	1196	900	600	300	100
VAT MIF 2 a 5 doses	19,9%	4758	3573	2382	1191	397
CPN	5%	1196	900	600	300	100
CPP	4,5%	1076	810	540	270	90
CPF	19,9%	4758	3573	2382	1191	397
Partos	4,5%	1076	810	540	270	90
Consultas de 0-11meses	4%	956	720	480	240	80
Consultas de 1-4 anos	17,1%	4089	3069	2046	1023	341
VIT. A Pois Parto	4,5%	1076	810	540	270	90
VIT.A	16,4%	3922	2943	1962	981	327

Macomia, aos de 03 Fevereiro de 2010

O Responsável da Saúde da Comunidade

Figure 4.9. 2010 Target populations of Mucojo health facility.

The estimated number of expected annual deliveries was calculated for the serviced population of each health facility by each area of influence complementing the database introduced above.

4.2.1.5 Determining institutional deliveries coverage.

Data from the Health Information System provided by the Health Provincial Board included the institutional deliveries registered in each health facility in 2009 of the sample under study. Using this information and the Institutional deliveries coverage, determined above, *Institutional deliveries coverage* can be calculated according to the following formula:

$$\text{Institutional deliveries coverage of a health facility} = \frac{\text{Deliveries registered at health facility}}{\text{Expected deliveries this year within the area of influence of the health facility}}$$

Figure 4.10. Formula to determine the institutional deliveries coverage of health facilities.

4.2.2 Across time analysis

Aiming to exclude potential confounders, a secondary hypothesis was tested in order to assess the effectiveness of MHWs: across time analyses show that MHW services increase institutional deliveries in health facilities. In this case, raw data (institutional deliveries and not proportions) were analysed, therefore it makes no sense to compare the number of deliveries between the different health facilities under study. The objective of across time analysis was to determine, with the information available concerning the establishment of the service, if there is a change in institutional deliveries related to the setting up of MWH services.

4.3 RESEARCH RESULTS

4.3.1 First approach to institutional deliveries Coverage results.

By application of the methodology, described above, coverage of institutional deliveries was determined for each facility and for each area of influence (8, 10, 12 and 14 km). Table 4.4 shows the findings, where those health facilities with MWH are marked in red and those without the service are marked in black.

	% INSTITUTIONAL COVERAGE				
HEALTH FACILITY	8 KM	10 KM	12 KM	14 KM	MWH
CHAI	63,8	63,8	50,1	50,1	NO
IMBADA	49,4	30,0	26,8	18,5	NO
IMPIRI	60,8	53,3	53,3	26,5	YES
KUEKUE	41,0	30,1	24,3	21,4	NO
MACHOCA	227,8	153,9	117,4	82,6	NO
MAPUPULO	157,1	67,5	51,9	44,6	YES
MARIRI	61,5	44,2	29,4	27,5	NO
MAVALA	78,9	78,9	66,9	32,8	NO
MELOCO	75,0	71,1	62,6	53,4	NO
MEZA	56,0	48,4	35,5	32,4	NO
MINHANHA	96,3	96,3	96,3	96,3	NO
MINHEWENE	130,3	34,3	25,2	20,1	NO
MIRATE	46,0	31,2	30,7	26,4	YES
MUAGUIDE	49,7	49,7	34,1	28,8	YES
MUCOJO	99,0	73,5	64,2	59,5	YES
MURRIPA	68,0	60,4	25,4	19,4	YES
NAIROTO	55,6	36,1	14,0	10,3	NO
NAMANHUMBIRE	57,1	41,0	36,6	32,8	NO
NAMUETO	8,1	7,8	7,5	6,8	NO
NAMRAPA	63,2	36,0	32,3	24,3	NO
NAUNDE	85,9	58,6	44,1	31,9	NO
NCUMPE	156,5	139,1	66,6	50,2	NO
NGEWE	148,4	73,6	73,6	64,1	NO
NGUIDA	67,5	67,5	53,2	53,2	YES
N'ROPA	87,5	47,7	47,7	38,1	NO
NTETE	44,8	35,4	21,2	19,9	NO
PAPAI	288,0	263,4	158,0	135,0	NO
QUITERAJO	91,7	91,7	77,3	67,3	NO

Table 4.4. Summary of the institutional deliveries coverage of the health facilities under study by different areas of influence (8, 10, 12 and 14 Km).

As can be seen in table 4.5 (descriptive statistics for 8 km) the range of the values is 279,9 % with a minimal extreme of 8,1 % and a maximum extreme of 288. Before going into detail about the analysis of the results, the data set of institutional deliveries coverage was carefully checked in order to identify any outliers. Such errors can strongly influence and bias the results, therefore they should be detected and corrected.

Descriptive Statistics

Statistic	Value	Percentile	Value
Sample Size	28	Min	8,1
Range	279,9	5%	22,905
Mean	89,818	10%	44,42
Variance	3573,6	25% (Q1)	55,7
Std. Deviation	59,78	50% (Median)	67,75
Coef. of Variation	0,66557	75% (Q3)	98,325
Std. Error	11,297	90%	164,17
Skewness	1,8837	95%	260,91
Excess Kurtosis	3,9894	Max	288

Table 4.5. Descriptive Statistics of the initial sample (n=28).

4.3.1.1 Data-checking procedures

Extreme values of institutional deliveries coverage were checked, considering the first area of influence or buffer (8km) for the following health facilities:

Health Facility	District	Institutional Deliveries	Institutional Deliveries coverage
MACHOCA	NAMUNO	877	227,79 %
PAPAI	NAMUNO	648	288 %
N'CUMPE	NAMUNO	662	156 %
MAPUPULO	MONTEPUEZ	561	157,15 %
NAMUETO	MONTEPUEZ	311	8,12 % *
MINHEWENE	ANCUABE	185	130 % **
NGEWE	ANCUABE	331	148 %**

Table 4.6. Data-checking procedures: extreme values.

Errors in calculating institutional deliveries coverage can arise because of two factors: (1) incorrect institutional deliveries values and/or (2) incorrect population under influence values.

The first data checking procedure consisted of investigating if the registration books of the 7 health facilities under revision were checked, and the following results obtained:

Health Facility	District	Institutional Deliveries (Health Information System)	Institutional Deliveries (Registration Books)
MACHOCA	NAMUNO	877	758 *
PAPAI	NAMUNO	648	648
N'CUMPE	NAMUNO	662	656
MAPUPULO	MONTEPUEZ	561	573
NAMUETO	MONTEPUEZ	311	315
MINHEWENE	ANCUABE	185	179
NGEWE	ANCUABE	331	330

Table 4.7. Data checking-procedures: comparing HIS with registration books.

**The registration book of Machoca only included deliveries from March to December 2009. The information about January and February was missing. However it was estimated, considering the mean of monthly deliveries and the annual deliveries, obtaining a value of 909 deliveries.*

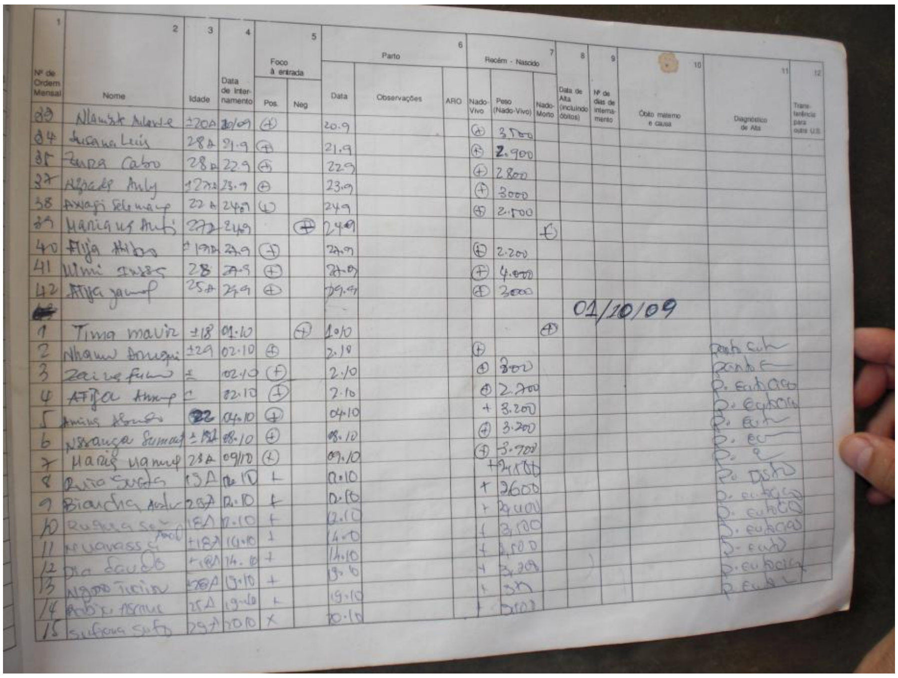


Figure 4.11. Example of a deliveries registration book used in health facilities type II and checked in order to find inconsistencies with the data provided by the health information system.

The results showed that the data from the health information system provided values with a high degree of validity (98,94 % of confidence). These results are consistent with the results from the national report of HIS verification elaborated by the Ministry of Health and cooperation partners in 2010 (MISAU, 2010).

Therefore, the extremely high or low institutional deliveries coverage, particularly the cases of Machoca (227,79 %), Papai (288 %) or Namueto (8,12%) could be just justified by errors in the population under influence of each health facility. Two important considerations should be highlighted in this context:

(1) Papai and Machoca are health facilities located on the border with districts of Nampula Province. The areas of influence of these health facilities include population of the districts of Nampula. However, unfortunately, no geo-referenced data for these communities is available. Under-estimation of the frontier population does not allow us to determine coverage of institutional deliveries with precision.

(2) The case of Namueto is completely opposite. Namueto is located just a few kilometres from the Rural Hospital of Montepuez in a rural area. For this reason, under the area of influence of the health facilities lies a considerable population. However, the population of this area uses the Rural Hospital of Montepuez to deliver, because of the wide range of services that this health facility offers, significantly higher than the capacity of Namueto. For this reason in Namueto, although it has delivery services, coverage is very low.

