ESTIMATION AND PROJECTION OF THE FERTILITY: NATIONAL, PROVINCIAL AND LOCAL LEVEL IN NEPAL

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We certify that this dissertation entitled "ESTIMATION AND PROJECTION OF THE FERTILITY: NATIONAL, PROVINCIAL AND LOCAL LEVEL IN NEPAL" was prepared by Bijaya Mani Devkota under our guidance. We hereby recommend this dissertation for the final examinations by the Research Committee of the Faculty of Humanities and Social Sciences, Tribhuvan University, in fulfillment of the requirements for the Degree of DOCTOR OF PHILOSOPHY in POPULATION STUDIES.

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APPROVAL LETTER

This dissertation entitled **Estimation and Projection of the Fertility: National, Provincial and Local Level in Nepal** was submitted by **Mr. Bijaya Mani Devkota** for final examination to the Research Committee of the Faculty of Humanities and Social Sciences, Tribhuvan University, in fulfillment of the requirements for the degree of **Doctor of Philosophy** in **Population Studies.** I, hereby, certify that the Research Committee of the Faculty has found this dissertation satisfactory in scope and quality and has therefore accepted for the degree.

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DECLARATION

I hereby declare that this Dissertation is my own work and that it contains no materials previously published. I have not used its materials for the award of any kind and any other degree. Where other authors' sources of information have been used, they have been acknowledged.

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ABSTRACT

Fertility levels and patterns provide an important demographic information regarding the population change, as well as socio-economic development and human well-being. There are very few specific studies in Nepal that estimate and project fertility among different caste/ethnic groups at the national, provincial and local levels. This study compares the fertility estimation and projection at national and its sub-domains, and verifies and validates in Nepal. National household censuses (2001 and 2011) were carried in 12.5 percent of the total households and (649,476 and 1,091,337) reproductive age group of sample women were identified through analysis respectively. Age sex pyramids and frequency table represent demographic scenario of national and provincial levels. The study was carried out adhering to the Arriaga method and changing P/F ratio method. Algorithm first smoothed local age specific rates (ASFR) using Empirical Bayes method and then applied a new variant of Brass's P/F parity that is robust under conditions of rapid fertility decline at local level. The small area estimation (SAE) was applied at local level and different caste/ethnicity were selected to estimate the fertility which is the contribution of the study. Total fertility rate (TFR) values will reach at national level using linear interpolation, and extrapolation by 2031, it reaches replacement level. The study showed that the Muslim, Hill Janajati, Madhesi Dalit, Madheshi Other Caste, Hill Dalit and Others Minor Caste will have (2.37, 2.31, 2.32, 2.20, 2.37, 2.51) high fertility rate which is above the replacement level of fertility at the end of 2031. Similarly, the fertility rate of Newar, Tarai Janajiti, Brahman/Chhetri and Madheshi Brahman (1.58, 2.03, 2.09, 1.8) will have below the replacement level of fertility. At the province level, Karnali (3.42), Sudurpashchim (2.59) and Lumbini (2.14) will have high fertility rates; Madhesh Province and Gandaki will reach 2.1; Province 1 (2.05), Bagmati (1.9) will be below the replacement level in the same period. SAE is most useful when the vital registration system is incomplete and small local fertility samples made it difficult to estimate rates reliably; applying 742 (2001) and 753(2011) local levels in household census; mainly standardising the empirical Bayes Brass (EBB) method in Kanda (Smallest), Dhanushadam (middle) and Kathmandu (largest) at rural and urban municipal levels were selected respectively. The fertility of SAE is valuable for analysing demographic change and is important for local planning and programme. Future researchers can study to ward levels for more effective results.

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ACRONYMS AND ABBREVIATIONS

Adj.	:	Adjacent Factors
ADJ.ASFR	:	Adjusted Age Specific Fertility Rate
ARIMA	:	Autoregressive Integrated Moving Average
ASFR	:	Age Specific Fertility Rate
BDHS	:	Bangladesh Demographic and Health Survey
CBR	:	Crude Birth Rate
CBS	:	Central Bureau of Statistics, Nepal
CDPS	:	Central Department of Population Studies Tribhuvan University
CDR	:	Crude Death Rate
CEB	:	Children Ever Born
CPR	:	Contraceptive Prevalence Rate
Cum. ASFR	:	Cumulative Age Specific Fertility Rate
CF	:	Cumulative Fertility
DHS	:	Demographic and Health Survey
EB	:	Empirical Bayes
EBB	:	Empirical Bayes plus Brass
f(i)	:	Period Age Specific Fertility Rate
F(i)	:	Estimated Parities Equivalent
f(i)+	:	Conventional Age Specific Fertility Rate
f*(i)	:	Adjusted Age Specific Fertility Rate
GFR	:	General Fertility Rate
GNP	:	Gross National Product
GWR	:	Geographically Weighted Regression Models
HDI	:	Human Development Index
IMR	:	Infant Mortality Rate
IUSSP :		International Union for the Scientific Study of Population
KAP	:	Knowledge, Attitudes and Practices of Fertility
LARC	:	Long Acting Reversible Contraceptive Method
MADN	:	Mean for absolute Difference in Neighbour
μ_i	:	Interpolated Moments
MoHP	:	Ministry of Health and Population

NDHS	:	Nepal Demographic Health Survey
NPC	:	National Planning Commission
OCM	:	Own Children Method
P	:	Reported Average Parities
ϕ (i)	:	Cumulative Age Specific Fertility Rate
PhD	:	Doctor of Philosophy
PPP	:	Population Perspective Plan of Nepal, 2010-2031
PUMS	:	Population Census Use Microdata Sample
RMSE	:	Root Mean Squared Error
SAARC	:	South Asian Association for Regional Co-operation Countries
SAE	:	Small Area Estimation
SDG	:	Sustainable Development Goals
SRS	:	Single Round Surveys
TF	:	Total Fecundity Rate
TFR	:	Total Fertility Rate
TFRLGST	:	Total Fertility Rate with Logistic Curve Function
TU	:	Tribhuvan University
UN	:	United Nations
UNDP	:	United Nations Development Program
UNFPA	:	United Nations Population Fund
UP	:	Utter Pradesh of India
USA	:	United States of America
USAID	:	United States Agency for International Development
VRS	:	Vital Registration System
Vs	:	Versus
WFS	:	World Fertility Survey

CHAPTER 1

INTRODUCTION

This study focuses on the estimation and projection of fertility at the national to the local levels in Nepal. This introductory chapter covers the background to the study, statement of the research problem, research questions, objectives, rationale, limitations, definitions of key terms and organization of the study.

1.1 Background to the study

Population growth recognizes three demographic components viz. fertility, mortality, and migration of the study population, which can have significant impact on future population growth. Among the components, fertility is an essential component of population growth. Information on fertility levels and patterns can assist to formulate and evaluate policies related to population change (Brass, 2015). Policy on fertility can affect the population change. Fertility relies upon accepted practices and desired family size (Bongaart, 2017). Fertility provides positive contribution to population growth if it is above the replacement level. The negative contribution occurs if it is below replacement level (Pressat, 1973). So, actual scenario of fertility data is essential for policy formulation.

When the practice of vital registration system was incomplete during 1960s and 1970s, indirect estimation of demographic variables of population was crucial and widely used method (Brass, 2015). Indirect techniques mostly rely on demographic theory and modelling applications, and these used to consider ingenious combinations of demographic data. The methods were robust and used to minimize the common errors. The demography of Tropical Africa (Caldwell & Okonjo, 1968) and United Nations (Coale & Demeny, 1968) were developed as the indirect estimation. A second generation of demographers developed the estimation techniques further. The indirect estimates for demographic characteristics were among the pioneering tasks practiced by the United States of America (USA) established back in 1977. These attempts ultimately lead; publication of the United Nations (UN) Manual X (United Nations, 1983; Schmertmann et al., 2013).

The world fertility survey and its successor surveys provided reliable data. The surveys not only estimated fertility, but also mortalities for infants and children

(Brown & Guinnane, 2002). The survey also provided the impetus for data collection, but the indirect estimation remained in practice (Cleland, 1996). Due to non-availability of complete and reliable data, a large number of indirect techniques have been developed to estimate the demographic parameters. The new variant of indirect methods, for example, use of small area estimation has been widely used to estimate fertility at sub-national levels. Some of these techniques are based on indirect estimation while others are based on the statistical modeling in which the parameters are estimated (Brass & Coale, 1977) and thus limits the understanding of population dynamics in the developing country (Hobcraft & Little, 1984). If such promising information is incomplete, and the perfection is not found within tolerable level for analysis and interpretation, demographers usually use two options for improving the analytical procedures. They either can get out into the field to collect new dataset or utilize the different statistical approaches to improve the dataset. Most of the literature on quality of fertility data have focused on the development of indirect estimation methods. These techniques deal with biases that are caused by recall lapse errors in retrospective estimates of fertility rates (Kamal, 2010).

Brass first introduced the indirect methods of demographic parameters estimation, with the aim of employing robust measure and reliable estimates for a poor demographic data (Brass, 2015; Kpedekpo, 1982). Accounting the probable source of errors and minimizing the influence of such errors, indirect estimates are carried out using demographic and making assumptions to translate clear mathematical relationships (Coale & Trussell,1974). Indirect methods also encompass collation of uncertain quality data and also the information which indirectly explains about demographic characteristics (Alkema et al., 2009).

Many demographers agree that the Brass techniques are the most significant advancement in measuring of vital rates throughout the post-war period (Coale & Demeny, 1968). Brass methods detect and correct common reporting problems found in demographic data from developing nations (Brass, 1996). With the popularity gained by the indirect methods, demographers have reexamined these techniques which have upgraded these approaches (Moultrie et al., 2013).

At this juncture, this study applies indirect methods in small area estimation as of Schmertmann Model for small area estimation (SAE). These estimates are important because even the large national surveys lack sufficient sample sizes to project demographic characteristics. The SAE method, therefore, grabs the advantage of information from vital registration and information obtained from censuses (Schmertmann et al., 2013). The estimation of constant fertility is based on utilizing the data from stable population theory while changing fertility is based on the population projection technique in which the parameters are estimated through various mathematical equations between the dependent and independent variables which is the total fertility rate (TFR) (Rodolfo et al., 2019). With the complex estimation scenarios are intensified by reporting errors (for reference periods and underreporting of children) in the developing country's surveys, this study is in-depth analysis of past, present and future projections at national, provincial and local (Gaupalika and Nagarpalika) levels using SAE in Nepal. This research also attempts to find out discourse of the sociological aspects of fertility and downscale the fertility from macro to micro (national to local) levels.

1.2 Statement of the problem

Demographic analysis in developing countries is inhibited by lack of adequate and reliable data. The limited registered cases suffer from serious reporting errors due to people registering at their own individual convenience (Moultrie et al., 2013). Current practice of estimating fertility is from data of recent births from population census, but the estimates determined using such method are often implausible small due to the errors resulting from omission of births, recall problems, misinterpretation of the reference period before the census, and significant non-response rates, amongst other problems (United Nations, 1983). Such challenges have directed to the development of demographic methods for estimating fertility by utilizing information that relates indirectly using indirect estimation methods (United Nations, 1983, Moultrie and others, 2013). Population census in countries include two separate questions on fertility, one relating with lifetime fertility and another on recent births, which provides a basis for consistency check between recent and cumulative fertility. In this context, direct estimates based on recent births can be adjusted by integrating information on lifetime fertility, the concept behind the P/F (parity/fertility) ration method (Brass, 1964). This concept can be further advanced and made it utilize information of both cumulative and recent fertility, such as in Arriaga's technique (United Nations, 1983; Arriaga, 1994; and Moultrie and others, 2013).

Although vital registration is a legal requirement in many countries, the limited access to registering institutions, as well as lack of law enforcement and/or positive incentives to register, renders the system are very inadequate (Karki, 1992). In Nepal as well, despite the 2001 and 2011 population census statistical report the census data, it cannot give total information (different caste/ethnicity and local level) of the fertility data.

The Vital Registration System (VRS) is incomplete with only 20-25 percent coverage according to 2011 census while taking 5.4 million households (Central Bureau of Statistics, 2014). Nepal Demographic Health Survey (NDHS), though has the flexible mechanism, covers about only 11 thousand (Ministry of Health, 2016) and therefore to contest smaller sample size, future data on fertility can control quality and collect frequently with detailed questions and larger number of households compared to targeted in population censuses (Marckwardt & Rutstein, 1996; Schoumaker, 2014).

The population survey has also non-sampling errors and relies on last census frame (Mulder et al., 2009). In Nepal, NDHS sampling frame also uses National Population and Housing Census (NPHC) that was carried out in 2011 by Central Bureau of Statistics (CBS) (Ministry of Health, 2016). Similarly, unintentional oversampling or under sampling could also affect fertility estimates (World Bank, 2015). NDHS as well has not covered fertility data of different ethnic groups and local geographical areas. The census reports did not provide different ethnic groups and local geographical areas regarding fertility data. The data set and plots of empirical data facility exploration of the empirical basis for fertility estimation, difference across primary data sources and have data gaps for each country. It is not clear from census/ survey studies reason behind the estimates are different which makes difficult to make conclusion about which and why the particular estimate is more plausible than others.

Feeny (1997) reported that the rate of decline by 0.77 children per women per decade plausible rate of decline in developing counties and has also shown high variability in fertility levels. From this point of view, the drop of fertility level is high (Central Bureau of Statistics, 2014). Indeed, none of the studies have determined fertility at the local level and different caste/ ethnic group. Therefore, this study has focused on point estimation, verified methodology and estimation projection of future fertility with changing fertility concept at different caste/ethnic local or any desirable area.

1.3 Research questions

There exists fertility information gap in each country (Schoumaker, 2014). The data gap in fertility data within the caste/ethnic groups, rural and urban municipalities needs fulfillment through estimation and projection of fertility from national, provincial and local levels. This research aims at answering the following questions.

a) What are the estimates and trends of fertility at national and caste/ethnic groups?
b) What are the estimates of fertility at the provincial and local levels using national scenario?
c) What are the future fertility trends at micro (local) levels, based on past and present data, using different mathematical models?

1.4 Objectives of the study

This general objective of this study is to estimate and project fertility trends in national, provincial and local levels of Nepal, and the specific objectives are as follows:

a) To estimate and project the fertility at national level, including for different caste/ethnic groups of Nepal,
b) To estimate and project fertility at the provincial level, and
c) To estimate fertility at the local levels using SAE empirical Bayes Brass.