4.3.2 Definitive institutional deliveries coverage results by health facilities.

The analysis of the institutional deliveries coverage by health facilities was an accurate method to exclude some elements of the sample because of the peculiarities of the population under influence. For these reasons, these three health facilities were excluded from the analysis. Final results of institutional deliveries coverage, considering a sample of 25 elements, by health facility are show in the following table:

	% INSTITUTIONAL COVERAGE				
HEALTH FACILITY	8 KM	10 KM	12 KM	14 KM	MWH
CHAI	63,8	63,8	50,1	50,1	NO
IMBADA	49,4	30,0	26,8	18,5	NO
IMPIRI	60,8	53,3	53,3	26,5	YES
KUEKUE	41,0	30,1	24,3	21,4	NO
MAPUPULO	157,1	67,5	51,9	44,6	YES
MARIRI	61,5	44,2	29,4	27,5	NO
MAVALA	78,9	78,9	66,9	32,8	NO
MELOCO	75,0	71,1	62,6	53,4	NO
MEZA	56,0	48,4	35,5	32,4	NO
MINHANHA	96,3	96,3	96,3	96,3	NO
MINHEWENE	130,3	34,3	25,2	20,1	NO
MIRATE	46,0	31,2	30,7	26,4	YES
MUAGUIDE	49,7	49,7	34,1	28,8	YES
MUCOJO	99,0	73,5	64,2	59,5	YES
MURRIPA	68,0	60,4	25,4	19,4	YES
NAIROTO	55,6	36,1	14,0	10,3	NO
NAMANHUMBIRE	57,1	41,0	36,6	32,8	NO
NAMRAPA	63,2	36,0	32,3	24,3	NO
NAUNDE	85,9	58,6	44,1	31,9	NO
NCUMPE	156,5	139,1	66,6	50,2	NO
NGEWE	148,4	73,6	73,6	64,1	NO
NGUIDA	67,5	67,5	53,2	53,2	YES
N'ROPA	87,5	47,7	47,7	38,1	NO
NTETE	44,8	35,4	21,2	19,9	NO
QUITERAJO	91,7	91,7	77,3	67,3	NO

Table 4.8. Definitive Institutional deliveries coverage by health facilities under study by different areas of influence (8,10,12 and 14 km).

GIS technology allowed us to collect, store and transform data to determine the population of influence of the health facilities under study considering four buffers (8, 10, 12 and 14 km). However, the importance of GIS goes beyond these functions, because of the particular capacity of this technology of visually representing the institutional deliveries coverage of each health facility. Analysis of institutional deliveries coverage was made easier through the interpretation of visual mapping of the results shows in the table 4.8.

In this function resides one of the relevant advantages of GIS technology over the traditional tables and charts. This capacity appears as a powerful element to facilitate the analysis done by the Health District Board of the health information. In areas, such as the districts under study, where human resources have weak training in epidemiology and health information analysis, GIS technology could be very useful to facilitate the planning process, and the correct monitoring and evaluation of the health strategies implemented.

In order to demonstrate this feature, figures 4.12 and 4.13 show the institutional deliveries coverage of the two extreme buffers, 8 and 14 km. Similar maps can be elaborated in order to show institutional deliveries coverage of areas of influence of 10 and 12 km. However, in order to illustrate the idea and main findings, only the extreme buffers have been represented here. The capacity to reach a conclusion based on these charts is considerable more than the findings that can be obtained from a standard Excel table. It is relatively simple to identify which health facilities have significant coverage, and which health facilities still have difficulties increasing their institutional deliveries. As can be seen, if the area of influence of the health facilities increases, the coverage of the great part of the health centres decreases. In the health facilities with a population concentrated near the health centre, the coverage does not fluctuate. In addition, it can be seen that there is no association between the geographic location of the health facility (by district) and the institutional deliveries coverage. However, the conclusions that can be derived from the maps go beyond coverage. This representation also allows us to study if the location of the health facilities has been carried out according to population criteria. In addition, if roads and forms of communication are also represented, analysis of accessibility can also be carried out considering other barriers. Those analyses are not part of this dissertation, however they reflect the multiple applications of GIS technology in the public health sector.

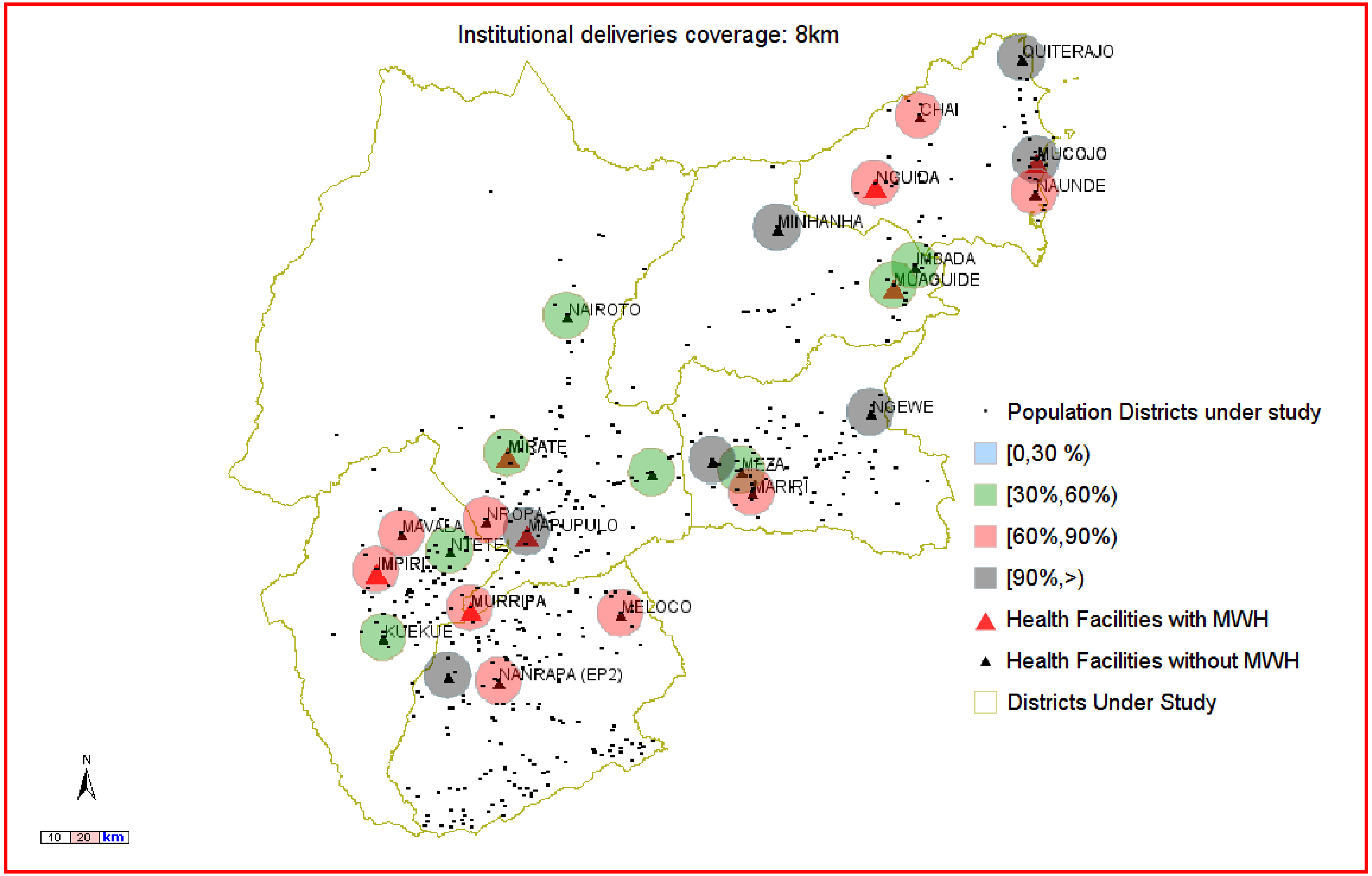


Figure 4.12. Map representing institutional deliveries coverage using an area of influence of 8 km.

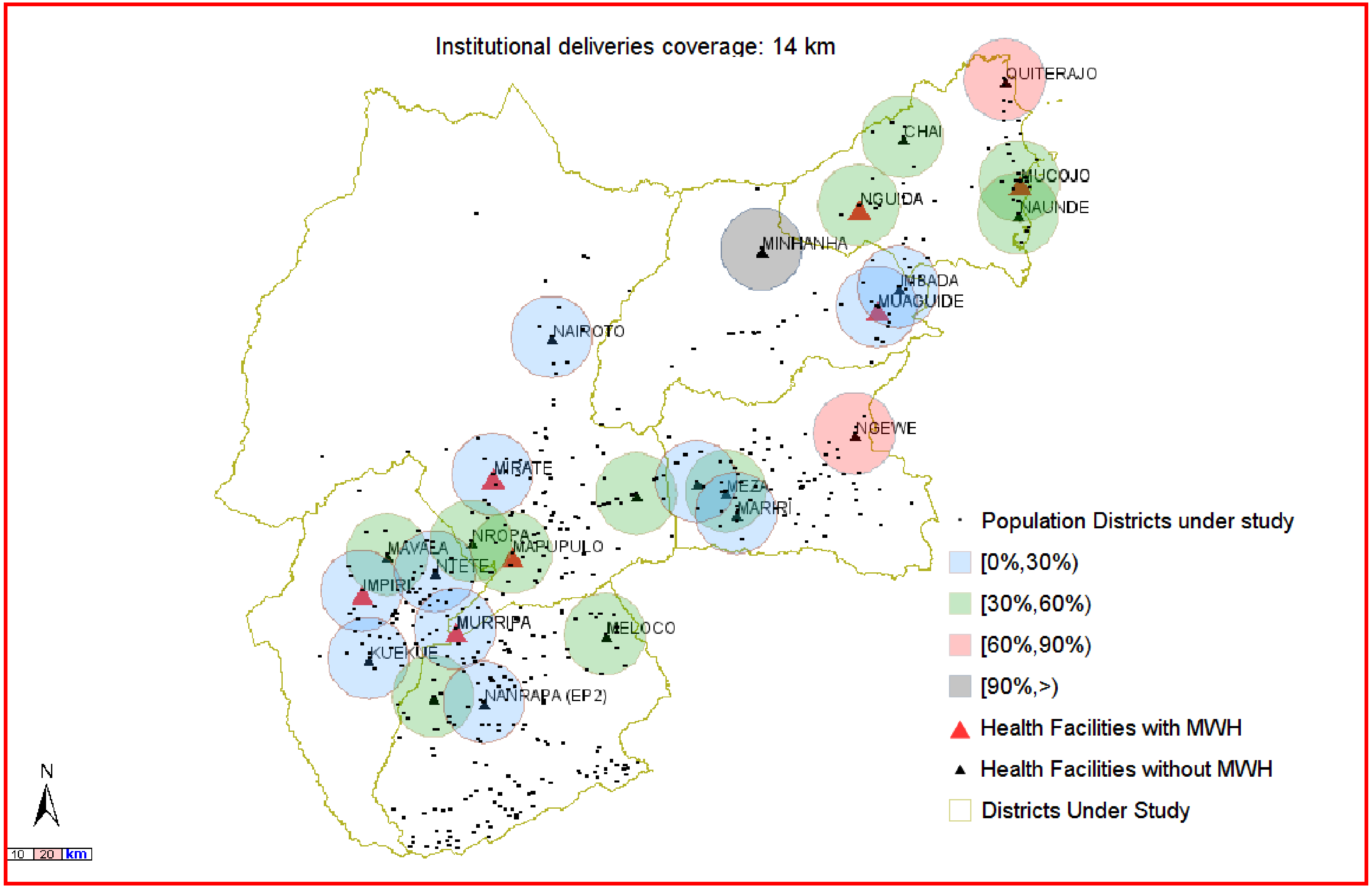


Figure 4.13. Map representing institutional deliveries coverage using an area of influence of 14 km.

Although the relevant importance of the coverage was evident, the analysis of the institutional deliveries coverage does not allow us to determine if health facilities with MWHs increase institutional deliveries compared with health facilities without this service. The findings at this point only enable us to study the institutional deliveries coverage by health facility. In continuing the analysis, comparison of the institutional deliveries coverage using the raw data from expected deliveries and registered deliveries of the health facilities with MWHs, without MWHs and the whole sample is presented.

4.3.3 Comparing institutional deliveries coverage of health facilities with and without MWH.

Results are shown in table 4.9 (Exp. Del. = Expected Deliveries; Reg. Del. = Registered Deliveries; Ins.del.Cov. = Institutional Deliveries Coverage).

	8 KM			10 KM			12 KM			14 KM		
	Exp. Del.	Reg. Del.	Ins.Del. Cov.	Exp. Del.	Reg. Del.	Ins.Del. Cov.	Exp. Del.	Reg. Del.	Ins.Del. Cov.	Exp. Del.	Reg. Del.	Ins.Del. Cov.
ALL SAMPLE	10269	7536	**73**	14217	7536	**53**	18614	7536	**40**	22872	7536	**33**
HEALTH FACILITIES WITHOUT MWH	7264	5232	**73**	10136	5232	**52**	13217	5232	**40**	16124	5232	**32**
HEALTH FACILITIES WITH MWH	3005	2304	**77**	4081	2304	**56**	5397	2304	**43**	6748	2304	**34**

Table 4.9. Institutional deliveries coverage of health facilities with and without MWHs and area of influence

Figure 4.14 shows the institutional deliveries coverage by area of influence of all the health facilities, and the two groups of health facilities under study.

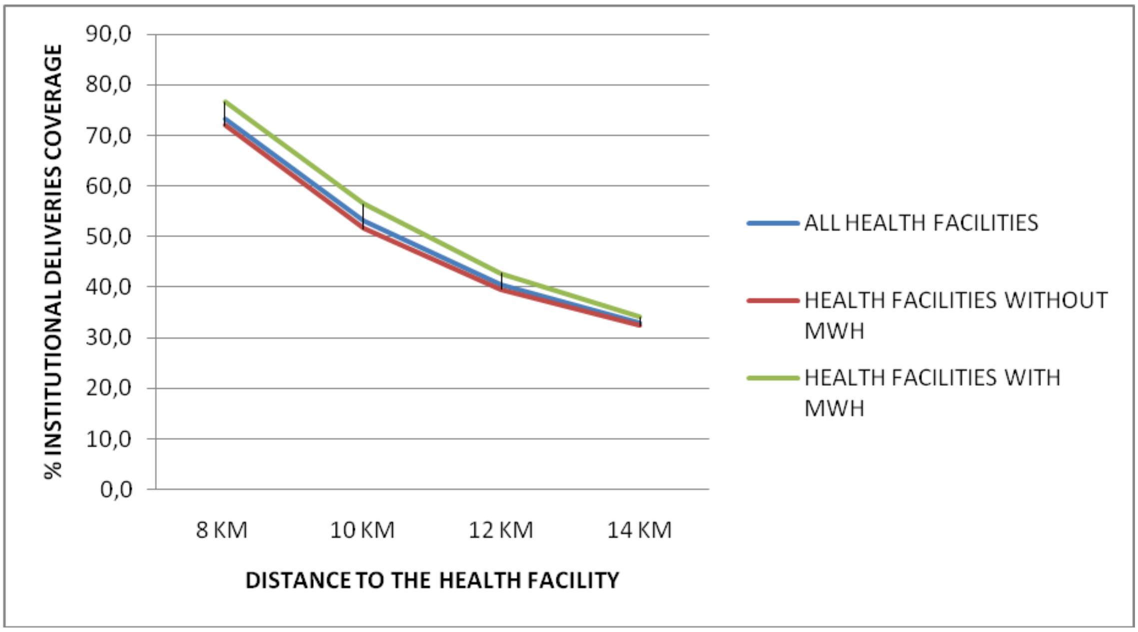


Figure 4.14. Institutional deliveries coverage of health facilities with and without MWHs and area of influence

The main conclusions that can be obtained from the analysis of the values showed above are:

(1) Institutional deliveries coverage decreases as distance to the health facilities increases. Figure 4.14 shows a negative relationship or inverse linear relationship between distance and coverage. The analysis of the coverage of all health facilities shows a decrease from 73 % for areas of influence of 8 km, to 33 % when this area of influence increases to 14 km. The same trend could be detected in health facilities without MWHs (73 % in 8km to 32 % in 14 km) and health facilities with MWHs (77 % in 8 km to 34 % in 14 km). These results are consistent with the literature review that indicates that distance is one of the main barriers to increasing access and usage of health services, noting that utilization decreases as distance increases (Cromley and McLafferty 2003:234-25).

(2) The chart indicates that institutional deliveries coverage of health facilities with MWHs is greater than the health facilities without this service, especially when areas of influence of 8, 10 and 12 km are

compared. The results show that, for a radius of 8 km, health facilities with MWH have coverage of 77 % whereas health facilities without MWH have coverage of 73 %. For 10 km area of influence, health facilities with MWH have coverage of 56 % while health facilities without MWH have coverage of 52 %. Considering an area of influence of 12 km, health facilities with MWH have coverage of 43 % whereas health facilities without MWH have coverage of 40 %. Finally, when considering the greatest area of influence, 14 km, health facilities with MWH have coverage of 34 % whereas health facilities without MWH have coverage of 32 %.

4.3.3.1 Testing null hypothesis: Chi-Squared test with the continuity correction

The research aim of this study focuses on evaluating the effectiveness of MHW in increasing coverage of institutional deliveries using Geographical Information Systems (GIS) in six districts of Cabo Delgado Province (Mozambique).

The research stated a main hypothesis that claims that health facilities type II with MWH have an increased coverage of institutional deliveries compared with those without MWH. We chose a *Chi-Squared test with continuity correction* to compare the two institutional deliveries coverage by area of influence (8, 10, 12 and 14 km).

The first step in testing this hypothesis was to formulate a null hypothesis that indicates that there is no significant difference between the coverage of institutional deliveries in Health Facilities type II with and without MWH.

The *p-value* is the significance test that establishes the probability of recording a difference between the two groups at least as large as that in the sample, if there was no effect of the exposure in the population. A significance level, or critical *P*-value, of 1 % (0.01) was established. Selection of the critical *P*-value is arbitrary; however the small *p-values* suggest that the null hypothesis is unlikely to be true. For this reason it was decided to establish the critical *p-value* at 0.01 rather than 0.05 (the conventional p-value used in medical and epidemiological studies). A test statistic *z* value of 3 corresponds to a *P*-value of 0.01, this means that if *P*<0.01 then the 99 % confidence interval will not contain the null value (Kirkwood and Sterne, 2006:74). The idea is that the smaller the *P*-value, the stronger is the evidence against the null hypothesis.

Contingency tables were elaborated and *Chi squared tests* were determined for each area of influence:

- 8 km area of influence

	POPULATION WHO HAD INSTITUTIONAL DELIVERIES		
MWH Service	**YES**	**NO**	**TOTAL POPULATION**
A (HEALTH FACILITIES WITH MWH)	2304	701	3005
B (HEALTH FACILITIES WITHOUT MWH)	5232	2032	7264
TOTAL POPUALTION	7536	2733	10269

Table 4.10. 2x2 table for a 8 km buffer

Chi-squared value = 23.253. The *two-tailed P-value* is less than *0.0001.* There is strong evidence against the null hypothesis.

- 10 km area of influence

	POPULATION WHO HAD INSTITUTIONAL DELIVERIES		
MWH Service	**YES**	**NO**	**TOTAL POPULATION**
A (HEALTH FACILITIES WITH MWH)	2304	1777	4081
B (HEALTH FACILITIES WITHOUT MWH)	5232	4904	10136
TOTAL POPUALTION	7536	6681	14217

Table 4.11. 2x2 table for a 10 km buffer

Chi-squared value= 27.154 The *two-tailed P-value* is less than *0.0001.* There is strong evidence against the null hypothesis.

- 12 km area of influence

	POPULATION WHO HAD INSTITUTIONAL DELIVERIES		
MWH Service	**YES**	**NO**	**TOTAL POPULATION**
A (HEALTH FACILITIES WITH MWH)	2304	3093	5397
B (HEALTH FACILITIES WITHOUT MWH)	5232	7985	13217
TOTAL POPUALTION	7536	11078	18614

Table 4.12. 2x2 table for a 12 km buffer

Chi-squared value= 15.205. The *two-tailed P-value* is less than *0.0001.* There is strong evidence against the null hypothesis.