1.5 Rationale of the study

In majority of the developing nations, vital registration systems are not good in coverage and quality (Joshi & David, 1983). The census is crucial for resource allocation and planning, because it is carried out only in every ten years and other methods are required for planning in the intervening years. In any society, fertility level is influenced by means of a series of socio-economic, cultural (Bongaarts, 2017), biological and environmental factors. The problem of unavailability of such complete and reliable data and the estimation of TFR is also not easy task as it requires the information about age-sex distribution of population (Close et al., 2012). Therefore, the demand of estimation of TFR is challenging (Karki, 2003). Population estimates use census as a baseline, add births, subtract deaths and make allowances for migration. However, still, in most countries, even large national samples do not produce reliable and accurate estimates for the fertility at minor and sub-national levels. Incomplete vital registration systems, as in Nepalese national context, and small local fertility samples cannot provide the reliable estimates for fertility. Incomplete and erroneous information also produces inaccurate population development forecasts and planning. The census conducted during 1961-2011, estimates the fertility data only at national level and does not cover different caste/ethnic and local geographical area. Myre's, Whipple's and UN age sex accuracy index have shown irregularities in the fertility estimations and trends, therefore, indirect techniques have been used in this study.

In this context, indirect estimation of demographic parameters is crucial in the developing world. As its application to census and survey data has greatly expanded knowledge of the demographic situation in data deficient countries (Brass, 1996). This study focuses on local and provincial levels, and different caste/ethnic groups for fertility estimation and projection. This study has main strengths in indirect estimation of fertility by Arriaga's method and P/F ratio method at micro (local) level including different caste/ethnic groups, and has been justified using different mathematical models. The methods also check consistency and make corrections during the fertility estimation (De Carvalho et al., 2017; De Oliveira et al., 2021).

In many countries or regions, vital registration is incomplete and some births and deaths go unrecorded in official statistics (Schmertmann & Gonzaga, 2018). Most of these demographers have proposed a variety of methods to estimate the completeness of birth and death registration to adjust fertility and mortality estimates in local geographical area by using SAE method (Queiroz, et al., 2019). This study has SAE using indirect estimation of changing P/F ratio method at local levels, which is new contribution for Nepal. Changing P/F ratio and SAE methods suitable for third stage of demographic transition theory. This method is the combination of old and new methods to solve the problems. In this study, SAE application on Coale Demeny and changing P/F methods for fertility estimation has added contribution in knowledge generation and new paradigm shift in the demographic data anlaysis (Schmertmann et al., 2013). The SAE, though is usually used for fertility estimation, other co-variates (educational level, life expectancy, income level etc.) which are determinants of fertility, can also be estimated at the local levels.

1.6 Limitation of the study

The study is based on 2001 to 2011 census data sets. This study has taken secondary data as inherent coverage and content errors as well as census. The study has consequently estimated TFR for 753 local levels, viz. municipality and rural municipality, for the 2011 census, and 742 local levels considered during 2001 census. Moreover, calibrations of the SAE lines were performed using Nepal Demographic Health Survey, 2016 data sets. The SAE estimation is based on neighbourhood approach pulls data from the closest local levels when there are less than 21,000 reproductive age group of women taking census data frame. For example, suppose there are fewer than 21,000 women of childbearing age in the M+7 neighborhood local levels. And, data are added from the 8th closest local level, then from the 9th closest, until there are at least 21,000 sample women in the considered neighborhood local levels. This method truly represents the projections only when the neighbourhood or estimations from considered local geographical locations are homogeneous.

1.7 Organization of the study

This study is categorized into seven chapters. The first chapter contains introduction of the research concept which is detailed with describing background to the study, statement of the problem, objectives, significance, limitations definitions of key terms. The second chapter contains elaborative review of theoretical and empirical reviews of literature adding rationale on the rationale for the indirect estimation of fertility, small area estimation and discussion on the need for small area estimation and conceptual framework. The third chapter delineates the research philosophy and methodology (source of data and method, methods of analysis) used in the study. The chapter four is the confounding opinions of other researchers regarding the Arriaga method and changing P/F ratio method, and discusses adjustment and analysis of estimation of fertility census data at national levels and on different caste/ethnic groups. The chapter five is developed based on adjustment and analysis of estimation of fertility census data at the provincial levels. The chapter six is based on data about evaluation and analysis of estimation of fertility in the local data (small area) vis-à-vis verification of small area estimation and projection. The chapter seven includes a summary, discussion and conclusion of the study followed by suggestions for further research work.

1.8 Definitions of key terms

The followings are the elaboration for the key terms frequently used in this study.

Fertility: Fertility refers to the actual birth performance of a group of women or to the relative frequency with which the birth rate occurs in total populations or in the population exposed it.

Period Measures: A statistic that measures events occurring to all or part of the population during the particular period of time.

Crude Birth Rate (CBR): The birth rate indicates the number of live births per 1,000 population in a given year.

General Fertility Rate (GFR): General fertility rate is the ratio of number of life births during a year to the mid-year of female population of child bearing ages 15 - 49 years.

Age Specific Fertility Rate (ASFR): It measures birth to women of a given age group in the year per 1000.

Total Fertility Rate (TFR): The TFR is the average number of children that would be born to a woman by the time she ended childbearing if she were to pass through all her childbearing years conforming to the ASFR of a given year.

Replacement level fertility: Replacement-level fertility is the level of fertility at which women in the same cohort have exactly enough daughters (on average) to "replace" themselves in the population.

Cumulative fertility rate: The TFR describes the average number of children per woman which makes it an intuitive measure of fertility. The TFR is calculated by adding up all the ASFRs, multiplying this sum by five (the width of the age-group interval), and then dividing by 1,000.

CHAPTER 2

LITERATURE REVIEW

This chapter focuses on review of theoretical and conceptual framework for fertility studies, assessment of different modelling exercises carried out for fertility across national and global levels. The review of previous studies on microeconomic and macroeconomic thematic approaches concerning fertility, review of sociocultural approaches and values affecting fertility, review of empirical studies carried out for discussing fertility status in Nepal, and review of small area estimation techniques for fertility estimation across the global scale.

2.1 Theoretical review of fertility

Theoretical review of fertility in the sub-sections below discusses on the scenario of historical fertility status, historical methods and trends in measuring fertility, theoretical analytical frameworks, the predictors of fertility situation and different theoretical thematic approaches used across the globe.

2.1.1 The frontier context

The concern about fertility has been regarded since the pre-modern society. Attempts have been made throughout societies to reduce the gap between population growth and food supply. The increase in gap creates adverse effects on demography and environment, and attempts should be made to narrow the gap between the two. In this context, Malthus (1817) made a strong argument that couples are responsible for the limiting their family size voluntarily. He suggested young people should not to marry until they become able support their family. The population size is based on the modes of production and distribution of properties (Marx, 1817). Therefore, birth control cannot be justified on the background of economic aspect. Quetelet (1848) established a linkage of social laws with the growing number of physical laws.

2.1.2 Measuring fertility

As per Lotka (1947), natural growth rate is a poor indicator of intrinsic dynamic population. Age structure of the population is shaped by pervious pattern of fertility and mortality, determines the number of births in the same year. In the dynamics of stable population, the main constituents are a number of births obtained by blending ASFR with the size of women of each reproductive age groups. Population trend analysis such as demographic forecasting can be made from ASFR, to explain or predict fertility rates (Coale, 1989; Kuczynski, 1931).

A merit of cohort analysis, especially when mechanism of postponement and recuperation affect the fertility at the time of childbearing and also it relates the mortality in terms of difference between a cross-sectional parameter resulted by summarising the ASFR observed in a year while longitudinal indicator can be obtained by summarising the rates within a given population (Pressat, 1973; Ryder,1956). This issue was considered as the declining of child bearing and as a result fertility in some developed countries has dropped remarkably. Hence, it was predicted that drop in TFR not only reflect a decline in fertility but also reflected a change in tempo with the postponement of birth to later ages (Rallu & Toulemon, 1994). The cross-sectional indicators of adjusted value led to the production of varying useful indices and two effects got truly disassociated until the cohort's concern reached the end of their reproductive lives (Bongaarts & Feeney, 1998), but it certainly boosted the understanding of fertility trends.

2.1.3 Structured analytical frameworks

(a) Considering determinants into account

Davis and Blake (1956) studied a large corpus of ethnological studies and suggested that the fertility influencing variables can be categorized into three different stages; first, the intermediate variables by which any social factors affecting the level of fertility should function; second, social norms which are ardently associated to the cultural conditions that govern the marriage behavior, fertility and other behavior; and third the features of social and economic structure which destine one’s position in the society. The classification of intermediate variables rendered to a principal error during 1960s to the mid-1970s despite of studies to exhibit the importance of breastfeeding, which was also often ignored including the questionnaires of demographic survey. Birdsall established in high-fertility variables and marriage to the development of economic development (Birdsall, 1988).

Henry (1961) developed the concept of natural fertility and a model of family formation process exhibiting that fertility under a natural domain is the foundation of controlled fertility. Fertility dominated by physiological factors which occurs without birth control is termed as natural fertility. Davis' and Blake's study of intermediate variables suggested that natural fertility is the core component and can be regarded as the analysis of proximate determinants which was developed by Bongaarts (Leridon & Dutreuilh, 2015).

(b) Modelling

Notestein (1953), indicates that three prerequisites for the declining of fertility in a particular society. These are, fertility must enter into the situation of conscious choice; advantage of low fertility should be considered as the merits in the prevailing social and economic condition; and availability of effective birth control techniques. Coale (1989) gave a brief incisive glimpse of fertility trends in the developing countries where family planning program got ended in failure. According to his opinion, it is not enough to control the birth by providing contraceptives for women.

According to Brass (1996), the primary consequence of indirect demographic technique is due to incomplete or indirect data on vital events and it is a major concern of developing countries for suffering from insufficient data quality. Indirect techniques are commonly employed in absence of such system (United Nations, 1983). There are different reasons qualified to the deficiency of a VRS in developing countries (Moultrieet et al., 2013). Political instability, institutional disorganization and lack of proper utilization of resources play a crucial role for the deficiency of vital registration system are major reasons in the developing countries (Cleland & Wilson, 1987).

According to Coale's model of fertility, one of the four indices, can be calculated (Van de Walle, 2015) by constructing it feasible to comparison of various surveys from Europe. Overall fertility index can be articulated in terms of an index of proportion of married women, fertility of married women and index of fertility of un-married women (Kamata & Iwasawa, 2009). All indices are standardized by age structure within the reproductive period. To differentiate the effect of early marriage and late marriage from those of birth control within marriage, Coale and Trussel (1974) used ASFRs pattern find an acceleration with decrease of age group.

Specific surveys had to be organized if relevant data are not always available in vital statistics. During the early 1950s statistically, representative surveys were very limited. However, things commenced moving in the 1960s and above and in the 1970s the World Fertility Survey (WFS) was launched as one of the major programs for statistically representative survey. The projection between 1974 and 1981 were analysed in more than 40 developing countries on the basis of sampling plan with structured questionnaire and common program of tabulation (Grebenik, 1981).

Bongaarts (1978), discussed the similarities of intermediate variables of Davis and Blake with proximate determinants which was exhibited to summarise the variables into some limited indicators such as the effect of marriage, post-partum infecundability drawn from frequency and duration of breast feeding, contraception and abortion (Caldwell & Okonjo, 1968; Garenne & McCaa, 2017).

When marital status of each female respondent is known, it is easy to calculate the marriage index. According to Singh and Hymowitz (1985), determining the fertility index from the observed duration of breast feeding is slightly complex but calculation of proportions contraceptive users would even be more questionable assumptions. This model of description is rather poor; using data from WFS or DHS mentioning the main indicators. This model is based on the presumption with some limitations. Nonetheless, it operates fine in a variety of circumstances from limited information as mentioned by Bongarts & Freeney (1998).

Hobcraft and Little (1984) split years into a series of epochs denoting various degree of exposure to conception risk and extended the model which a more precise estimation of different intermediate variables that influence of socioeconomic factors.

It has unlocked an era of micro-demography predicted on the availability of individualized data. In 1970s, it moved quickly with a mathematical formulation of the reproductive process (Menken, 1974; Sheps et al., 1969) and the construction of micro-simulation models. The interval between the births measures the pace of reproduction and indicates that the rate of fertility depends upon the components such as fecundability or post-partum infecundability (Yaukey, 1969).

The estimation was too difficult to study the impact on the completed fertility of a sharing of mean fecundability which answers queries accurately using a mathematical model (Leridon, 1977). The levels of fertility for the ancient populations were explained without considering voluntary birth control and measure a potential impact of one or other theoretical presumptions (Leridon & Dutreuilh, 2015).

2.1.4 Thematic approaches

Out of many studies on population history, only a few studies impart a theoretical framework to analyze fertility as it indicates pointless exercise given the precise data or fertility which is presumed to be stable over the period considered (Bardet & Dupaquier, 1986). French historians have made their mark by applying the procedure of historical demography (Laslett & Wall, 1972); Hanjal (1953) highlighted on the history of marriage and discovered the big age difference between husband and wife that necessarily influenced the complete fertility. Aries (1980) developed a concept of understanding of the history of mentalities which are of particular interest and discussed his ideas on fertility trends in Europe.

2.1.5 The anthropologists' contribution

In conjunction with historical population, the reproductive pattern and family of contemporary societies has been studied by ethnologist that offer plenty opportunities to study the behavior in an ample of contexts which was profoundly established in the overview by Davis and Blake (1956).

Based on the certain economic arguments, Caldwell (1982) opined that a baby boom will not always be disadvantage for economic development. A glimpse of traditional African societies demonstrates that children and young adults give a significant contribution in the family's income while power is centered by elder males. In contrary, parents should spend money to raise and educate their children with a little expectation of ultimate return in modern societies. The economy flow from children to parents have thus been get reversed (Caldwell, 1982; Jensen, 1990).

2.1.6 The institutional and political environment

Anthropological approach takes an account of the social environment and is based on detail observation of behavior. The institutional construct tends to weaken the role of family or society with the development of structured nation states. The example of interaction between the states and local structures has been presented by McNicoll (1982). The individual rationality, economic constraints or marital relationships do not provide a practical solution for such matters. And hence, Casterline placed a progressive formation of nation states with effective means of intervention for center of analysis (Casterlines, 1989). Therefore, the state makes a new form of solidarity and communication between all citizens by advancing agriculture production, creation of new jobs for social protection (Poirier & Piche, 1999).