- 14 km area of influence

	POPULATION WHO HAD INSTITUTIONAL DELIVERIES		
MWH Service	**YES**	**NO**	**TOTAL POPULATION**
A (HEALTH FACILITIES WITH MWH)	2304	4444	6748
B (HEALTH FACILITIES WITHOUT MWH)	5232	10892	16124
TOTAL POPUALTION	7536	11078	22872

Table 4.13. 2x2 table for a 14 km buffer

Chi-squared value= 6.109. The *two-tailed P-value* is less than *0.0134.* There is weak evidence against the null hypothesis.

The results obtained by the above analysis suggest that there is strong evidence against the null hypothesis in the area of influence of 8, 10 and 12 km and weak evidence against the null hypothesis at 14 km. These results indicate that high coverage is associated with the presence of MWHs, suggesting that MWHs could contribute to increasing the coverage of institutional deliveries. However it is important also to analyse potential confounders. This aspect is analyzed in chapter 5 (limitations of the study).

The results of inferential statistics for an area of influence of 14 km suggest that there is weak evidence against the null hypothesis, which means that there are no significant differences of institutional deliveries coverage between health facilities with and without MWH. These results indicate that at greater distance, there is relatively no association between the presence of MWHs and increased coverage, suggesting that the effect of the MWH has a limited impact if distance of population to health facilities increase. 14 km of distance (28 km if it we consider both a forward and return journey) is a considerable distance to travel in order to have access to maternal health care. Initially, it seems reasonable that the improvement of the services, or the set up of MWHs, would have little influence on a population that would need to walk 28 km, there and back, to obtain care. However, on the other hand, MWHs are intended to exactly respond to this population: pregnant women that live in remote areas. Initially, it should be expected that the real difference between coverage appears as the area of influence increases, suggesting that MWHs are contributing to improving coverage of women living in more distant regions.

4.3.4 Results of across-time analysis of institutional deliveries.

Across-time analysis was based on an analysis of institutional deliveries considering three main units under examination: (1) the whole sample; (2) the health facilities with MWH and (3) the analysis of each health facility with MWH.

Figure 4.15 shows across-time analysis, from 1994 to 2009, of the institutional deliveries in the health facilities under study. The main idea that can be extracted from this chart is that there is generally a steady increase of institutional deliveries from 1994 to 2009. However, some health facilities show considerable fluctuations of institutional deliveries, even in successive years.

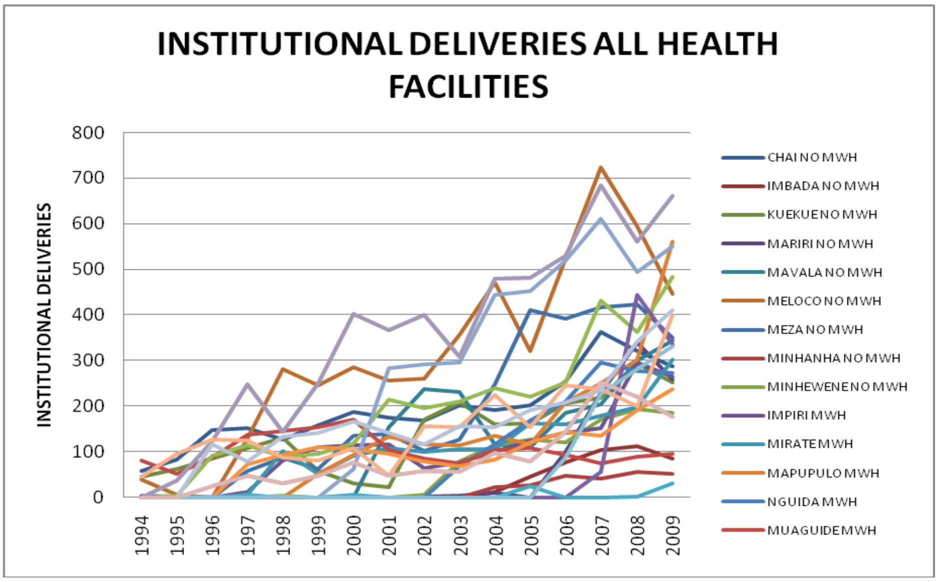


Figure 4.15. Across time analysis of institutional deliveries of the sample.

In order to clarify just the effect of the MWH services, figure 4.16 focuses only on an analysis of the institutional deliveries in health facilities with this service. Again, the chart shows erratic movements of the institutional deliveries, though there is a gradual increase over the time.

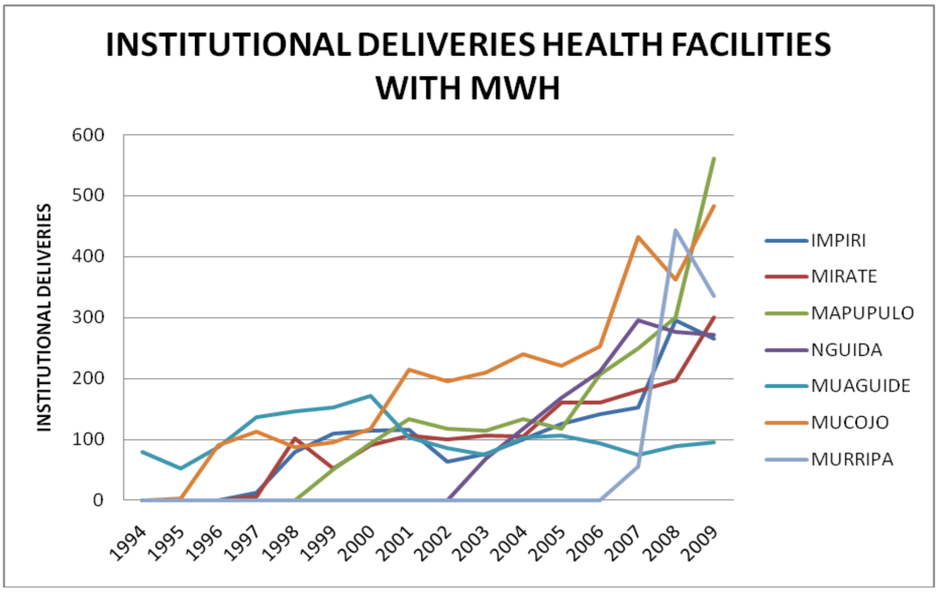


Figure 4.16. Across time analysis of institutional deliveries of health facilities with MWH.

With the aim of detecting with more detail if the set up of the MWHs has had some influence in the institutional deliveries, figures 4.17 to 4.23 show the trend of institutional deliveries from 1994 to 2009 by each facility and also indicate (where available) the year of set up and termination of the MWH service.

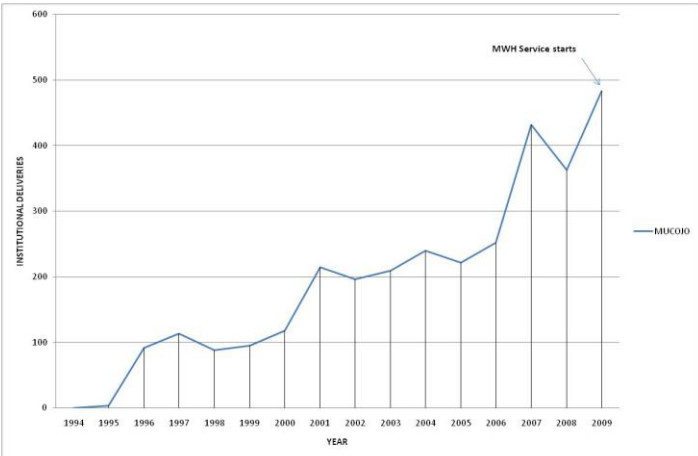


Figure 4.17. Institutional deliveries in Mucojo

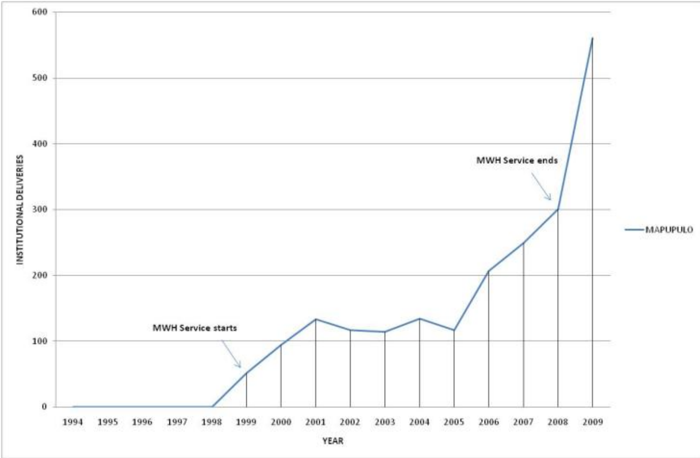


Figure 4.18. Institutional deliveries in Mapupulo.

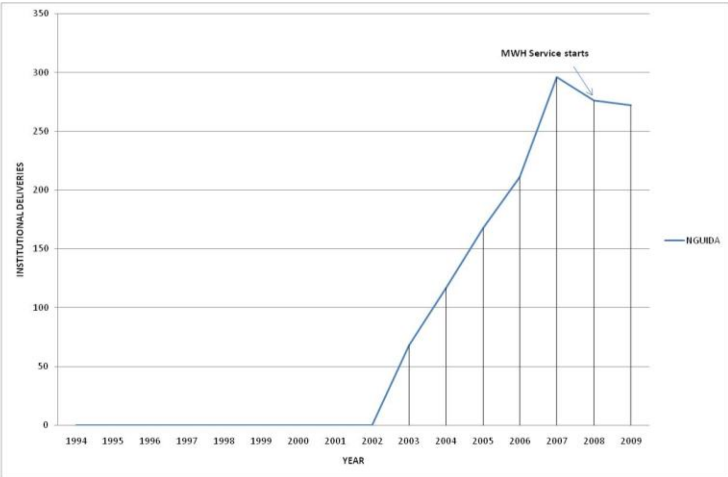


Figure 4.19. Institutional deliveries in Nguida

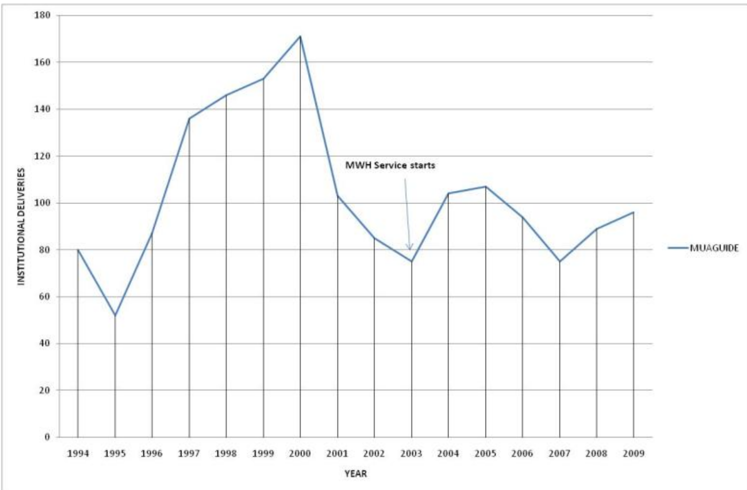


Figure 4.20. Institutional deliveries in Muaguide

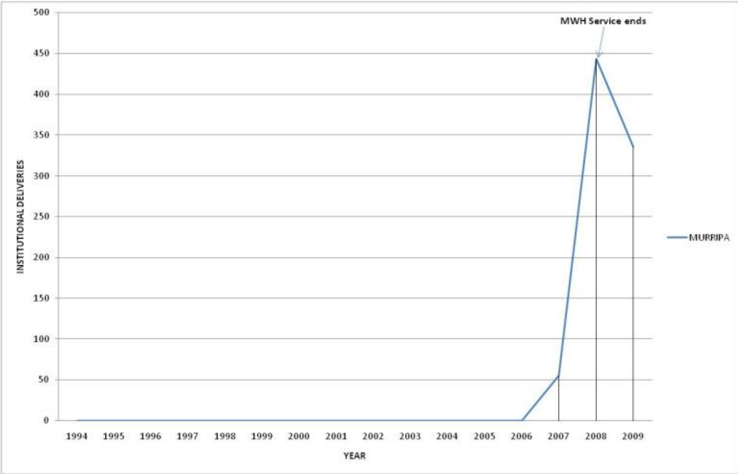


Figure 4.21. Institutional deliveries in Murripa

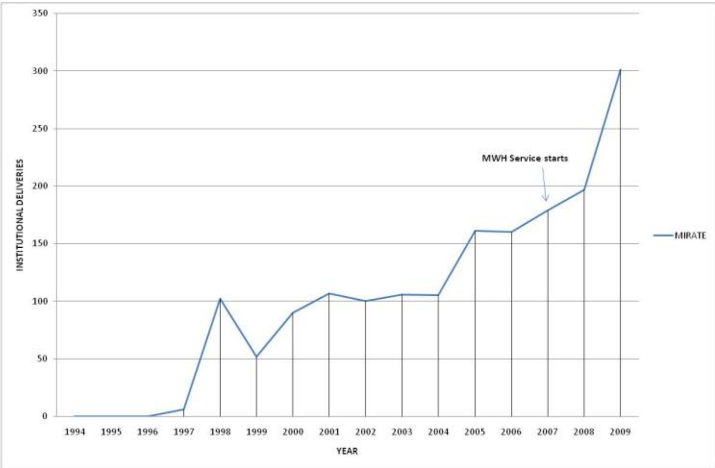


Figure 4.22. Institutional deliveries in Mirate

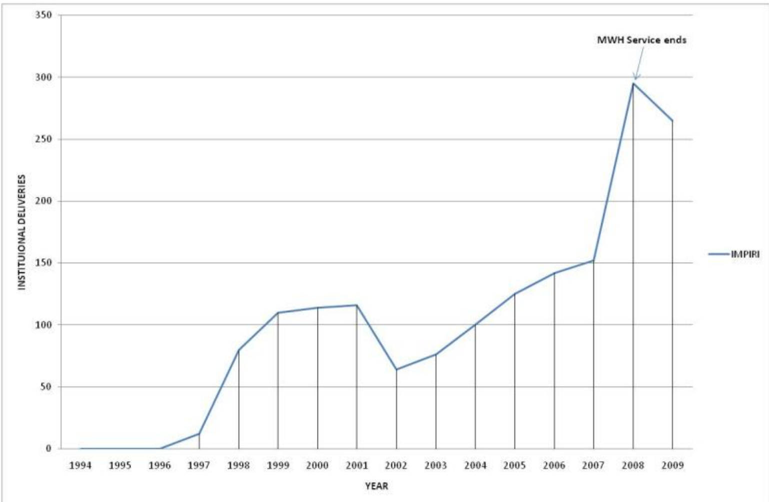


Figure 4.23. Institutional deliveries in Impiri

Of the seven health facilities with MWHs under study, the results show:

(1) In Impiri the MWH started in 2008. In 2008 registered institutional deliveries were 295. In 2009, institutional deliveries registered were 265.
(2) In Mirate the MWH started in 2008. Registered institutional deliveries in this year were 197. In 2009, registered institutional deliveries were 301.
(3) In Murripa the MWH started in 2008 when registered institutional deliveries were 443. In 2009, registered institutional deliveries were 336.
(4) In Muagide the MWH started in 2003 when health facility registered 75 deliveries. During the next six years institutional deliveries fluctuated, however there is a positive trend. In 2009 the institutional deliveries registered were 96.
(5) In Nguida the MWH started in 2008, that year registered 276 institutional deliveries. In 2007 the institutional deliveries were 296 and in 2009 the institutional deliveries were 272.
(6) In Mapupulo the MWH stated in 1999 and ended in 2008. During these years institutional deliveries showed a gradual rise from 51 to 301 deliveries.
(7) Finally, in Mucojo MWH started in 2009, therefore it is not possible to analyse the trends across time.

Considering the six health facilities that provide data from at least two consecutive years, across time analysis indicates that:

(1) Four of the health facilities show an increase of the institutional deliveries after the set up of the MWH.
(2) Two of the health facilities show a decrease in the institutional deliveries after the set up of the MWH. However, in both cases, the set up of the MWH was recent, in 2008, allowing us to compare only the change with respect to 2009 data.

As the setting up of MWHs was in different years, it was not possible to compare the variations in institutional deliveries between the two groups under study due to the impossibility to establish a common snapshot of reference. Also, because of the different periods of time of MWHs functioning, it was not possible to compare trends in institutional deliveries. In this context, the findings should be analysed with caution. However, the analysis has been useful to complement the information provided by testing the main hypothesis.

4.4 OVERWIEW OF RESEARCH FINDINGS

Analysis of the internal and external validity revealed that the population and institutional deliveries data, provided by the National Statistics Institute and the Health information System respectively, are consistent data with a high degree of reliability. In addition, during analysis of the results, data checking procedures were implemented in order to detect values that could negatively affect the quality of the findings. On the other hand, it was highlighted that the internal validity of the data used to examine across-time trends showed a lower reliability because of the non-existence of trustworthy records indicating the set up of the MWHs. For these reasons, the overview of the findings is focused on the results obtained from the testing of the main hypothesis of the research.

Within this context the findings show that health facilities with MWH have higher institutional deliveries coverage than health facilities without this service, suggesting that MWHs could contribute to improve deliveries at health facilities. However, the analysis of this impact by area of influence indicates that the hypothetic impact of the MWH decreases as distance to the health facility increases. The difference coverage between the health facilities with and without MWH is particularly relevant in areas of influence of 8 and 10 km (4 %), and decrease slightly (3 %) with an area of influence of 12 km. Inferential statistics have shown that these differences are significant. On the other hand, with a maximum distance of 14 km, difference between coverage of the two groups of health facilities is 2 %. In this case, inferential statistics have shown that this difference is not statistically significant.

Therefore, one of the main aims of the MWH service seems not to have been accomplished. The literature review (Lonkhuijzen *et al*, 2009; Talmanca, 1996), and the Mozambican national MWHs strategy (MISAU, 2009) indicate that one of the main targets of MWHs are pregnant women that live in remote areas. The results obtained suggest that the impact of MWHs at distance greater than 14 km is not evident. These results could indicate that at long distances the improvement of the primary health care services has no impact on the demand of the population. Barriers to access and long distance could be insurmountable for populations living in isolated areas. Summarising, the results suggest that MWHs could contribute to an increase of 4-3 % of institutional deliveries coverage for short and medium distance. On the other hand the expansion of the health network seems to be a better solution to provide maternal health care services for longer distances.

The Provincial Health Board of Cabo Delgado claims to increase institutional deliveries coverage at 2 % each year from 2008 to 2011 (DPS, 2008: 15). This projection provides an idea of the difficulties that faces the National Health System to increase institutional deliveries in rural settings. Results obtained suggest that MWHs could contribute to this increase in a range between 3 and 4 %. However, it is important to note again, that confounders should be carefully analysed (see chapter 5). Nevertheless, reference to the provincial annual targets illustrates the importance of a 3 to 4 % degree difference found between the two groups under study.

Across time analysis has shown that in four of the six health facilities with MWH, institutional deliveries have increased after the set up of the service. These results are consistent with the results obtained from the comparison between health facilities with and without the service. However, the limitations as a result of the reduced sample and the viability of the data, restrict the generalizability of the findings (for more information about the limitations of the study see chapter 5).

4.5 CONCLUSION

Chapter 4 has detailed the methodology and data management implemented in this research in order to obtain the institutional deliveries coverage of the sample under study, and specifically of the two groups of health facilities compared (those with MWH and those without these services). GIS technology has been applied with the aim of obtaining populations under influence for each health facility. With the information provided by the health information, institutional deliveries coverage of the two groups of health facilities have been determined in order to test the main hypothesis of the research that states that health facilities with MWH have increased institutional deliveries coverage when compared with those without this service.

The results obtained indicate that health facilities with MWH have increased institutional deliveries coverage compared with those health facilities without this service. This difference is especially relevant in areas of influence of 8, 10 and 12 km (from 4% to 3 %). For an area of influence of 14 km the difference between the two groups of health facilities is 2 %. Inferential statistic (*Chi-Squared with continuity correction*) has been used in order to determine if differences are significant. The results show that differences are significant for areas of influence of 8, 10 and 12 km whereas they are not significant for areas at a greater distance. Finally, an across time analysis has been executed in order to test the second hypothesis of the research. Across time analysis has indicated that 4 of the 6 health facilities with MWH have increased their institutional deliveries after the setting up of the service.