2.1.7 Microeconomic approaches

The classical economists of the 1960s affixed and appropriated the economic approach in relation to any theory of fertility should be known and given due credit for it. Homo-economist were invented offering a framework subjected to few adaptations for the study of reproductive behavior as a specific instance of choices available. This approach can be summarised as the macroeconomic theory of consumer demand for durable goods can be used for analysis of child demand (Fonseca & Tayman, 1989).

Becker (1960) developed microeconomic approach and tested the theory by using empirical statistics. In contrary to the anticipation, the fertility has no systematic relation with the increase of income. The choice and quality effects mentioned above must be factored to get round the problem by adding a sociological dimension to the reasoning. The limitations on individual decisions are hardly be applied for the economic models that can only function by making enough use of concepts like “child quality” or by considering psychological satisfactions of parents.

Blake (1968) stated that children are durable goods for economic methods and have a difficult time incorporating “irrational” that need to reproduce individual’s ability making right decisions based on incomplete information or power which favors men.

Leibenstein’s (1977) had presented at the international union for scientific study of population conference, in which cost and benefit of children approach denoting the multitude dimensions for concept and examining the relationship between income and children’s number (Dougherty & Psacharopoulos, 1977). A micro-economic approach emphasizes the difficulty of identifying the benefits from children after their birth of twenty or more years.

Parents in some societies may adopt a positive insurance policy by protecting the mother for the case of early widowhood or by caring in old age that guarantees a lifetime of their children. In addition, it minimizes the risk and having two adult sons is reasonably objective (Cain, 1886; Jensen, 1990).

2.1.8 Sociocultural approaches and values

Fertility study owes much to sociology with key contributions from Freedman (1963) and Hawthorn (1970) which reveals that psychology has focused on qualitative aspects or a few numbers of cases with a little impact on demographic debate. Furthermore, analysis of Khol and Fawcett (1995) are discussed often centered around the notion of “values” guiding the decisions of individual or of couples and the search to identify their nature, scope and determinants.

Lesthaeghe (1983) rendered difficulties in using statistical methods specially for general use of components analysis and rank correlations that are fine examples of quantitative method to sociological concepts.

Inglehart’s (1977) built three types of indicators on post-materialism. Non-material ideas and wishes take superiority over the search for material advantage to the ideals of Simons (1982 & 1986) using the data from European values surveys. Variables such as familyism are dependent variables; independent variables like religiosity, materialism, post materialism, altruism and control, where age, sex, household income and education are dependent variables (Hill & Simons, 1989).

Preston (1986) for that the worries regarding overpopulation arose in the late 1970s that led to relative devaluating of motherhood as a greatest concern on the issue for those with fewest children. Rise in the individualism to change in socio-economic environment instead of an independent dynamic was focused by Lesthaghe (Jacobs, 1986).

Simons (1982) presents that consideration of religion or religious practice are more crucial than simply use of independent variable. Religion is a system of meanings which structures various behaviors including reproduction.

Durkheim (1952) states that each society creates an ideal and consecrated perception of itself for the manifestation of religion. Lutz (1987) considers the same reasoning that religion not only impacts directly on individual behaviours but also play distinct roles independently for the socioeconomic variables (Kemmer & Lutz, 1987).

Fawcett (1983) introduced a term “value” to denote something different value of children from their parents. The economic concept of costs and satisfactions is wider than analyzing the framework of costs and satisfactions used (Hoffman et al., 1973).

Increasing ambitions of couple and family for better life, expectations from children for future satisfactions and no economic role of children are the most significant factors in the fertility decline (Bulatao, 1979).

Sociocultural claims may be very skeptical for the explanatory power of microeconomic approaches (Cleland & Wilson, 1987) as they believed that the forces shaping historical trends are considered insufficient.

2.1.9 Birth control and family planning programmes

In the early 1950s, a longitudinal study shows that Punjab region of India lunched a program with an objective to provide contraception to people, monitor its approval and measure its outcome on birth rates. After eight years of concluding of program, the result was below par. The effect of contraception on birth rate was negligible despite a certain level of acceptance. However, upon returning to the same village in 1969, the research findings show a falling birth rate in the years without any major changes on the rate of contraceptive uses (Wyon & Gordon, 1971).

In fact, the findings of Knowledge Attitude and Practices (KAP) surveys reflected the decrease on knowledge of use of contraceptive methods and desired number of children below the actual number. However, as already seen with the text by Coale presented earlier, the most vigorous issues of family planning where the biggest international fund providers were quite spectacular at the Bucharest conference 1974 (Burke, 1974).

The several countries in Latin America and the Caribbean have made important progress increasing the use of modern contraceptives, but important inequalities remain. The prevalence and demand for modern contraceptive use in Latin America and the Caribbean with data from national health surveys. The rise in contraceptive use has largely been driven by short-acting methods of contraception, despite the high effectiveness of long-acting reversible contraceptives (Pellegrini et al., 2019). The several organizations, non-government organizations attached with this program to promote the birth control devices in the areas where the use of birth control devices are less and females are having larger number of children were estimate (Jain, 1997). Rossi (1975) illustrated the necessity of effective knowledge on family planning methods to restrain the population pressure. Assessment of the birth control program with the use of family planning methods are questionable as the numbers of births that have been avoided (Roy et al., 2015). All family planning relative issues need to fertility estimation used by indirect estimation.

2.1.10 Gender approaches

The gender studies affair on the reproduction have pursued the women's status and agency as the center of debate. Rothschild argues that rise in the levels of education of male and female might have substantive future change. There are different problems for industrialized countries where fertility rate is already low. The role of men and women are not essentially same at the same pace (Pyeritz et al., 1988). Despite their an enormous involvement in the work force, women's employment often considered secondary within the couple and fragmentary at the labor market (Rothschild & Stiglitz, 1978).Bernhardt (1988) indicates that women were regarded as supplimentary worker and but in recent years the perception has shifted in the value towards a new balance which favours the women (Allen et al., 1988).

Table 2. 1: Thematic study of fertility

Perspective of Study	Contributors	Main Themes
The frontiers	Malthus (1817)	Theory of a Malthusianism of poverty exhorted couples to voluntarily limit their family size.
	Marx (1867)	Modes of production and distribution of wealth determine the size of population.
	Quetelet (1848)	Establish a link between social laws to determine the fertility.
Measuring fertility	Lotka (1947)	Natural growth rate and birth and death rates
	Pressat (1973)	Cohort analysis and period fertility rates
	Bongaarts &Feeney (1998)	The idea of producing tempo-adjusted "cross-sectional" indicators at indices
	Rallu & Toulemon (1994)	Enhanced understanding of fertility trends
Structured analytical frameworks		
Determinants into account	Blake (1956)	Intermediate variable determines the size
	Bongaarts & Henry (1957)	Analysis of proximate determinants determine the size
	Leridon (1989)	Natural factors rather than biological to children
Modelling	Coale (1966)	Rational calculation to indirect estimation of fertility projection & estimation
	Bongaarts (1978)	Synthesize the variables into a limited number of indicators
	Hobcraft & Little (1984)	Series of periods at different degrees of fertility
	Henry (1957)	Developed the concept of natural fertility
	Potter & Sakoda (1967)	The mathematical formulation of the reproductive process
	Sheps & Menken (1973)	

	Adolfsson (1964) Jacquard (1967) Leridon (1977) Ridley (1966)	Construction of micro-simulation models
	Thematic approaches	
The contribution of history	Laslett & Wall (1972)	Applied the methods of historical demography
	Hajnal's (1953)	Pre-transitional influenced completed fertility
	Aries (1980)	Reproduction, the family turned becoming centered upon the child and its future
Anthropologist's contribution	Caldwell (1982)	Economic arguments central focus of theorization reproduction organized by monetary returns
The institutional and political environment	McNicoll (1982)	Interaction between the state and local structures
	Casterline (1989)	Security of citizens at home and along its borders, thereby divesting families, clans and kin groups of this role and weakening their traditional legitimacy
Microeconomic approaches	Leibenstein (1957)	Child demand analyses using the macroeconomic theory
	Becker (1960)	Fertility does not generally increase income
	Blake (1968)	Classifying children by durable goods
	Leibenstein (1977) Cain (1983-1984)	Offspring as positive insurance policies, protecting mother as early widowhood providing care in old age.
Sociocultural approaches and values	Freedman (1963)	Focused on a small number of cases or on qualitative aspects
	Durkheim (1952)	Believed, generating an ideal and sacred perception which religion to size the determination of family
	Lutz (1987)	Reasoning, considering that religion not only influences individual behaviors directly structural factors
	Hoffman (1973)	Influencing variables (socioeconomic status, cultural influences, gender roles)
Birth control and family planning programs	Gordon (1971)	Fertility change necessarily correlated with contraceptive practice
	Bucharest Conference (1974)	Knowledge, attitudes and practices (KAP) use contraception to limit their family size
	Rockefeller (1978)	An ongoing social development, an interest among the couples to limit the family size
	Liefbroer (2009)	Fertility prediction in terms of marital status, terms of union, education level, income and religion.
Gender approaches	Mason (1987)	Reproduction is a woman's affair
	UN (1974,1984,1994)	WID, WAD, GAD feminist theory determines the family size
	Rothschild (1978)	Determinants influenced by women's social position
	Bernhardt (1988)	Women are supplementary workers and social welfare

Sources: Complied from cited sources.

Theoretical review of fertility discusses on the scenario of historical fertility status, historical methods and trends in measuring fertility, theoretical analytical frameworks, the predictors of fertility situation and different theoretical thematic approaches used across the globe.

2. 2 Global and regional scenarios of the fertility

International Conferences' of Population and Development (ICPD) 1994, in its chapter eleven reveals that the education is the most important variable in sustainable development. Education helps to reduce fertility, morbidity and mortality. The study of 60 developing countries found women working outside tend to have fewer children than those working in the fields and plantation. The world fertility survey showed women who worked in modern sector such as teacher, nurses, administrative workers, marry 2.4 years later than women who worked in domestic and agricultural sector. Employment in modern sector tends to have lower fertility rate (Jensen, 1990).

2.2.1 Global scenario of the fertility

The DHS survey also using the analysis TFR/CPR relationship and analyze using regressions method in 40 developing countries (Starbird et al., 2016). In the study of family planning also needs of fertility estimation has covers indirect estimation of fertility in different caste/ethnic at national, provincial and local levels. Can the high rate and associated burden of unintended pregnancy (Roy et al., 2015) and adolescent pregnancy in Latin America and Caribbean be reduced through wider access to and use of long-acting reversible contraceptive method (LARC)? Bahamondes discussed about improved access to and use of LARC methods as an effective tool for reducing the high rates of unsafe abortion and abortion-related complications, and maternal deaths as well as reducing their social and financial burden using least square method (Bahamondes et al., 2018).

In global aspect, fertility rates of women remain high in some part of the world though having fewer babies. The global fertility rate got declined from 3.2 to 2.5 since 1990 to 2019. The sub-Saharan Africa had the highest fertility levels, that was decreased from 6.3 to 4.6 birth per woman from 1990 to 2019. Over the same period, the fertility rate got declined from 4.4 to 2.9 in Northern Africa and West Asia. Similarly, it was declined from 4.3 to 2.4 in Central and South Asia, from 2.5 to 1.8 in Eastern and South-Eastern Asia, from 3.3 to 2.0 in Latin America and Caribbean, and from 4.5 to 3.4 in Oceania. The fertility rate was already below 2.0 in Europe, Northern America, Australia and New Zealand (Shapiro & Hinde, 2020).

Compared to other regions, the declining of fertility rate in sub-Saharan Africa was slow and occurred lately. During 1950s, the fertility rate was above 6.0 in many regions such as it was 6.1 in Eastern and South-Eastern Asia, 6.6 in Northern Africa and Western Asia, 6.2 in Oceania, and 6.5 in sub-Saharan Africa.

The TFR rate was decreased from 6.0 to 4.0 live birth per women over twenty-four years in the Eastern and South-Eastern Asia (from 1950 to 1974) while the same declining rate was observed only in 19 years in Northern Africa and Western Asia from 1974 to 1993 while that was 35 years in Oceania from 1968 to 2003. However, it is expected 34 years (from 1995 to 2029) in sub-Saharan Africa, to decline the fertility rate from 6.0 to 4.0 live birth per women. (Frejka, 2017).

Many countries have observed huge declines in the TFR in recent years, yet in comparison to other regions Sub-Saharan Africa the fertility was higher in 2019. Between 2010 and 2019, the largest reductions in the TFR were seven sub-Saharan countries out of ten which are Chad, Ethiopia, Kenya, Malawi, Sierra Leone, Somalia and Uganda (Barber et al., 2020).

Global TFR range was wide across the five scenarios, from 1·5 in the SDG pace scenario to 2·6 in the slower pace scenario. The slower scenario of TFR was due to the progressive shift of global birth cohort but not due to increase of TFR in certain locations. In the slower scenario, the global forecast for this century wouldn't drop to below the replacement fertility levels.

It is forecasted that the global to be dropped below the replacement level before 2034 or if faster in 2029 or even fastest in 2026 in the reference scenario, and SDGs scenarios in 2025. The effect of modern education and improved reproductive health services might have difference in TFR globally. Sub-Saharan Africa was projected to have the high fertility rate with above replacement level until 2063, TFRs of countries which is shown in Table 2.2.

The Table 2.2 shows that highest fertility rate (TFR) 4.6 in Sub Sharan Africa and lowest fertility rate 1.7 which reached the replacement level in Southeast Asia and Oceania which is below the replacement level. North America and Middles East (2.7), Central Asia (2.5) and South Asia (2.3) has above the replacement level of the fertility. Southeast Asia and Oceania (1.7) and Europe (1.8) has achieved the below replacement level, TFR reached 2.1.

Table 2. 2: Distribution of global fertility (TFR)

Region	Total Fertility Rate
Europe	1.8
Central Asia	2.5
Latin America and Caribbean countries	2.2
North America and Middles East	2.7
South Asia	2.3
Southeast Asia and Oceania	1.7
Sub Sharan Africa	4.6
Global	**2.4**

Sources: Vollset et al., 2020.

The fertility level is estimated to decline globally and it is expected that the fertility rate reaches to 2.2 live birth per woman by 2050 and 1.9 by 2100. The level of fertility in sub-Saharan Africa is estimated to decline to 3.1 live birth per women by 2050 and to 2.1 by 2100 (Barber et al., 2020).

2.2.2 Regional scenario of the fertility

After 1980s, the regions having sustained higher fertility levels showed some signals of fertility decline caused by contraceptives prevalence surveys (Muhwava & Timaeus, 1996) and demographic health survey (DHS) were endorsed in developing countries. Even so, this happens due to data quality problems such as sampling coverage and contents errors (Srinivas & Muthiah, 1987).