CHAPTER 5 – CONCLUSIONS AND RECOMMENDATIONS

5.1 INTRODUCTION

This research report has been written following a logical sequence with the aim of answering the research purpose that seeks to evaluate the effectiveness of the MWHs in increasing coverage of institutional deliveries using GIS in six districts of Cabo Delgado Province (North of Mozambique). Within this context four chapters have been presented:

Chapter 1 has given an overview of the research, providing information of the source and background of the research problem. In addition, Chapter 1 has presented the main background to the study, serving as an introduction to the whole research. In this sense, in Chapter 1 has launched the research problem, aim, foundations, scope and significance of the study and the definitions of the key terms that have been used in the course of the report. Also, in Chapter 1 has been introduced the main aspects of the research design and method. However, Chapter 3 has dealt with more detail of these aspects.

In Chapter 2 the literature review has been presented. The literature review has been structured in three large sections. The first section, focuses on the problem of maternal mortality in Africa, with special focus on Mozambique and Cabo Delgado Province. The main causes that contribute to the high maternal mortality rates that still occur in the country have been highlighted. To continue, the three delays model has been detailed as a foundation model to explain the main causes of maternal mortality. Within this context, it has been highlighted how the lack of access to a health facility, the second delay, is identified as one of the main causes contributing to the high rates of maternal mortality.

Following this, the second part of Chapter 2 has introduced the safe motherhood interventions that have been promoted in Mozambique, with special attention to Maternity Waiting Homes. This approach appears to be a valuable strategy in developing countries, such as Mozambique, to reduce the gap between communities and the National Health System service (second delay). One of the key assumptions of MWHs is that this service will contribute significantly to an increase in institutional deliveries. All countries in the world that have reduced their rates of maternal mortality have increased considerably the institutional deliveries coverage. In this context, this second section of the literature review has focused extensively on the description and purpose of the MWHs, and particularly on the description of MWHs experiences in different countries of the world. Practical experiences and limited theoretical systematizations has allowed us to describe the key elements of MWHs management and functioning. After that has been described the MWHs strategy in Mozambique, presenting a general assessment performed by the Ministry of Health of Mozambique. Thereafter, in order to complete the MWHs literature review, Chapter 2 has summarized the key findings about the MWHs effectiveness that appears in the published literature. Few studies have attempted to assess the impact of MWHs, and the few that have already been published focus on evaluating the impact of this strategy in reducing maternal mortality rates. Practically no studies have been found that refer to the impact of the MWHs in increasing institutional deliveries (except for one in Eritrea). No evidence of this type of research has been found in Mozambique.

Finally, the literature review has presented the Geographic Information Systems technology and its application in Public Health, with particular focus on its capacity to study access, usage and health care coverage.

Chapter 3 and 4 have presented the research design and method, and the analysis, presentation and description of the research findings respectively. These two chapters, as key elements of the conclusions and recommendations are briefly summarized in the present chapter, analysing the most important elements that have allowed us to conduct the research, as well the key findings obtained.

Besides the analyses of the key elements of chapter 3 and 4, in chapter 5 are presented the conclusions, recommendations, contributions and limitations of the research.

5.2 RESEARCH DESIGN AND METHOD

In Chapter 3 the research design and method of the study have been presented and widely detailed.

An ecological or correlational study has been considered as the most suitable research design, as the units of analysis were groups of people rather than individuals. The main aim of the research was to study if there is an association between the presence of MWHs and better institutional deliveries coverage. In order to study this, a main hypothesis and null hypothesis were formulated, stating that:

- ✓ $Hypothesis_1$: health facilities type II with MHWs have a major coverage of institutional deliveries than those without MHWs.
- ✓ Null $Hypothesis_1$: there is no significant difference between the coverage of institutional deliveries in Health Facilities type II with MHWs and without.

In order to test these hypotheses, two groups of health facilities were compared, namely those with MWHs and those without this service. As the literature research about designs indicates, ecological studies are often difficult to interpret since it is seldom possible to examine directly the various potential explanations of the findings. Sometimes, the association observed between variables at the group level does not necessarily represent the association that exists at the individual level. In order to exclude potential confounders, in Chapter 3 a secondary hypothesis to be tested has been described:

- ✓ $Hypothesis_2$: Across time analyses shows that MHWs services increase institutional deliveries in health facilities.

In Chapter 3, we have also detailed the procedures to determine the sample under study. Inclusion and exclusion criteria have been identified, allowing us to define that the best sample of health facilities to answer the research purpose are health facilities type II. This was one of the key aspects of the research method, as an appropriate selection of the health facilities under study has allowed us to reduce potential confounders, by selecting a homogeneous group of health facilities. The sample under study has been selected from a group of 28 health facilities. Finally, a description of the health facilities type II has been presented.

Thereafter, in Chapter 3, the data collection approach, method and characteristics have been presented. A blend of secondary and primary data has been used in order to implement the research. Primary data used were the MWHs locations and the year of set up. Secondary data (most predominant) included geo-referenced population and location and health facilities locations. Institutional deliveries from health information system by health facility from 1994 to 2009 have been collected. Finally, the 1997 and 2007 censuses were obtained from the National Institute of Statistics of Mozambique.

Thereafter, data analysis has been introduced presenting the descriptive and inferential statistics that have been used. Descriptive statistics are based on the analysis of institutional deliveries coverage by health facility and also, the analysis of institutional deliveries coverage of the two groups of health facilities under study (those with and without MWH). Inferential statistics are based on the application of a *Chi-square test for a 2x2 by using a continuity correction*.

Finally, Chapter 3 was concluded with a description of the internal and external validity of the study. In this context, internal validity of both, primary and secondary data has been analysed, highlighting the high reliability of the data, with the exception of the data for setting up of the MWHs because of the lack of official records.

Summarizing, we consider that the research method and design has allowed us to achieve our research purpose. It is important to note that in Chapter 3, we have detailed the huge limitations of data related to the MWH services. No records about the activities of MWHs have been registered in Mozambique at the time of analysis, considerably reducing the possibilities of implementing other types of research design (cross-sectional, cohort, others). In this context, an ecological study based on secondary sources (mainly) appears to be the best option to study the impact of MWHs in increasing institutional deliveries.

5.3 SUMMARY AND INTERPRETATION OF THE RESEARCH FINDINGS

In Chapter 4, we have presented the analysis, presentation and description of the research findings.

Section 4.2 has focused on the presentation of the data management strategy and analysis. Within this context, we have detailed several procedures, as the projections of census that have been used in order to work with 2009 population, and on the other hand, it has been detailed how GIS technology (using KOSMO software) has been used to analyse the institutional deliveries coverage of the health facilities under study.

Thereafter, in section 4.3, we have presented the research results. A summary and interpretation of those findings is currently presented.

5.3.1 Coverage of the health facilities with MWH versus health facilities without MWH.

Institutional deliveries coverage by area of influence has been determined in three groups of health facilities: (1) the entire sample, (2) the health facilities without MWH and (3) the health facilities with MWH.

The analysis of coverage indicates that:

(1) Institutional deliveries coverage decreases as distance to the health facilities increases. There is a negative relationship between coverage and distance. These results are consistent with the literature review that indicate that distance is one of the main barriers to increased access and usage of health services, noting that utilization decreases as distance increases (Cromley and McLafferty 2003:234-25).

(2) Institutional deliveries coverage of health facilities with MWH is higher than coverage of the health facilities without this service. The difference varies from 4 % in areas of influence of 8 and 10 km, to 3 % in areas of influence of 12 km and 2 % in areas of influence of 14 km.

(3) Inferential statistics (*Chi-squared test with the continuity correction*) indicates that the difference of coverage registered in areas of influence of 8, 10 and 12 km is statistically significant whereas the difference registered in a distance of 14 km is not statistically significant.

These results suggest an association between the presence of MWH and major coverage of institutional deliveries, confirming the main hypothesis of the research. However this association exists only in areas of influence up to 12 km. For areas of influence greater than 12 km it seems that there is no difference between the coverage of institutional deliveries between health facilities with and without MWH service.
These findings suggest that the improvement of maternal health care service in health facilities by the setting up of MWHs does not impact on populations living in remote areas (> 12 km). These populations could be exposed to many access barriers that prevent them from accessing maternal health care services. These findings contradict one of the main aims of the MWHs that seeks to increase the access of pregnant women that live in remote areas.

On the other hand, it seems that the MWH strategy could improve the coverage of institutional deliveries in more restricted areas. However, the fact that difference of coverage between the two groups of study decreases as distance increase indicates that further research should be done in order to confirm if the differences detected are due to health facilities factors or the presence of MWHs.

5.3.2 Across-time analysis.

In attempting to exclude confounders, the research carried out an across-time analysis in those health facilities with MWH services, with the aim of studying the variations in institutional deliveries after the setting up of the service.

Section 4.3.4, in chapter 4, provides the details of this analysis. The main conclusions indicate that 4 of the 6 health facilities with MWH under study have shown an increase in institutional deliveries after setting up the service. In addition, the two health facilities with negative results have only recently established the MWHs.

These results suggest that setting up the MWH service can contribute to an increase in institutional deliveries. In addition, the results suggest that the impact of the MWHs can not be measured immediately after setting up the service.

5.3.3 Linking research findings with the literature review.

The literature review presented in chapter 2 reveals four main assumptions of the Maternity Waiting Homes:

(1) Initially, MWHs mainly targeted women with high-risk pregnancies (major obstetric abnormalities) living in remote and sometimes inaccessible areas.

(2) Progressively, in developing countries like Mozambique the admission criteria have been expanded to include all women in order to increase institutional deliveries coverage and therefore reduce maternal mortality.

(3) Interpretation of the results of the studies implemented in order to assess the impact of MWHs in reducing maternal mortality should be analysed with caution as potential confounders have been identified in all the studies reported.

(4) There is only evidence in one study (Andemichael *et al*. 2009: 18-21), implemented in Eritrea, that assessed the impact of MWHs in increasing institutional deliveries coverage. The study concludes that institutional deliveries increased 48,5 % since the introduction of the strategy compared to data from previous years.

The results obtained in the research presented here suggest that, in the districts under study, the strategy of MWHs is not meeting the expectations of increasing the coverage of institutional deliveries in populations living in remote areas. The results show that there are no significant differences between health facilities with and without MWH in areas of influence at distances greater than 12 km.