In 2020, Pakistan had the highest fertility rate among the countries of South Asia, with a fertility rate of just under 3.4 children per woman. Comparatively, the fertility rate in the Maldives was approximately 1.9 births per woman in 2020 (Godha et al., 2020).

The demographic landscape of the south Asian association for regional cooperation (SAARC) region has seen unprecedented changes over the last 100 years. The population growth rate accelerated and India (which accounts for three-fourths of the region population) doubled its population between 1961 and 1991 and crossed one billion marks in 2001. India, Pakistan and Bangladesh are respectively the second, seventh and ninth most populous countries of the world. In the later period, only Sri Lanka has experienced a much slower population momentum whereas the population of India, Pakistan and Bangladesh continued has been boom. According to 2017 Global health matrices analyze the fertility levels SAARC countries in Table 2.3.

Table 2. 3: Distribution of fertility in SAARC countries

Country	Total Fertility Rate
Afghanistan	6.0
Bangladesh	2.0
India	2.1
Bhutan	2.0
Pakistan	3.4
Nepal	2.2
Maldives	1.9
Sri Lanka	1.8

Sources: Vollset et al., 2020.

Table 2.3 shows highest fertility rate (TFR) 6.0 in Afghanistan and lowest fertility rate (TFR) 1.8 which below the replacement level in Sri Lanka Global health Matrices data and TFR 2.2 in Nepal which is medium change of fertility in SAARC countries. Sri Lanka, Maldives, Bhutan and Bangladesh have lowered the replacement level, TFR reached 2.1. Afghanistan, Pakistan, Nepal and India above the replacement level being considered as a demographic success story in the region.

2.2.3 Empirical studies of fertility in Nepal

Nepal Fertility Survey (1976) data has shown that the number of children ever born (CEB) among literate women was 2.3 compared to illiterate women 3.3. Women with literate husband have fewer mean numbers of children ever born 3.0 than those with illiterate husband 3.5. With regard to level of education, women with no education have mean CEB of 3.3 compared to 2.2 among those with some education and women whose husband have some education (Joshi & David, 1983).

The negative relationship between women’s education and fertility has also been established from the Nepal family health survey (NFHS) 1991. Total marital fertility rate among women with secondary level of education is lower (4.0) than among women with no education (6.2) that study significant difference in fertility of women with some education and non-education (Storey et al., 1999).

The women in relatively younger age have similar fertility performance and when the age increases and difference in fertility by educational status becomes move evident (KC et al., 1997). Though Nepal began to set fertility reduction target as early as in 1965, it never met the target. During the period of fourth planning (1970–75), nearly 132000 spouses were provided with family planning services (Joshi & David, 1983). The demographic information shows that the TFR of Nepal was above 5 until early 1990s (Pradhan, 1997).

During the third plan, the target to reduce the crude birth rate was from 39.1 to 38.1 during 1967 to 1971. However, no target was set for the fourth plan (1970 to 75). During the fifth plan (1975-80), the newly estimated crude birth rate was decreased from 40 to 39 by 1980 (Joshi and David, 1983). The official estimates for 1980, crude birth rate was 42 and it was projected to reduce to 40 by the end of the sixth plan (1980- 85). However, the fertility and family planning survey (1986) revealed that CBR of 39 for 1968 (Ministry of Health, 1993). The seventh plan (1985-90) had set a plan to achieve the TFR of 4 per woman during the period. However, the demographic information showed that TFR was observed at above 5, though it was not more than 6.0 until the early 1990s (Ministry of Health, 1993).

The eight plans (1991/92-1996/97) had set a goal to reduce TFR from estimated 5.8 per women to 4.5 during this period. The ninth plan (1996/97-2001/02) and the family health plan set a goal to reduce the fertility level. The NDHS 2001 revealed the level of fertility was achieved more than expected with the TFR 4.1 for the three-year plan of 1998-2000 (Ministry of Health, 2001).

In the census of 2001, the TFR was slightly less than 4 per woman in Nepal as per the various methods of estimation. With the mean value of 3.75, the lowest level of TFR, 3.7 was recorded by the Rele’s method and the highest level of TFR, 3.8 by Gunsekaran and Palmore’s regression method. The mean TFR value was 3.75 for 2001 by using P/F ratio method (central Bureau of Statistics, 2003). National census could not use direct method, but it uses indirect estimation. The many research and surveys could not give information in different caste/ethnic and local bodies (Central Bureau of Statistics, 2014). So, need of fertility estimation in different area and level.

The current fertility in Nepal at the national level and by urban-rural is residence. The TFR for three years preceding the 2011 NDHS is 2.6 births per woman. Fertility is considerably higher in rural areas (2.8 births per woman) than in urban areas (1.6 births per woman), where fertility is below replacement level, and ASFRs pattern show that higher rural fertility is prevalent in all age groups (Ministry of Health and Population, 2011).

The TFR has continued declining and by mid-2001 it was projected to have declined to 3.8 per woman (Karki, 2003). The TFR has declined markedly in Nepal over time. The TFR is lower in the hill zone (2.1 children per woman) than in the terai (2.5

children per woman) and mountain (3.0 children per woman) zones. In Nepal, by province, the TFR ranges from a low of 1.8 children per woman in province 3 to a high of 3.0 children per woman in Province 2 (Madhesh Province), a difference of 1.2 children per woman (Ministry of Health, 2016). The population census of Nepal 2011 shows that fertility rate of Nepal has been declining at faster rate over last decade. The CBR for the year 2011 was projected to be around 22 per thousands (Central Bureau of Statistics, 2014). The TFR of women throughout life time is expected to be around 2.5 children against 3.3 in 2001(Central Bureau of Statistics, 2003). The series of Nepalese census use indirect techniques as mentioned in Table 2.4.

The fertility rate was even lower in Urban areas which was 1.5 which is below the replacement level and it was 3.4 children in rural areas. Hence in urban areas number of children get born will not be sufficient to replace the parents. Fertility level is high 6.3 in 1981. Then gradually decline by 0.5 children per women per decades, and 2001-2006 census fertility drop of one child per women.

Table 2. 4 :   Total fertility rate trends of Nepal

SN	Reference Year	TFR	Methods
1	1961	5.74	Stable population analysis
2	1971	5.83	Brass P/F ratio method
3	1976	6.33	Direct estimate
4	1981	6.39	Brass P/F ratio method
5	1986	5.75	Brass P/F ratio method
6	1991	5.6	Brass P/F ratio method
7	1991	5.16	Arriaga’s modified P/F ratio method
8	1991	5.12	Arriaga’s modified P/F ratio method
9	1993-95	4.64	Direct estimate
10	1996	4.6	Direct estimate
11	2001	4.1	Direct estimate
12	2001	3.8	Arriaga’s modified P/F ratio method
13	2001	3.25	Arriaga’s modified P/F ratio method
14	2006	3.1	Direct estimate
15	2011	2.52	Arriaga’s modified P/F ratio method
16	2011	2.6	Direct estimate
17	2016	2.3	Direct estimate

Source: Central Bureau of Statistics, 2011& MoHP (2016).

From 1961 to 1981, population dynamics shows a high share of the population at the bottom of the pyramid and narrowing upward. A low number of populations was observed in 1991, 2001 1nd 2011 at the bottom of the population pyramid that may be due to significant fall in the fertility rate since 1991.

In Nepal, the population policies targets fertility trends, Nepal, 1956 to 2020 were discussed National Planning Commissions report as five years plan perspective (Appendix VII). The TFR thus obtained was 2.7 per woman of reproductive age group in 2011 compared to TFR of 2.6 reported by NDHS in 2011. The number of live births estimated using this TFR for 2011 was 628,934 (United Nations Population Fund, 2017). The DHS has provided a platform for use of direct methods of fertility estimation as increased availability of reliable survey data in the developing countries as well as in the sub-Saharan African countries (Hauer & Schmertmann, 2020).

2.2.4 Fertility analysis direct and indirect measures

Population statistics is the oldest of all statistics collected by nation, even in ancient days, when population organization was not developed and human race was comparatively less civilized, the leader of the tribble or the group always estimated his man-power. Kings collected population of their subject as head counts, and their property with a view to safeguard their territory from foreign attacks and to assess the income of the individual taxation. But nowadays, each and every policy is necessary for data of population statistics. In mathematical Demography to collect the data and estimation of fertility, mortality migration was related other phenomena. Problems with developing countries are that, though they have plenty of population data, the data couldn't be used directly of estimate population parameter because they are either highly under numerated or wrongly reported as well as their coverages are limited (Singh & Saymi,1990).

Adequately funded evaluation activities are essential for the improving and maintaining systems and that have deficiencies function satisfactorily. The quality assurance in vital registration system encompasses operations of each stage, registered without duplication, information is recorded, compiled, validated and processed, and released timely. The quality assessment is specific studies for specific questions, coverage of registration of vital events, accuracy of variables, functioning of sub-systems and can be regular exercises. The quality assessment of two types are direct and indirect methods. The direct methods are matching of records match registration records with records from an independent source birth registration with death registration, administrative records, lists from population censuses and surveys in a dual records system. The set-up survey specifically to collect information on vital events (Shryock & Segel, 1976).

The advantage of direct techniques is more accurate assessment of registration completeness, may indicate sources of under or over registration, can be applied at any geographical level. Then limitations and accuracy are affected by the choice of the second source of records, true independency of the second source is unlikely matching criteria, difficult to find if there is like identity number, if manual: time consuming, automated: computer algorithms can get too complex and cost management. Census can be regarded as the second criteria of the traditional demographic estimation input. It is far from producing perfect data where errors are the failure to enumerate all the numbers of relevant and poor age-reporting on the part of the population canvassed and its effect cannot always be separated from those of age misstatement (Moultrie et al., 2013).

The indirect methods as demographic analysis is comparison of trends, delayed registration, comparison with census data, if two censuses: balancing equation, Lexis diagram, if only one census: compare aggregated numbers, methods for incomplete data and questions on birth registration in surveys. The advantages of indirect techniques are prompt assessment of vital statistics completeness and several can be applied at various geographical levels. Then limitations of indirect techniques are having assumptions that may not hold, require reliable data from two censuses, affected by the degree of census completeness (United Nations, 1983). In case of the huge degree of data errors, the techniques themselves could be the source of errors (Fenney, 1996). If vital statistics is compiled fully from civil registration, both direct and indirect measure the quality of civil registration and vital statistics. When the two systems do not correspond completely, measures of quality of one system cannot be used to represent another statistical modelling.

Mostly in south Asia fertility estimates are made indirectly. In India, the TFR estimation of fertility estimation, child women ratio treated with moments of age distribution of women in reproductive age with applying own children method. Bangladesh has used in Brass method of P/F ratio. Mostly South Asian countries use indirect methods such as the Arriaga method, changing P/F ratio and logistic model which are commanding tools for estimating fertility levels so they do not provide an ideal to problems of data shortage for fertility estimation. Beyond South Asia, USA used Arriaga method for fertility estimation. Schmertmann and collaborators have used a smart method in 2013 called as Bayes plus Brass method to estimate total fertility model in local levels. They applied a variant of Brass's P/F method which is strong under the conditions of rapid fertility decline.

Estimates are frequently made to provide the basis for constructing projections and forecasts. In non-census years, estimations of populations of sub domains areas are commonly based on estimates of occupied housing. First, a projection of an undesirable future underlying conditions, a range of projections revealing a significant variance in future population levels at reduce uncertainty and consideration of different futures. The community, region, and nation used to predict and plan for population growth and change is through active projections and planning deciding what would be desirable and then designing policies and programs to achieve that future.

2.3. Why small area estimation techniques?

Census count all units of its target population but might not have sufficient details about the characteristic of interest. Small area estimation is a method to provide reliable estimation in which, a survey borrows data from the wide coverage of a census producing estimates that remains dependable even when disaggregated at levels or small areas. Though small area usually denotes to a geographical area like a country, municipality or ward, it also related to a small realm such as an age and sex certain group of people living in a huge geographical coverage (Gosh & Rao, 1994). Normally, the sample size of the survey area is bigger than that of a small area. The detailed local information on the population of subnational areas (e.g. wards, districts) informs: how resources are allocated between areas; the nature of local service provision identification of areas for specific area -based policy interventions, the success of policies over time, local population information is important. In fact, national level organizations conduct survey to take detail information on household income, expenditures, working conditions as well as health indicators. Basically, surveys do not collect information from each unit of its target population, and hence survey estimates lead to a marginal error (Pfefferman, 2002). In contrary, most of the census collect information all units of its target population however face a deficit of sufficient detail regarding the characteristics of interest. Surveys burrow strength from the varied (Datta & Lahiri, 2000) levels or "small areas" even not designed to give dependable (Tang et al, 2018) in SAE. The region defined as the survey's domain in which sample size is calculated for each targeted population (Stukel &Rao, 1999). A province can be taken as a small area if a region consists of multiple provinces to produce reliable estimates at the provincial level. Likewise, if disaggregated estimates for a certain minor group within a region is wanted. Several methods rely on a multitude data sources and the choice commonly depends upon estimated parameters and source of available data as well as data requirements of various SAE techniques (Datta et al., 1999).

Direct estimation of small area is carried out under sampling or designed-based methods and model-based approaches with involving statistical models have been presented elsewhere (Rao et al., 2003). Here, it is to be noted that, inferences are involved with statistical models in a model-based approach whereas inferences are fully based on sampling design in designed-based approach. Harvitoz Thompson estimator (Milton, 1986), generalized regression estimator (Sarndal et al., 2003), modified direct estimator (Rao et al., 2003) or survey regression estimator (Battese et al., 1988) are common direct estimator. Rao (2003) has described that a model based direct estimation methods might have poor performance due to misspecification of a model in case of increased sample size. Poor performance is the cause of asymptotic design and irregularity of the model-based estimator for a stratified random sampling (Sinha & Rao, 2009).

The national statistical system might have limited resources as well as the cost constraints so that the data collection duration become longer. However, it cannot undervalue the rich and granular data. The accessibility of granulated or disaggregated data will be effective in decision-making process (Potter et al., 2010).

Most probably, the increased interest originates to decentralize the targeted policies and demographic parameters (Moultrie et al., 2013). In many countries, demands of small areas estimates for reliable demographic information is huge regardless to the adequacy of important. The demand for small area estimates has been increased by the interest of international organizations in developing local indicators (Bray et al., 2012).

Direct SAE estimator led to extremely large standard errors because of excessively small samples (Assuncao et al., 2005). In general, sample units may not be selected from small areas. This condition requires to pursue indirect or model-based that requires large sample size which effectively reduces the standard error for sufficient statistical precision (Tanton et al., 2007). There are plenty of attentions in creating indirect estimators for small area in Australia because of lacking of adequate sample for small geographical area (Tanton et al., 2014).

Smaller area fertility estimations are vital assets in analyzing demographic change, especially for local planning, population projection of those countries which are lacking complete vital registration or census data (Schmertmann et al., 2013). These types of estimations need new methods for old problems; procedure should be automated in situations of the requirements of large-scale estimates. Extreme sampling variability might be delt in many areas and also required to incorporate corrections for possible data errors (Hauer & Schmertmann, 2020). Demands for reliable demographic estimates in many countries is growing rapidly irrespective of adequacy of vital registration for small areas (Schmertmann & Rau, 2018).

2.3.1 Review of small area estimation techniques

Housing unit, component, or regression methods of holistic population are the usual requirements for small area estimates (Murdock et al., 1991). Housing unit is the widely used population estimate method by the calculation of occupied housing units and its attributes. The component methods evaluate the population estimates from birth, death and migration data. The population estimates can also be derived using regression methods from asymptotic indicators of population change like births, enrollment in the school, utility customers (water, electricity), voters list, drivers' licenses, tax payers, etc. (Smith, 2013).

Among the three-methods housing unit method is widely used because of the availability of vital information however all three types of methods are useful to produce estimation. Demographic estimation of age, sex and race are studied in aging population based on the cohort-component method (Siegel, 2011).

For each age, sex and race subgroup in population, birth, death and migration rates are applied for SAE. Estimation of socioeconomic characteristics such as employment, income and education are usually relied on SAE whereby known proportion of population demonstrating a characteristic in a larger area (e.g., a state) are applied to population estimates for smaller areas (World Health Organization, 2008). Estimation of demographic and socioeconomic characteristic also be made from administrative records (Fonseca & Tayman, 1989).

The extrapolation approaches cover the observed historical trends. These types of approaches may be simple such as past growth rates projected to remain constant or complex (Smith et al., 2001). Smith et al. exhibited that the trend extrapolation methods are often used for small area estimation because of their minimal data requirement and also easy to apply. Forecast of such methods have often proven to be practically accurate.

Three components of population change i.e., birth, death and migration are accounted by the cohort-component method (Pressat, 1973). According to this method, population is divided into age-sex subgroups and even distinguished by race, ethnicity or other demographic characteristics. The prediction of each component is based on the extrapolation of past trends, projected trends in other areas, structural models or professional judgement (Siegel, 2011). The cohort component method is most widely used projection method as it includes a broad range of data sources, assumptions and application techniques which can provide projections of demographic characteristics along with total population (Assuncao et al., 2005).

The simplified method can also be applied in SAE and the structural models are based on utterly different logic (Hamilton & Perry, 1962). The population projections to variables are noted to drive population change. Some variables are very simple having only a single equation while some variables are very complex having lot of equations, variables and parameters. The structural models are often used in combination with cohort-component method which typically differentiate among individual component (Bahamondeset et al., 2018). The plenty of effort on modeling skill and structural models provide a wider range of predictions in comparison to other methods and small area estimation is well established in the population sciences (Ndagurwa & Odimegwu, 2019).

Synthetic, empirical linear unbiased prediction, hierarchical Bayes, sample size dependent and empirical Bayes estimation are the major statistical parameter for SAE. It was found that the methods that presented greater benefit over the others for analysing small samples (Ghosh & Rao, 1994).

In some countries, hierarchical Bayes modelling was used specially for fertility research to understand spatial variability and diffusion of low fertility rates (Assunção et al., 2015). Bays modelling is a multilevel modelling of structured data which was developed in different fields to know the population outcomes based on the smallest possible domain. (Ndagurwa & Odimegwu, 2019). In others study, have conducted small area estimation of demographic events using child women ratio (CWR) which are considered as spatial extensions to the conditional Kernel regression (Kamata & Iwasawa, 2009). This study shows estimation of fertility and other outcomes by establishing the importance of small areas that includes small samples.

The Bayesian models were good estimates of complete mortality schedules for small areas even when the expected number of deaths is very small. The models also provide estimates of uncertainty. The relational model is the primary building block of regression model. Fertility estimation models produce estimates for single year ages from a small number of local parameters. The experiment with Bayesian models for smoothing and 'borrowing' mortality information across sexes and across spatial units. Preliminary research on data has using German counties suggest that approach produces reasonable age-specific mortality schedules for small areas with sparse data. It therefore provides a solid foundation as a first step in the development of the Bayesian spatial models for even smaller areas (Schmertmann & Rau, 2018). This study also focuses scenario of fertility in different sectors of the country.

2.4 Summary of literature review

The existing literature suggests a need of indirect estimation and small area estimation to estimate and project the fertility. Demographers will have two strategies to improve analysis of vital events when vital information is lacking and the degree of perfection is unbearable as a basis for analysis and interpretation; i.e. either to go out to the field and collect new data or to use different types of statistical techniques from the given data.

Main sources of demographic sources of data like decennial census has coverage and content errors, VRS has incompleteness and DHS has small sample size is questionable, that is why need for indirect estimation. Most of developing countries have data collection procedure might be error, and cannot give reliable information. Nepal has not directed estimate reliable demographic data different time gives different data were indirectly estimated demographic data in national level. Consequently, the estimation of vital rates using national registers is problematic in Nepal.

In the majority of developing nations, vital registration systems are not good in coverage and quality with a help of various techniques of indirect estimation. Fertility is the one of the major events of demographic data. Robust fertility estimate methods were discussed indirect estimation like Arriaga's techniques and changing P/F ratio and project the binary logistic curve function method. Direct estimation depends upon the estimates which are completely based on domain specific data. An appropriate sample that could be enough for typical observations available to all small areas for consistent direct estimation. A vital problem with national or state level surveys is that these are designed for effective estimation of small areas. This study discussed that why need small area estimation and its application discussed in literatures.

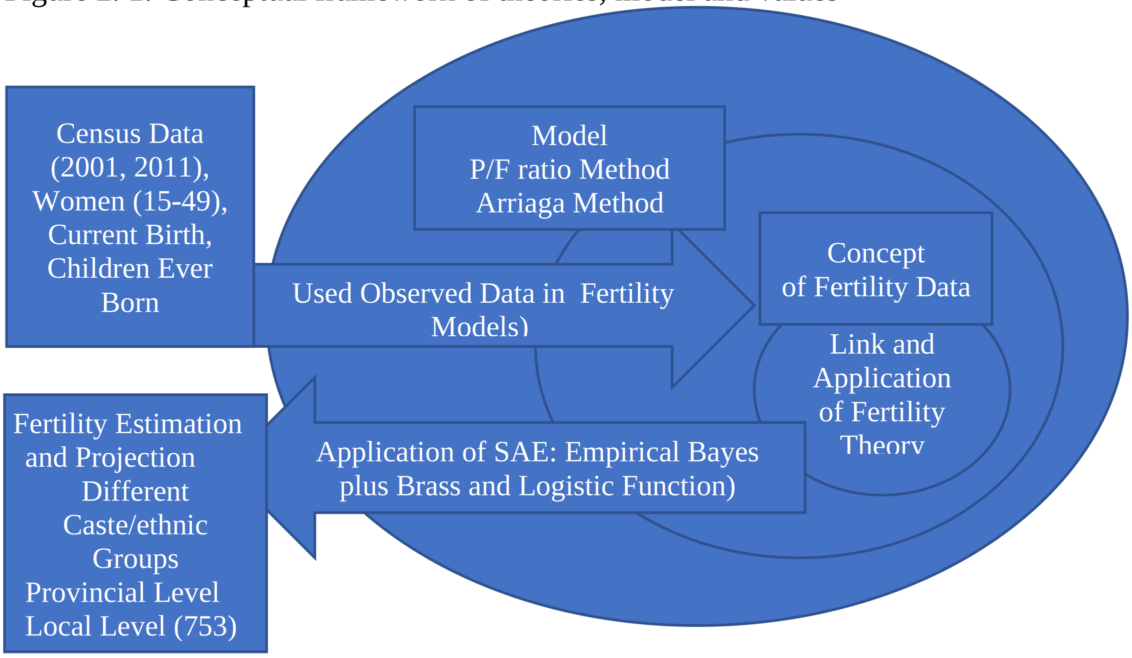
For this, as Nepal is different from other countries in terms of its socioeconomic, and infrastructural development, effective intervention would also be essential. In this context, there must be a study that may observe in the wider area of socioeconomic, demographic and fertility preference in the use of indirect methods. Another important fact is that the emphasis on need for indirect estimation; however, the pattern of fertility parameter as mentioned in Chapter-I. Research highlighting the situation of estimation in the context of Nepal is unavailable. Therefore, there must be a study that also analyzes the estimation and projection of fertility in national level in different major caste/ethnic and provincial level in Nepal. The present study is application and explanation of local level fertility estimation and projection.

2.5 Conceptual framework

Major characteristics of population dynamics such as structure, size and changes are discussed in Malthusian theory and his views were the basis for discussion of population and resources for more than 150 years until challenged by Ester Boserup in 1965. Boserup (1976) criticized the Malthusian theory on the grounds that it exclusively focuses on food production technology and ignores the effects of technological changes in other sectors and the effects of environmental changes (Boserup, 1976). There is reciprocal relation between population change and influence of fertility change. Accordingly, fertility determines the rate of population change and population change, in turn influences in the fertility. The Malthusian hypothesis was also illustrated in the first overall model of the world system. None of the theoretical approaches provide a complete picture; such as newly emerging issues childbearing at advanced age and new fertilization technologies (Schmertmann et al., 2010).

To some extent, the differences among various theories are not complementary; however, reflect different interests and assumptions, and differences that might be irreducible unless human sciences in general succeed in developing Meta theory. Given the state of fertility theory, how is it likely to evolve in the near future? This will depend on a number of forecasting, policy development, and contributions to intervention programs (Ryder, 1956). Both the demographic transition theory and Malthusian provide a fertility trends and patterns. Although, most theoretical approaches to fertility lack a dynamic perspective, the institutional analysis, relying on its historic and path dependent interpretation might improve this situation with respect to the social context of fertility. Among various mathematical methods for prediction of fertility Arriaga method, changing P/F ratio methods and SAE are widely used.

Figure 2. 1: Conceptual framework of theories, model and values



SAE follows the Schmertmann models (Schmertmann et al., 2013) in which new data and empirical analyses of both historical and contemporary fertility declines are described; however, it has damaged the standard theory of the demographic transition. But none of the excess of new theories of fertility change has emerged as alternative guides to empirical research. The empirical evidence on the origins, speed and correlates of fertility declines in different historical and geographical settings that shows more diversity than a simple theory of fertility change prediction. The challenge for the field develops a common theoretical framework that will accommodate the diversity of historical paths from high to low fertility (Schmertmann & Rau, 2018).

In this study, some appropriate techniques were applied to reduce the aforementioned errors. Firstly, knowledge and data were used through the census data and theoretical reviews. Subsequently, deductive approach was applied by selecting appropriate indirect estimation and projection methods, such as Arriaga's method, changing P/F ratio method and small area estimation (SAE) (Figure 2.1).

This study is based on estimate and compares the fertility level and trend in Nepal in census data and used to point estimation with medium variant interpolation of different caste/ethnic groups at national and provincial levels. The purpose of two-part strategy to address these problems; first, use of empirical Bays (Schmertmann & Gonzaga, 2018) estimation of local fertility and parity schedules to borrow the strength from data in neighboring places which smoothed the signal-to-noise ratio in local census determines and then P/F adjustment procedures were applied to Empirical Bays (EB) estimates of TFR and parity for each municipality to develop a final set of estimate which is called empirical Bayes plus Brass (EBB).

Using 2001 and 2011 censuses data for national, provincial and caste/ethnic group wise data were generated from national level, changing Brass and Arriaga methods that were used to verify estimate and project fertility level and trends by using logistic curve function. Similarly, the data were used for the estimation EB and EBB using regression analysis. The output of regression analysis was compared and calibrated using fertility data of Nepal Demographic Health Survey 2016.

CHAPTER 3

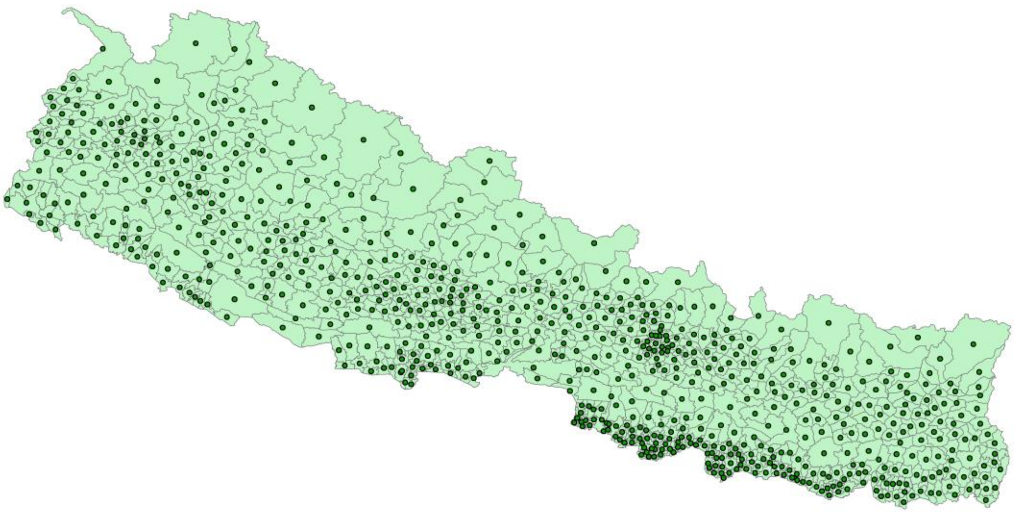
RESEARCH METHODOLOGY

This chapter incorporates methodology (research philosophy and paradigm) and the research design process of this study which is based on the research questions and research objectives. This study is based on quantitative data of two censuses, which were conducted in 2001 and 2011 along with the key information of NDHS, 2016.

3.1 Study area

The constitution of Nepal has defined three tire government systems viz. the federal government, provincial governments and local levels which are governed according to the constitution of 2015. The Article 5 of the Constitution of Nepal defines local government as rural municipalities, municipalities and district assemblies. There are seven provincial levels, 77 districts and 753 local levels (including six metropolises, 11 sub-metropolises, 276 municipalities and 460 rural municipalities) each with their own executive body (Secretariat Constituent Assembly, 2015).