The present research design and purpose is not intended to analysis the impact of MWHs in reducing maternal mortality. The research purpose attempts to determine if MWH are contributing to one of their main assumptions: MWHs increase institutional deliveries and, as a result of this increase, maternal mortality decreases.

Finally, the findings are consistent with the results presented by Andemichael *et al* (2009). However the increase of the institutional deliveries coverage in the six districts of Mozambique is considerably limited. It is important to note that the methodology used in the two studies is very different: Andemichael performed a rapid assessment of the MWHs strategy just comparing institutional deliveries data from two years, not determining coverage. Also it is important to note that in the case of Eritrean MWHs strategy, incentives were given to mothers that used MWH services.

5.4 CONCLUSIONS

The present research has contributed to increasing the existing knowledge about the impact of MWHs in Mozambique, specifically in Cabo Delgado province, considering one of the main assumptions of this service: its capacity to increase the number of institutional deliveries.

The research has been conducted in a limited area (six districts) and considered only one type of health facility (type II) in order to improve the potential to analyse the findings. Within this context, the research findings suggest that MWHs could contribute to increasing the institutional deliveries coverage (increases from 4% to 3 %) when areas of influence lower than 12 km are considered. For areas of influence superior to 12 km, the findings show no difference in the level of coverage of health facilities with and without this service. These results contradict one of the main objectives of MWHs: to increase the access of women living in remote areas. This suggests that extreme access limitations, in the case of remote populations, are a significant barrier and the presence of a MWH for these pregnant women makes no real difference.

The research has detected several potential limitations and confounders that should be analysed carefully (section 5.9). In addition, the fact that differences of coverage between the two groups of study decreases as distance increase, contradicts one of the main assumptions of the MWHs strategy, and indicates that further research should be promoted in order to provide more information about the real impact of MWHs in increasing institutional deliveries coverage.

Another relevant conclusion that should be highlighted is the significant contribution of GIS technology to Public Health, especially in planning and analysis. In this research, GIS technology has allowed us to estimate the users of MWH services despite the lack of institutional records. In fact, without GIS technology this type of study would not be possible. GIS appears to be a particular useful technology at district and sub-district levels where administrative limits are especially tenuous. In this case, the determination of population by geographic methods (defining buffers and area of influence according to distance) appears as the most suitable methodology. It is expected that the research, and the findings exposed, contributes to promoting this technology within the health sector in the country.

5.5 RESEARCHER'S RECOMMENDATIONS

The findings of the research indicate that health facilities with MWH have a better institutional deliveries coverage that those health facilities without this services (at least if we consider areas of influence less than 12 km), suggesting that MWH are contributing to increased coverage. However, as is indicated in Section 5.9, limitations of the study do not allow us to generalize these findings, and further research should be promoted before concluding that MWHs have a direct impact in the increase of institutional deliveries coverage.

Analysis of the impact of MWHs in increasing coverage of institutional deliveries has confirmed the huge difficulties highlighted in the assessment of MWHs performed by the Ministry of Health (MISAU, 2009c). Besides sample limitations, one of the most important aspects that limit the generalizability of the results is the weak application of the ministerial guidelines regarding MWHs. The Ministry of Health indicates that, up until the time of this research, MWH services are not homogeneous. Through the implementation of this research we have confirmed the wide range of MWH types, location, and services offered, etc.

Considering the wide range of MWH services offered, and also the results obtained in this research, the main recommendation consists of effectively applying the ministerial guidelines and recommendations regarding the policy of

MWHs, before setting up new services. A homogeneous service will enable studies with fewer confounders and allow us to determine if MWHs have impact in increasing coverage. Other relevant recommendations are:

5.5.1 Improvement of records used in the MWHs

Currently, the MWHs do not have records to register the usage of the service. There is no information about the number of pregnant women that use this service, origin, number of nights, outcomes of the delivery, etc...
This information appears to be essential to promote further research that seeks to contribute to an analysis of the impact of the service.

5.5.2 Improving access of remote populations by increasing health network.

The results of the research suggest that women living in remote areas are not accessing MWHs. Nowadays, for distances greater than 12 km (remote populations) it seems that expansion of new health facilities is the best solution to improve access.

5.5.3 Characterization of the MWH services and promotion of the homogeneity.

It is particularly necessary to elaborate a services availability database including the number, location, characteristics, integration in the NHS (total or partial) and attributes of MWHs located around the country. This systematization will be the point of departure for the promotion of the homogeneity of the services. It is indispensable to effectively regulate the current provision of services in order to effectively analyse with more certainty the impact of this strategy within the scope of safe motherhood policies.

5.6 RECOMMENDATIONS FOR FURTHER RESEARCH:

A list of recommendations for potential future research is provided, below:

5.6.1 Increasing the sample size

The first and most important recommendation for further research would be to increase size of the sample under study. It would also be relevant to implement a study of the impact of the MWHs using a sample of health facilities located in different provinces of the country (at least with representation from the northern, central and southern regions).

5.6.2 Analysis of the coverage regarding the characteristics of the MWHs.

It would be useful to analyse the impact of MWHs taking into account the characteristics of the infrastructure (brick construction/traditional material, availability of water, and other factors). Analysis of the coverage with respect to these variables will be extremely useful to homogenise (and to promote innovations if necessary) in the policy that the Ministry of Health is promoting.

5.6.3 Comparing target populations obtained by the use of GIS technology with administrative target populations.

Currently, health facilities determine target populations using administrative criteria, considering the population that by election use a determined health facility. Using this methodology and, sometimes, indicators obtained from the health information system, show coverage largely greater than 100 % (for example, vaccinations coverage of 220 %, and so on). These indicators manifest, that the determination of the target population is a key factor to have a realistic and useful health information system.

The present research has determined target population of a health facility by defining concentric buffers (radius) of difference diameters. This methodology seems to be useful as distance is one of the most (or possibly the most) important criteria from the perspective of the population.

A relevant research question would be the comparison of the coverage (institutional deliveries, vaccinations, others) obtained through the determination of target population calculated by administrative methods versus the determination of target population determined by distance. This research could also be implemented using the application of GIS technology.

5.6.4 Consider other key variables that can affect coverage

Further research is needed in order to determine the impact of the MWHs on the institutional deliveries coverage introducing the analysis of key variables that affect coverage, such as:

(1) Number and training of the health staff.
(2) Means of communications.
(3) Geographic characteristics of the area (rivers, mountains, others).
(4) Type of ethno linguistic population.
(5) Other variables.

5.6.5 To study the efficiency of the strategy

It is also important to study the efficiency of the strategy by analysing the projected cost of maintenance of the MWHs compared to their activities. This cost-efficiency should be compared to the cost of maintaining a health facility type II.

5.7 CONTRIBUTIONS OF THE STUDY

5.7.1 Assessment of the effectiveness of MWHs in increasing institutional deliveries.

This study has contributed to the analysis of the effectiveness of the MWHs strategy promoted by the Ministry of Health of Mozambique. Before this, no information was available about the impact of the MWHs in increasing coverage of institutional deliveries even though this is one of the main assumptions of this strategy.

Despite the limitations of the research (detailed, in depth, in section 5.9), the study demonstrates relevant findings concerning the impact of the MWH, quantifies the increase of coverage, and delimits the area of influence of the service. These findings can be a first step to informing further research that provides more information about the impact of this strategy within the scope of the Safe Motherhood strategies launched in several African countries.

5.7.2 Actualization of the Geo-coded Data Bases in Cabo Delgado Province.

The data collection and analysis of the research has been based on the geo-coded data obtained from the health provincial of Cabo Delgado. This geo-coded database includes the location of the health facilities of the province as well as important attributes (type of health facility). The present research has contributed to enrich this geo-coded data based on the introduction of new attributes in the health facilities located in the six districts under study. In this context, it has also added the MWH in the health facilities.

5.7.3 Developed Maps.

The present research has generated several maps that contribute to the analysis of the national health services offered in the districts under study. Within this context the following are highlighted:

(1) Health network of Montepuez, Balama, Namuno, Macomia, Meluco and Ancuabe district.
(2) Health facilities type II of Montepuez, Balama, Namuno, Macomia, Meluco and Ancuabe district and population.
(3) Areas of influence (or buffers) of health facilities type II of Montepuez, Balama, Namuno, Macomia, Meluco and Ancuabe district.
(4) Areas of influence (or buffers) of 8,10,12 and 14 km and population intersected of health facilities type II of Montepuez, Balama, Namuno, Macomia, Meluco and Ancuabe district.
(5) Institutional deliveries coverage of the health facilities type II under study (with and without MWH) by area of influence (8,10,12 and 14 km).

5.7.4 Applications of GIS in Public Health: analysis of coverage

One of the key objectives of the research was to study the potential contribution of GIS technology in the discipline of Public Health. The research has revealed the huge potential that GIS technology and analysis has on the scope of planning, analysis, monitoring and evaluating public health strategies. Especially, the research has contributed to exploring the capacity of GIS technology in evaluating the coverage of health facilities.
Some potential applications have been introduced during the analysis and the presentation of the findings and are summarizes in the list, below:

(1) GIS technology can allow us to determine the population serviced by an area of influence using different radii (buffers). With these values and the registered deliveries by health facilities, it is possible to determine the institutional deliveries coverage.

(2) With the determination of the population under influence of each health facility and the location of the main roads and other geographic attributes

of the area under study (rivers, mountains, etc.) GIS technology can allow us to determine access barriers to health care services.

(3) GIS technology can allow us to visualize institutional deliveries coverage by health facility, facilitating the analysis and interpretation of the results.

(4) GIS technology can allow us to determine the target population for the health facilities, facilitating the future determination of expected institutional deliveries and other key indicators.

(5) GIS technology appears as a particularly useful strategy at district and sub-district level where administrative limits are tenuous. The study of population using geographical criteria, distance, is revealed as a practical application of this technology.

Without doubt, the geo-codification of the attributes of a geographic area (population location, health facilities locations, others) will be compulsory in the future for the public health arena. As John Snow in the 19th Century used geographic representations to study a Cholera Outbreak in London (Jessica Scott, 2010), in the present and future of public health, the use of GIS will help to visualize the health events, health status of the population, or area of influence of the services provided by the National Health System.