Figure 3. 1: Map of Nepal sharing 753 local levels



Source: Survey Department, 2022

As of 22 June 2011, the total population of Nepal was 26.5 million, where growth was 14 percent from 2001. A decade ago, 2001 census provides information, the population was 23 million. There were 5.4 million households in 2011. The population growth slowed from 2.25 percent in 2001 to 1.35 percent in 2011. This reflects both declining fertility rates and youth migration.The sex ratio is 94 in 2011 which is the lowest in South Asia. The sex ratio of urban areas (104) was higher than that of rural areas (92). The male to female ratio by age group was lowest in the 20-24, 25-29, and 30-34 age groups (Central Bureau of Statistics, 2014).

The caste/ethnic groups of Nepal as per the diffrent dimensions of human development, can be classified into four broad groups: i) Adibasi/ Janjati, ii) Hindu caste/ethnic groups, iii) Musalman and iv) Others. These groups were further classified into i) Janajati consisting of Hill Janajati, Newar and Terai Janajati, ii) Hindu caste/ethnic groups consisting of Brahman/ Chhetree, Madhesi caste/ethnic groups including Yadav, Hill Dalit and Madhesi Dalit and iii) Musalman consisting of Madhesi Musalman and Churaute. These classification of caste/ethnic groups of Nepal were detailed in Appendix VII.

Many scholars of anthropologists, sociologists and demographers and others had begun to classify Nepal's caste/ethinic groups in different clusters. Based on the caste/ethnic origin the classification of 2011 population census, there were 4-Hill groups (3% of population), 50-Hill adibasi/ Janjati groups (28% of population), 5-Hill low caste or Dalit (8% of population), 3-Madhesi caste/ethnic origin groups (socio-economic level 1- 8% of population), 21-Madhesi caste/ethnic origin groups (socio-economic level 2- 15 % of population), 15-Madhesi low caste/ethnic groups (socio-economic level 3- 5% of Population), 13-Madhesi (Teari) Adibasi/ Janjati groups (8 % of population), 1-Musalman or Muslim group (4 % of population), 4-Others cultural groups (0.3 % of population) and 1-Unidentified group (1% of population) (Central Bureau of Statistics, 2014).

3.2 Research philosophy

Thomas Kuhan (19620 used 'paradigm' used to the study of scientific structure. It represents "a particular way of thinking shared by the scientific community to solve problems in the field" and represents "the commitments, beliefs, values, and techniques shared in this discipline (Creswell & Creswell, 2003). Research philosopy is also known as reseach pardigm which comprrises ontology, epistomolgy, axiology and methodology. In addition, paradigm is a way of explaining a worldview based on philosophical assumptions about the nature of social reality, knowledge, and value systems.

A research paradigm therefore guides ask to specific questions and use appropriate systematic methodological approaches (Walliman, 2001). Epistemology inquiries into the nature of knowledge and truth obtained from questions: What are the sources of knowledge? How reliable are these sources? What can one know? How does one know if something is true?

Specific research paradigms are associated with certain methodologies and hence, a positivistic paradigm classically assumes a numerical methodology, while positivistic paradigm utilizes a quantitative approach. This study is the evidence based that explains the components of the research paradigm and assumptions. In this study positivistic research paradigm has been adopted to find out reality through quantitative research which is the ontology of this study. Ontology defines the nature of being existence and hence it tries to answer to the questions that being with 'what' or it asks what exist? It deals with existence of reality.

The ontology (reality) of this study is estimation and projection of fertility at national, provincial and local level of Nepal (2001 to 2031). For the solution of any problems, there should be scientific procedure to conduct the research either empirical or experimental method. Thus, scientific sampling procedures were applied to collect data and statistical tools were employed to interpret the data.

Epistemology is the study of knowledge i.e., what is known? What is not known? What is the context of knowledge that is understood? How can it be applied and collected? It asks how is the perceived knowledge is valid (Walliman, 2001)? Hence, it deals with the knowledge of fertility estimation at national level, provincial level, local level and trends of future time period. For this study, knowledge is acquired from the collected information of 2001 and 2011. The source of knowledge or truth of this study has been estimated by applying Arriaga model, Brass model and small area estimation methods.

The definition of axiology is the branch of philosophy that deals with the nature and types of value such as in ethics and religion. In this study, axiological study has been carried out by the estimation of TFR at national, provincial and local level which are the axiology of this study.

3.3 Research design

This study is based on descriptive and explanatory survey research designs. This research design is important in describing event, phenomenon and situation. It is aimed at finding out "what is?" So, census and survey methods are frequently used to collect descriptive data (Gall & Borg, 1989).

In this study, summary data such as measures of mean, age sex structures, percent, and relation and between variables were analyzed. The explanatory research relationship explained number of women (15-49), CEB and current birth which were specific problem to explain the patterns of relationships between true, observed and estimated fertility. This study used the estimation and projection of fertility from national to local levels.

3.4 Defining indirect technique

Indirect demographic estimation includes a variety of techniques, most of which use only information obtained from a single census/survey (United Nations, 1983). Data from registration systems are too limited and defective for adjustment as well as correction. However, there are might be directly correct errors based on comparisons with the census.

If errors of coverage are small, reporting is adequate and estimation from censuses and large survey will be more accurate (Brass, 1996). So, explanation of these facts does not need any description and different research can get the same findings/results. The study is the application of indirect estimation and statistical tools in fertility dynamics.

As a result, vital rate estimation using national registers in Nepal is problematic and also NDHS has a limited sample size for accuracy. These censuses suffer from coverage and content errors and hence, this study has applied indirect techniques that assume objective reality aiming to test available literature; the epistemological standing is positivist approach.

3. 5 Nature of study and data sources

It is discussed in the introduction, the main objectives of this research are to predict results, test a theory, interests of those being compared fertility levels and trends in application of indirect techniques (changing P/F ratio, Arriaga's method and by logistic model). In this regard, this study has undertaken to predict results, and test existing theory to the estimation and projection using small area estimation. The published data using CBS, Nepal from the two censuses and methodology were adapted the sample design, sampling frame, domains and sample selection in 2001 and 2011 censuses. This study analyzed and interpreted the CEB, current birth according to number of reproductive age group of women from micro data files of census long-form questionnaire. The sampling fraction for the 2001 and 2011 censuses long form was 12.5 percent from unweight data. The data set of NDHS 2016 was used in calibration of TFR and alternative users in regression equation. Most of the municipal sample sizes used in this study are quite modest. Thus, the study uses these weights; however the control is applied for the original sample size.

The use of Whipple's index in all censuses indicates a high level of irregularities. This result shows that quality of age data reporting is very rough. Data of the Whipple's index for the census 2011 of Nepal was189; however, the value of 175 and over-data are considered very rough. Myres' blended index also shows relatively high value in Nepal for the census 2011. The Census UN Age Sex Accuracy Index values decreased from 1971 to 2011. However, age sex distribution from 1971 to 1991 was highly inaccurate and the data for 2001 to 2011 has improved the quality. In the 2011 census, the UN Age Sex Accuracy Index was as high as 23.2, which is inaccurate. These indicators show age sex data which were inaccurate, so use of indirect estimation is necessary to obtain accuracy (Central Bureau of Statistics, 2014).

3.6 Sampling based design

This research design was based on Monte Carlo sampling techniques used in local level estimation where Root mean square error (RMSE) and bias of TFR estimates from regression. The P_2/F_2 corrections from examples were taken at dissimilar steps of a simulated transition. The regression-based P/F correction are compared during a simulated fertility transition, which might not match at assumptions of this model. This study shows a representative transition in which the TFR remained constant at 6.0 for many years, dropped to 2.5 over 40 years, and then remained constant at 2.5, with 100 in each transition year. Smoothed using the sample size.

3. 7 Methods of data analysis

This study has used the quantitative information and estimation was carried out by using quantitative method since the deductive method demands use of quantitative technique as described above. The data of censuses were analysed by using indirect techniques, statistical methods and procedures. The simple statistical parameters like frequencies and percentages are used in this analysis. These parameters have helped to summarize the characteristics of the respondent included. The analysis highlights the present status of the age-sex pyramids, dependency ratio, ageing index, number of women, number of births in past year and CEB of the study population.

3.7.1 Approach of Arriaga

The Arriaga technique assumes that fertility is not constant, it can provide an estimate of fertility as it has been changing. Fertility estimates are obtained from the year of the censuses or surveys. An analysis of the adjustment factors allows for an evaluation of the data used. The fertility rate of Nepal is decreasing since more than thirty years hence the Arriaga method is applicable for the data analysis at national level, provincial and different caste and ethnic groups.

The Arriaga fertility method (1994) is used for the estimation of fertility levels by comparing two or more sets of average CEB. This method was designed to be useful for those cases where the Brass P/F ratio method could not be appropriate due to the changing fertility level. The method was implemented as part of the population analysis system used in demographic software. This analysis has reviewed the Arriaga method from the theoretical perspective and is based on simulations and addresses the performance of the method, as implemented, under different assumptions such as fertility change, the effect of fertility under age 15, the impact of the number of decimal places and sample variation in the average parity data.

The preliminary simple simulation of a rapid linear decline in age specific fertility rates (ASFRs) indicates that the method tends to measure the average ASFRs over the period between the two sets of CEB data. It is based on the mean value theorem, the slope of any continuous function connecting two points will at some point be equal to the slope of the straight line connecting them linearly. Thus, the method might work best near the midpoint between the dates of the two sets of CEB data, rather than near the endpoints. The method is estimating ASFRs based on differences in CEB data, it seems logical that the number of decimal places of the CEB data may affect the results (Arriaga, 1994).

Step 1:Average number of CEB for women at exact single year

The average number of CEB for women at exact single year of age x for two censuses can be obtained from interpolation of average number of CEB for five-year age group of same year.

First Census (2001), $CEB_x^{t1} = F\ {}_5CEB_x^{t1}$

Second Census (2011), $CEB_x^{t2} = F\ {}_5CEB_x^{t2}$

Where t_1 (2001) and t_2 (2011) are times of first and second survey respectively and F is interpolation function ${}_5CEB_x^{t1}$ and ${}_5CEB_x^{t2}$ are average number of children for women of age group x to x + 5 years at the 2001 and 2011 respectively.

Step 2:Exact single year CEB (one year after and before)

It is estimated from the average number of CEB for women of the same exact single year of age at 2001 and 2011 by linear interpolation as

First Census (2001), $CEB_x^{t1+1} = \frac{n - 1}{n}\ CEB_x^{t1} + \frac{1}{n}\ CEB_x^{t2}$

Second Census (2011), $CEB_x^{t2 - 1} = \frac{1}{n}\ CEB_x^{t1} + \frac{n - 1}{n}\ CEB_x^{t2}$

n = time of interval between two survey date, here to mentioned 10 years.

Step 3: Exact single year ASFRs (one year after and before)

It is calculated as the ASFR on the basis of cohort difference in the average number of the CEB according to 2001 and 2011 census.

First Census (2001), $f_x^{t1 + 0.5} = CEB_{x+1}^{t_1 + 1} - CEEB_x^{t1}$

Second Census (2011), $f_x^{t2 - 0.5} = CEB_{x+1}^{t_2} - CEB_x^{t2-1}$

Step 4: Conventional five years ASFRs (one year after and before)

The ASFRs for conventional five-year age group by taking the average of the single year ASFRs belonging to each five-year age group in 2001 and 2011 census.

First Census (2001), $_5f_x^{t1+0.5} = \frac{\sum_{i=x}^{x+4} f_i^{t1+0.5}}{5}$

Second Census (2011), $_5f_x^{t2-0.5} = \frac{\sum_{i=x}^{x+4} f_i^{t2-0.5}}{5}$

Step 5: Adjusted ASFR and TFR

The data on CEB for women are available for more than two survey dates, then the estimates of fertility rates for the intermediate data are obtained by taking the average of fertility rates of the year prior to and the year after the intermediate year. The 's' is an intermediate survey data and the single year ASFRs are calculated as:

$f_x^S = \frac{f_x^{t1+0.5} + f_x^{t2-0.5}}{2}$ and

$$TFR = 5 \times \sum_{i=1}^{7} f_x^S$$

The ASFRs estimated by this procedure are sensitive to underreporting of the number of CEB and/or is reporting of mother's age. The frequently observed tendency of women over age 35 or 40 to underreport birth and to misreport their age could be adjusted the average parity of women in each 5-year age group. However, it has been recognized that the average number of children born up to age 30 or 35 years reported in censuses and surveys could be considered as reliable information.

3.7.2 The changing Brass P/F ratio

The indirect method of demographic assement aviable to date are frequently insufficient to predict levels. However, the use of hypothetical cohort-based measurements is used to reduce the impacts of trends and estimate period levels in different caste/ethnic groups. If fertility rate changes, lifetime fertility and cumulative period fertility rates will not be same and hence an adjustment factor should be used to deterrmine it on the basis of comparison, that will refelect not only probable data mistake but also the impacts of changes over time. Instead of lacking age specific rates of end points for the given period, a set of rates corresponding to the period's mid-point could be utilized and in case of hypothetical inter- survey cohort method two dates of number of CEB and number of births before 12 months according to reproductive age groups of women can also be taken (United Nations, 1983).

Step 1: Reported average parities P (i, j)

The average parities obtained from census 2001 and 2011are denoted P (i, 1) and P (i, 2). The number of CEB divided in reproductive age group of women in same age group (i).

First Census (2001), $P(i, 1) = \frac{CEB(i, 1)}{W(i,1)}$

Second Census (2001), $P(i, 2) = \frac{CEB(i, 2)}{W(i,2)}$

CEB (i, 1) and CEB (i,2) = Number of CEB for reproductive age of women age group (i). And, W (i, 1) and W (i, 2) = Number of reproductive age group of women for age group (i).

i = Age group of women 15 to 49 years which is denoted 1…..7.

Step 2: Changing reported average parities P (i, s)

The average parities are depending upon the length of inter-survey interval, the parity increment between survey for corresponding cohort is equal to P (i + 1, 2) - P (i, 1) 2001 and 2011 census.

$\Delta P(i + 1) = P(i + 1, 2) - P(i, 1)$ for i = 1, ... 6

$$P(i, S) = \sum_{j=1}^{i} . \Delta P(j)$$

The parity increment ΔP (i + 1) for the youngest age group (i = 0) is taken as being directly equal to P (1, 2). If fertility is changing rapidly, this value of ΔP (1) will reflect period rates somewhat closer to census 2011.

Step 3: Age - specific fertility f(i)

The ASFRs are calculated number of births divided by number of women age group (i) preceding the census to women of age group (i) by same age group in each census.

ASFR Census (2001), $f(i, 1) = \frac{B(i, 1)}{W(i, 1)}$

ASFR Census (2011), $f(i, 2) = \frac{B(i, 2)}{W(i, 2)}$

Combine ASFRS, $f(i) = \frac{f(i, 1) + f(i,2)}{2}$

Where, f (i, 1) = ASFRS for census 2001

f (i, 2) = ASFRS for census 2011

Step 4: Cumulative age - specific fertility Φ (i)

The calculation of cumulated fertility is denoted by Δ (i) which is interpolation of period ASFR for 2001 and 2011 censuses.

$$\Phi(i) = 5 \sum_{j=f}^{i} . f(j)$$

f(j) = inter-survey ASFR from younger age group up to the upper limit of the age group considered.

Δ (i) = Cumulated ASFRs for a hypothetical inter-survey cohort.

Step 5: Estimated average parity equivalent F (i)

The average parity equivalent for hypothetical inter-survey cohort F(i), which is interpolation of cumulative ASFR for 2001 and 2011 censuses. The average parity equivalent for hypothetical inter-survey cohort of age group (i) is estimated interpolation of cumulative ASFR for 2001 and 2011 censuses.

$F(i) = \Phi(i - 1) + a(i)\, f(i) + b(i)\, f(i + 1) + c(i)\, \Phi(7)$

Coefficients: a (i), b (i), & c (i)

Step 6: Conventional age-specific fertility rates f + (i)

It is calculated by following relationship for 2001 and 2011 census.

$f^{+}(i) = [1 - w(i - 1)]\, f(i) + w(i)\, f(i + 1)$

$$w(i) = x(i) + y(i)\frac{f(i)}{\Phi(7)} + z(i) + \frac{f(i+1)}{\Phi(i)}$$

Weighting factors: x (i), y (i) and z(i)

Step 7: Adjusted (P/F ratio), k

The adjustment factors are the ratio of reported average parities to the estimated parities equivalent on the basis of 2001 and 2011 census data:

$$k = \frac{P(i, s)}{F(i)}$$

Step 8: Adjusted ASFER f*(i), TFR

The adjusted ASFRs and TFR calculated on the basis of adjusted factor 'k'.

$$f^*(i) = k \times f^+(i)$$

$$TFR = 5 \times \sum_{i=1}^{7} .f^*(i)$$

Demographic Health Survey, 2016 shows value of TFR to be 2.3 showing the range of medium variant (2.1-2.6 used as medium variant) (World Health Organization, 2019), and hence the use of medium variant was considered in this study and completed cohort fertility for cohorts aged 20-24, 25-29, 30-34, ...at time t estimates the period TFR at times t + 7.5, t + 2.5, t - 2.5 years and respectively t denoting the time of the census. The appropriate consequence for taking mean age at childbearing to be 30 years. Thus, current fertility is estimated as the average of completed fertility for the age group 25-29 and 30-34 and estimation of all age groups are plotted against the corresponding time points to an estimated trend of fertility.

3.7.3 Projection by using Logistic function

The "S-shaped" behavior of growth of some population can be observed on the generalized logistic curve. The early stages of growth are nearly exponential, with growth slowing as saturation sets in and stopping at maturity. Fertility rate is proportional to both existing population and number of available resources, all else being equal (Pearl & Reed, 1920). This equation was published on AN ESSAY ON THE PRINCIPLE OF POPULATION after Verhulst had read Thomas Malthus. Then, derived his logistic equation is describing the self-limiting growth of demographic processes such as nuptiality, fertility, and mortality and migration population. These models have been used in studies of all these issues and diffusion processes are often modeled by logistic curve function. The logistic function is:

$$f(x) = \frac{1}{1+e^{-x}}$$

Where e is Euler's number and x-values in the real range from -∞ to +∞ are S-curves. Due to the nature of the exponential function e−x, it is often sufficient to compute x over a small range of real numbers, such as [−6, +6]. Biology, Biomathematics, Demography, Economics, Chemistry, Mathematical Psychology, Probability Theory, Sociology, Political Science and Statistics (Willekens & Rogers, 1978).

It has used derivative:

$$\frac{d}{dx} f(x) = f(x).(1 - f(x)).$$

This variant is used to project TFR for both population of census. The logistic is defined in terms of the complement of the TFR; that is, of the difference between TFR in year and the lower bound of the logistic. The specification ensures that proportionate changes in provincial and local level proportionate changes that TFR projected.

3.8 Small area estimation at local level

SAE is a method that combines census and household survey data. It also based on data of case study from Nepal. Case studies demonstrate how census, demographic, and health survey data can be used to estimate fertility-related indicators for local level as Municipalities in rural and urban areas respectively. It gains advantage of the correlation between variables that are commonly measures census and surveys. The procedure of small area estimation (Elbers et al., 2003) as,

1. Census and Survey Data Evaluation and Census and Survey Data Harmonization: The evaluation process includes identifying common relevant variables with key indicators X that are contained in both survey and census data. Analysis and comparison of the distribution of each of the variables across the two datasets and harmonization of the datasets.
2. Developing and identifying optimal models: Using survey data to build the first regression model to predict the probability of an event of interest occurring among

survey respondents. Then, variables common to census and survey data are used as predictors to select the best model based on assessments of predictive power and accuracy.

3. Apply the model to the census data to predict local-level estimates based on the census data: Apply the coefficients of the survey-based regression model to the common variables of the census data to create a suitable model for estimating the index X at the individual level using the census data.
4. Aggregate estimates from each local level to each geographic level: Individual level estimates can be aggregated into any unit analysis, including various geographic levels at the local level.

This study has been used for the estimation of fertility at a local level as per Schmertmann (2013) model. It is also called θ the 7×1 vector of accurate fertility rates in local levels. The survey includes both the local census sample estimates of these rates (local vector) and the neighborhood average rate vector (Nhood) around the local levels.

3.8.1 Stage 1: Empirical Bayes (EB) smoothing of P and F schedules

This study has applied all vectors as unknown quantities with probability distributions *P* () and the rule of conditional probability is:

$$\mathrm{P}\left(\frac{\theta}{\mathrm{Local,Nhood}}\right) = \mathrm{P}\left(\frac{\mathrm{Local}}{\theta\mathrm{,Nhood}}\right).\mathrm{P}\left(\frac{\theta}{\mathrm{Nhood}}\right).\mathrm{P(Nhood)P(Local,Nhood)} \;\ldots\ldots\text{..(1)}$$

or more simply that

$$\mathrm{P}\left(\frac{\theta}{\mathrm{Local,Nhood}}\right) \propto \mathrm{P}\left(\frac{\mathrm{Local}}{\theta}\right).\mathrm{P}(\frac{\theta}{\mathrm{Nhood}})\ldots\ldots\ldots\ldots\ldots\text{(2)}$$

The terms which do not depend on θ are removed from the equation (2) terms and assumes that the probability of a given local sample, conditional on true local rates θ, is identical regardless neighbouring local levels' rates.

In equation (2), the first term on the right-hand side depends on the local level estimate if the true rate is equal to θ. The probability is low when θ and the local parameters are different.

The second range on the right shows a priori information that can cause problems.

What is the probability that the rate θ can be different in neighborhoods where the average rate equals Nhood? The main assumption of this study is that θ and Nhood are not similar and the second probability is lower.

In this study, the logarithm of the two terms in equation (2) gives the normalized squared error distances between local and θ and between θ and Nhood when the associated distributions are approximately multivariate normal. Therefore, the vector EB estimator of ASFR in the smallest rural community can minimize a scalar function that penalizes both local data and neighborhood deviations.

$$\theta EB = argmin\theta(Local - \theta)'\Omega^{-1}\ (Local - \theta) + (Nhood - \theta)'\textstyle\sum^{-1}(Nhood - \theta) \qquad \text{……..(3)}$$

$argmin\theta(Local - \theta)'\Omega^{-1}\ (Local - \theta)$ = Penalized deviation from local estimates

$(Nood - \theta)'\sum^{-1}(Nood - \theta)$ = Penalized deviation from neighbors estimates

This equation (3) uses matrices Ω and Σ which serve as weights representing expected sampling error in the local area and the covariance of ASFRs among the set of neighbouring local levels, respectively. If the local sample size is large, the matrix Ω will be small (eigenvalues are small and its determinant tends to zero; will intuitively describe matrices as “big” and “small”). Similarly, when the neighbourhood is homogeneous Σ is small and rates changes delicately across local levels.

The problem of minimisation is a matrix-weighted average of local and it used for neighbourhood data.

$$\theta EB = Local + \Omega\ [\textstyle\sum + \Omega]^{-1}(\text{Nhood} - \text{Local}) \qquad \text{……….(4)}$$

In small samples, the variability falls, and only a small increase in the mean and modal TFR estimates occurs due to the shrinkage effect of the Empirical Bayes step that appears to dominate. The medium samples, estimations show balance in between downward shrinkage effects and upward parity effects. This results in positively skewed EBB distribution with higher mean and mode compared to the census TFR. Large municipalities, however, showed very small EB shrinkage effects and small parity adjustment effects (Assunção et al., 2015).

There are fewer than 21,000 women of childbearing age in the M+7 neighborhood local levels. And, data are added from the 8th closest local level, then from the 9th closest, until there are at least 21,000 sample women in the considered neighborhood local levels. This method truly represents the projections only when the neighbourhood or estimations from considered local geographical locations are homogeneous (Schmertmann et al., 2013).

In this study, estimation of Ω and Σ matrices for choosing neighborhood sizes to interpret the smoothing properties of the EB method and the performance of the EB estimator using the Nepalese census data. Local and neighborhood data are averaged with more weight on the local data, but a larger local sample is the underlying logic in EB approach (Assunção et al., 2015).

By combining local and neighborhood sampling, the data varies proportionally to local conditions, and nonparametric EB smoothing reduces local sample variation for f and P schedules. Another way to reduce sampling error is to assume that all schedules have some mathematical form and estimate the parameters from local sample data. A relational Gompertz approach to indirect estimation is used, assuming that one pair of parameters (α, β) represents the shape of the regional period and cohort fertility schedules (Moultrie & Dorrington, 2013) uses the parametric strategy. Using very strong prior assumptions, a parametric model can use the absence of other data, assume no local rates are needed, and derive flexible strengths from it.

3.8.2 Stage 2: A modified Brass P/F method

The neighbourhood based mostly on EB smoothing efficiently acts for the number one trouble in close by quality estimation. It minimizes the problems due to small samples and mistakes of close by data. It's going to progress the signal-to-noise ratio in close by fertility valuation.

However, EB valuation also can moreover despite the fact that significant problems of misreporting, in particular numerous styles of mistakes that might bring about underreporting of changing fertility in a survey or census (Moultrie & Dorrington, 2013). Its generating an accurate set of multiple estimates at the local level requires an automated, reproducible algorithm that also takes into account potential reporting errors in the EB estimates.

3.8.3 A modified P/F method for changing fertility levels

This study has used the Brass assumption first without considering the second. The changing P/F ratio are not drastically changed fertility but this model using declining fertility which generalizes the standard model. The adjusting small area EB estimates, develops a regression-based medium variant of the changing P/F ratio method. Simultaneously, changing fertility (TFR) estimates robust regression approach.

At time *t*=0, then let φ(*a*) explains true fertility at the same time in each reproductive age group of women. Then adjustment factor multiplies K (a, t) ≥ 0, that

$$\varphi(a,t) = k(a,t)\varphi(a) \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots (5)$$

The reproductive age of women at age *x*, time of survey denoted x, time of birth -x at previous year and age of old in each women a that denoted a-x. For this analysis at age *x*,

$$\phi x = \int_0^x \varphi(a)\, da = \text{Cumulative period fertility (true)} \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots (6)$$

$$Fx = \int_0^x f(a)\, da = \text{Cumulative period fertility (reported)} \ldots\ldots\ldots\ldots\ldots\ldots\ldots (7)$$

$$Px = \int_0^x \varphi(a, a-x)\, da = \text{Parity} \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots (8)$$

$$\mu x = \frac{1}{\Phi x} * \int_0^x a\varphi(a) da = \text{Period mean age of previous childbearing} \ldots\ldots\ldots\ldots (9)$$

At time t=0 which is corresponding to the census date to estimate the TFR at the same date:

$$TFR = \Phi\omega = \int_0^w \varphi(a) da \quad \ldots\ldots \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots (10)$$

The changing Brass method used in census data with the help of adjustment factor and estimates the observed fertility as F_ω:

$$Yx = F\omega . \frac{Px}{Fx} \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots (11)$$

Then, different age of cohort estimates by P and F values which is reporting errors are nearly equal-proportional across ages as there is a single constant *c* such that *f* (*a*)

$\approx c\, \varphi\, (a)$ equation (11):

$$Yx \approx \Phi\omega.\frac{Px}{\Phi x} = TFR.\frac{Px}{\Phi x} \quad \ldots (12)$$

Expression as past and presents rate:

$$Yx \approx TFR.\frac{\int_0^x K(a,a-x)\varphi(a)da}{\int_0^x \varphi(a)da} = TFR.\ \overrightarrow{Kx} \quad \ldots (13)$$

The $\bar{K}_x$ is the weighted adjustment function on basis of past trends which has mean value age $a = \mu_x$ then, expression as Yx mean of the age-specific rates $K(a, a-x)$:

$$\approx TFR.\ \overrightarrow{Kx} \approx TFR.\ K(\mu x, \mu x - x) \quad \ldots (14)$$

As the adjustment function $K(a, t)$ using changing Brass method assumes that $K(a, t)$ =1 in all reproductive age groups at the same time periods. The value of Y_x in each age group to estimate TFR valuse using adjusting P/F ratio for hypothetical inter survey cohort. The Y_x using the adjustment P_2/F_2.

3.8.4 A regression approach using P/F adjustment

This study used to change at a constant rate at 15-49 years of women:

$$K(a,t) = e^{rt} \quad \ldots (15)$$

TFR also changes exponentially function:

$$TFR(t) = e^{rt}.TFR \quad \ldots (16)$$

Brass model growth rate, r=0.