5.8 LIMITATIONS OF THE STUDY

5.8.1 Sample limitations

The final sample under study was composed by 25 health facilities located in six districts of Cabo Delgado Province: 18 health facilities without MWH and 7 health facilities of this service.

This sample size limits the generealizabity of the results. It would be important to implement further research with a major sample and also with a sample with health facilities from different regions of the country (at least with representation from the southern, central and northern regions of the country).

5.8.2 Data limitations

Data limitations can be analysed from different perspectives:

(1) Geo-coded information was restricted to Cabo Delgado Province. This aspect limited the study of coverage of health facilities located near the border of other province (specifically Nampula).

(2) Incomplete publication of some important features of the last census (2007) of population, specifically the population data by community. This aspect forced us to work with projections of populations based on the 1997 population size and location.

(3) Non-existence of registered information about the location and year of setting up of MWHs. This aspect was overcome by the use of structured formularies and interviews with health district directors. However, the reliability of the data related to the set up is low.

(4) Non-existence of records inside the MWHs. This data limitation is fundamental and in fact, was the determinant to implement the actual research design based on GIS technology. With information about the origin of the users it would be possible to study the impact of the MWHs in increasing institutional deliveries coverage related to this key variable.

5.8.3 Analysis of Confounders

Chapter 3 introduces the research design noting that with the current availability of MWHs data in Mozambique, an ecological study will be the most suitable approach. Ecological research has several positive aspects, as its ability to generate hypothesis in studies in which units of analysis are groups of people and not individuals. However, ecological studies can be difficult to interpret because of the multiple explanations of the findings. When inappropriate conclusions are obtained on the basis of ecological studies, the interpretation obtained is called an ecological fallacy (Bonita *et al*, 2006:43). Within this context it is important to highlight that the findings provided by an ecological study should be supplemented with follow-up studies. Also, it is essential to enumerate the potentials confounders that could be influencing the results.

5.8.3.1 Means of communication and other physical characteristics of the districts under study (rivers, mountains, etc..).

Sone of the main determinants related to health access are the proximity and type of means of communication. Figure 5.1 shows the main means of communication of the districts under study (the red cross indicates the location of health facilities with MWH and green cross the location of health facilities without this service). Unfortunately, information about the type and means of communication (main road, secondary, path, etc...) is not available. As the figure indicates, there are many populations (black points) without access to a means of communication.

These two aspects (type and access to a mean of communication) could affect the findings. A better access to a principal mean of communication could be influencing the coverage of institutional deliveries.

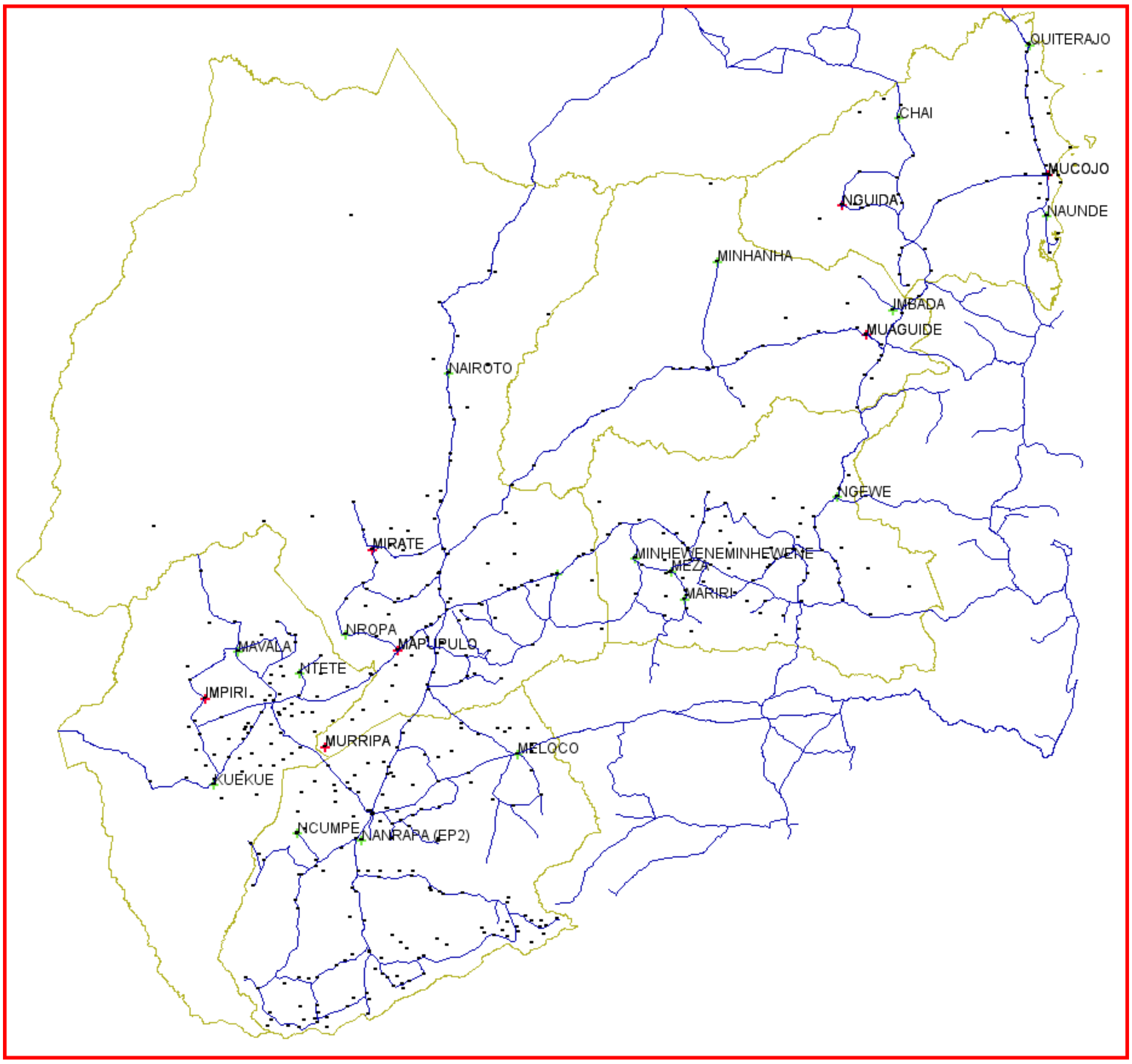


Figure 5.1. Main means of communication of the districts under study.

5.8.3.2 Number and health staff category.

Number and type (basic, medium or superior) of technicians working in the health facility under study could also influence the demand for maternal health care services. An association between the presence of a MWH in a health facility and a major number of health staff (or staff with more competencies) could be contributing to an ecological fallacy. The quantity and quality of human resources affect the confidence of the population in the services offered by a health facility.

5.8.3.3 Characteristics of the MWHs

The assessment of the MWHs elaborated by the Ministry of health of Mozambique (MISAU, 2009c: 105-111) reveals the substantial differences in the type of MWH that exist around the country. The situation in Cabo Delgado is similar to the rest of the country. Figures 5.2, 5.3 and 5.4 show the characteristic of a MWH located in Mucojo, Macomia district.

Figure 5.2. MWH in Mucojo health facility

Figure 5.3. Beds and bednets in the Mucojo's MWH.

Figure 5.4. Water supply in Mucojo's MWH

As can be seen, this MWH is built of brick, has different rooms, bathroom, beds, bed nets, water and other quality features. This MWH was built in 2009.

On the other hand, figure 5.5 shows the MWH of Muaguide health facility, also located in Meluco Distric. As the picture shows this MWH has an old infrastructure (colonial time) which has been adapted to this service. This MWH has no water, just one room, and no beds.

Figure 5.5. MWH in Muaguide.

These huge differences in the characteristics of MWHs could also be affecting the demand for the services (from this particular facility), and therefore the coverage of institutional deliveries within the group of health facilities with this service.

5.8.3.4 Socio-cultural characteristics of the communities under study.

Several studies highlight the importance of socio-cultural characteristics of the population in the demand of maternal health care. For example, in the south of

Mozambique, it is widely documented that the mother in law has a powerful influence over the decisions that young mothers take in relation to maternal health care (medicusmundi, 2007). In the area under study two ethno linguistic groups exist: Maconde and Macua. There is no evidence in the literature of a correlation between ethno linguistic groups and MWHs usage. However, because of the documented information that emphasizes the weight of socio-cultural considerations it is important not to underestimate this factor.

5.9 CONCLUDING REMARKS

Maternal mortality is indeed one the most challenging health problem in the majority of developing countries. Several strategies have been launched within the scoop of safe motherhood policies to reduce the current high mortality rates. In this context, Maternity Waiting Homes, have been promoted in several countries, including Mozambique, following the empirical examples obtained from different countries.

However, there is limited information about the impact of this strategy in reducing maternal mortality. Furthermore, in Mozambique there is limited information of the capacity of maternity waiting homes in increasing institutional deliveries coverage, although this is one of the main assumptions.

It is essential to empirically study the question of whether Maternity Waiting Homes do indeed contribute to an increase in coverage. Through the increase of the globalization in health policies, several experiences have shown that several strategies are not completely replicable in different contexts or national health systems. It seems logical, before promoting a major expansion of the MWH strategy, to assess its real impact in the Mozambican context.

The present research contributes to our knowledge and provides information that allows us to assess whether Maternity Waiting Homes (considering the manner in which the strategy is being implemented currently in Mozambique), are in fact, a valuable strategy in this country.

The research concludes that, coverage of health facilities with MWH are greater than those without (in a range from 4-2%), however it is not possible to conclude that MWHs are in fact succeeding in the aim to offer a service for pregnant women living in remote areas. For this reason, and also, for the great diversity of MWHs characteristics in the area under study, it is recommended firstly to standardize the service, before expanding the MWHs network. Of course, further research to assess the impact is necessary.

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ANNEXURES

Annexure 1: Authorization of the Health Provincial Board of Cabo Delgado to implement the research and to use the data of HIS and GIS.

Annexure 2: Authorization of the Agriculture Provincial Board of Cabo Delgado to use the data of HIS and GIS.

Annexure 3: medicusmundi letter of support to implement the research.

Annexure 4: Data collection form to confirm data.

Annexure 5: Confirmation of collected data by the Health Provincial Board of Cabo Delgado