Generalized version using P/F adjustments in Equation (14),

$$Yx \approx TFR \cdot K(\mu x, \mu x - x) \approx TFR.\, e^{r(\mu x - x)} \quad \ldots (17)$$

Finally,

$$Yx \approx TFR\,(\mu x - x) \quad \ldots (18)$$

This estimation good equations (18) estimates current fertility from equation (13). The correction factor for each age group women's TFR 15-49 age group. Likewise, adjusting factor are adjust in same logic. However, it was projected based on time series cohort analysis childbearing, μ-*x*, rather than past mean μ_x-*x*. Equation (17) illustrations that strong time distribution at μ_x. Moultrie and Dorrington (2013) verified Feeney's method in virtual pasts year fertility which is μ-*x* rather than μ_x-*x* as a regression approach that uses time-allocated values to estimate both current TFR and the recent rate of fertility change.

$$lnYx = \ln\left(F\omega.\frac{Px}{Fx}\right) = \ln TFR + r.(\mu x - x) \quad \ldots\ldots(19)$$

The linear regression of the logarithms of P/F adjusted TFRs. It based on $\mu x - x$ produces the logarithm of current TFR. Here fertility rate was changed. This method has uses interpoaltion moments and estimation. The $F_{15\text{-}49}$,….$F_{45\text{-}49}$ as well as moments $\mu_{17.5}$ -17.5… $\mu_{47.7}$-47.5 which is measured by ASFR $f_{15\text{-}49}$…$f_{45\text{-}49}$. The adjusted value (P/F) ratio using regression equation (19). It shows that huge variation younger group and estimated parity equivalence has low. The cumulative fertility (CF) measures each age group which is equivalent to estimated parities equivalent in each age group x (F_x). Using a suitable model Poisson distribution for each reproductive age group and their CEB. Average parities $\hat{F}_x = n^{-1} B_x$, would be average evaluation $E(\hat{F}_x) = F_x$. The measurement of variance $V(\hat{F}_x) = n^{-1} F_x$ was proved. Likewise, if period births before and after age *x* are statistically independent then cov $(\hat{F}_x, \hat{F}_\omega) = n^{-1} F_x$ (Schmertmann et al., 2013) at combining using delta-rule for the approximations as $\approx \frac{\sigma x^2}{\sigma y^2}$ and cov (ln *x*, ln *y*) $\approx \sigma_{xy}/(\mu_x / \mu_y)$ rregression analysis justifying equation (19):

$$V(lnYx) \propto Px^{-1} + Fx^{-1} - Fw^{-1} \quad \ldots\ldots(20)$$

Fitting Brass model in equation (19), constant and regression weights are used as approximate variances (United Nations, 1983) and omitting 15–19 age group 45-49. Equations (18) and (19) states that a regression approach using regression-based P_2/F_2 adjustment factor which helps to estimation of TFR all local level assumes average errors.

3.9 Research ethics/ ethical issues

The study is exclusively based on secondary data which are obtained from the Central Bureau of Statistics and NDHS data from the MoHP through written application of USAID. Due to the secondary source of data from authorized agencies, there was no complicated ethical issues except confidentiality and anonymity of the data. The data analysis and interpretation were carried out by following the national and international research ethics.

CHAPTER 4

FERTILITY ESTIMATION AT THE NATIONAL LEVEL

This study has estimated the fertility estimates using changing P/F ratio which considers past time data reducing the errors and minimizing their influences. When the significance of the errors is high, the modelling leads to clouded situations. In this context, to improve credibility of the estimate, evaluation of data is required for discoursing the errors associated with the variables. These situations are required for using changing P/F ratio and Arriaga's method.

4.1 Data quality evaluation and demographic analysis

The evaluation includes the errors of failure areas in reporting events. It is related to the misreporting of events, and/or errors during the time allocation of events. Shryock and Siegel discuss the reason on reporting of failure events for high literacy levels in developing countries (Siegel, 2011). In the same line of thought, Iversen argue that even in advanced societies, reading skills and general literacy competences are associated with reporting errors in surveys Iversen et al. (1999). A similar failure in reporting events increases with the duration of the recall lapse. This is used to describe women's retrospective births, which is often subject to recall lapse that results in higher levels of misreporting for aged women. Despite the fact that proper interviews and edits improve the quality of estimates and failure in reporting events is inherent in the adjusted data according to the kind and magnitude of the inaccuracy.

Reviews at this point are restricted to individual responses. For Preston and colleagues, error assessment is possible even when corrections are not possible as it shows confidence that can be placed in the estimation. This survey reports the mistakes of many respondents, including omissions and incorrect responses. In addition, this study concedes that need of obtaining accurate results can compromise the integration of information. Therefore, care must be taken when implementing corrective actions (Burch, 2018).

The study assesses the feasibility of applying variable P/F ratio methods using the proposed dataset, which can be obtained objectively by evaluating the quality of each variables required for the Arriaga method.

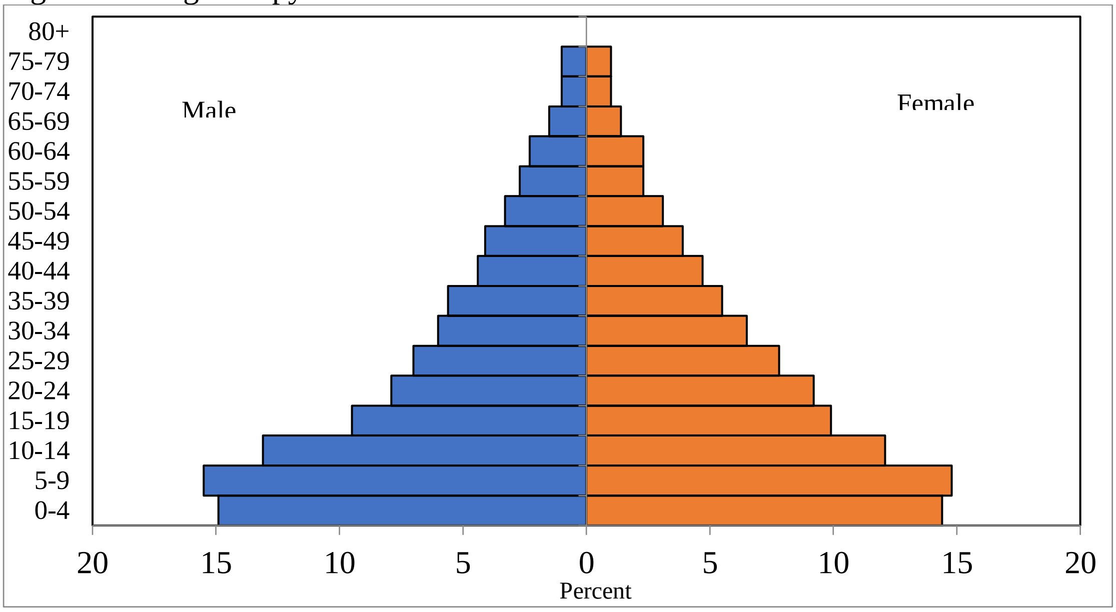
4.2 Fertility estimation at National Level

The various demographic policies developed to achieve these goals are changing over time in terms of their impact on births. Since the 1970s, proactive measures have been taken and population policy has shifted to "family planning" that emphasizes the health of children and mothers. The Cairo Population Conference in 1994 made two major changes in population policy in the late 1990s. Goals have been abolished and planning and implementation have been decentralized. Within the framework of anti-analytical policies, governments are free to implement their own programs in accordance with the framework set out in the country's population policy.

4.2.1 Household population by age and sex

Of all the characteristics of the population, age and sex are called "demographic variables" because they are the most important and relevant for demographers and very important for demographic analysis (Bogue, 1994). The demographic process of fertility, mortality, and migration are the essential factors for the structure of age and sex of the population, and hence structure of age and sex influences the demographic process. The age sex distributions for household of population according to 2001 and 2011 census was found as presented at Figures 4.1 and 4.2.

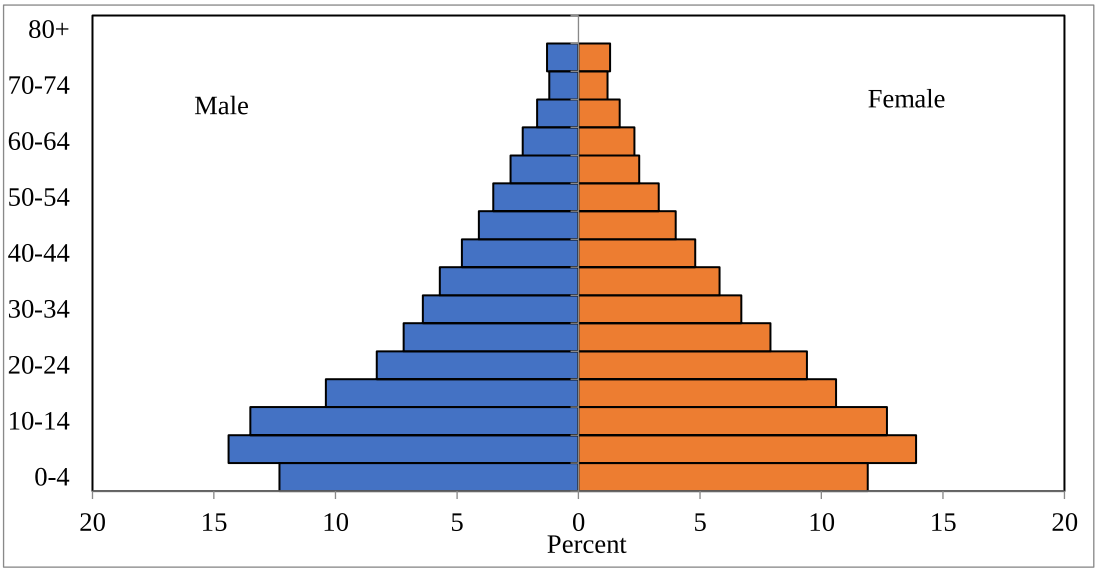
Figure 4. 1: Age sex pyramid 1991



Source: Census data files, 1991.

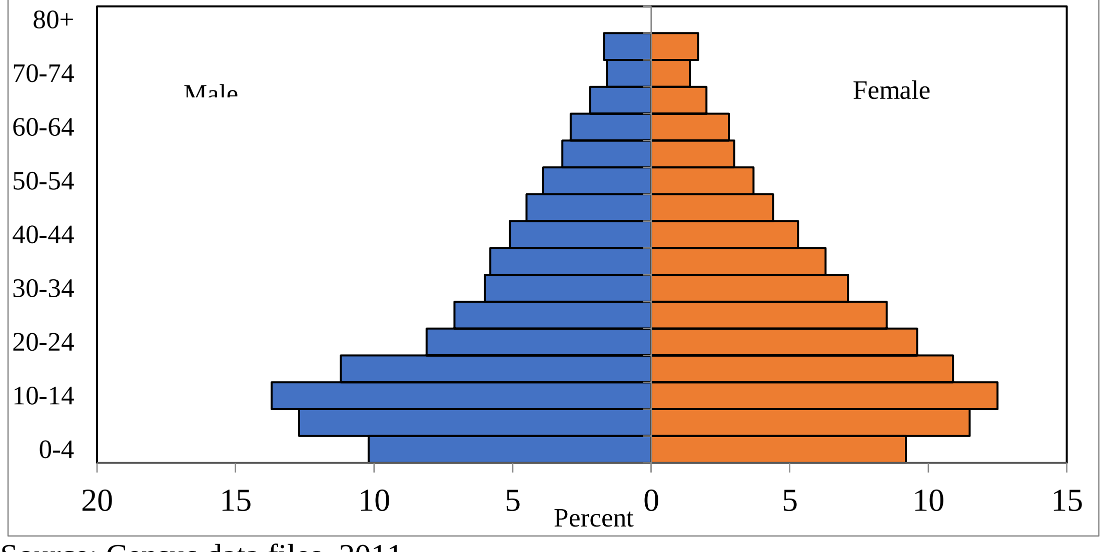
Age sex structure analysis of 1991, proportion of the population has the highest in the 5-9 age group followed by the 0-4 and 10-14 age groups. The data clearly indicates the declining fertility and mortality. In 1991 data was smoothed by Hill tecniques. The Figure 4.1 shows that aging index increases from 13.7 to 16.7 that means starting to ageing demographic dividend and there was significant increase in life expectancy and decrease in sex ratio at reproductive age group. The child -ageing dependency ratio (93.3), sex ratio (99.5), ageing dependency ratio (13.7) and women ratio (0.921) which indicates starting the change of demographic scenario.

Figure 4. 2: Age sex pyramid 2001



Source: Census data files, 2001.

Figure 4. 3: Age sex pyramid 2011



Source: Census data files, 2011.

Age sex structure analysis of 2001, in the age group 5-9 has the highest proportion of the population followed by the 10-14 and 0-4 age groups. The data clearly indicates the declining fertility and mortality. In other hand, 2011 census shows that the age group 10-14 has the highest proportion of the population followed by the 15-19 and 0-4 age groups. It also shows that the population of 0-4 age group is lower than the age groups of 5-9 and 10-14. In 2001 and 2011 data were smoothed by Arriaga method. The Figure 4.2 and 4.3 shows that aging index increases from 16.7 to 23.3 and median age increases from 20 to 22.6 accordingly. This means there was significant increase in life expectancy and decrease in sex ratio at reproductive age group.

The child dependency ratio has decreased from 73 to 61, working ratio has increased from 53 to 57, ageing dependency ratio has increased from 12 to 14, child dependency ratio has decreased from 88 to 76, child- aged ratio has decreased from 88 to 76, sex ratio has decreased from 99.8 to 94.2 and women ratio has increased from 0.249 to 0.361 during census 2001 to 2011 (Appendix I and Appendix III).

The sex ratio of the study population shows that male population with the age group between 15 to 40 years has declined sharply in comparison to other age groups. It might be the effect of absentee population. The demographic parameters represent the general idea about the child, adults, working age, reproductive age, schooling age and so on. It is important to study fertility and effect of migration.

4.2.2 Estimation of fertility Arriaga method at National Level

The Arriaga fertility method is used for estimation of fertility levels by comparing two or more sets of average CEB. The estimations are used to adjust observed fertility patterns like as changing Brass P/F ratio method. As a part of the Population Analysis System (PAS) in two different dates, the method is applicable. For both theoretical analysis and simulations, the Arriaga method can be utilized which is a latest statistical approach over the traditional deterministic population estimating method. In case of missing or insufficient crucial event registrations, TFR can be estimated using data of age and gender distribution.

The information of the vital statistics in Nepal is incomplete as like other majority of developing countries, hence, it requires the use of indirect estimation methods to estimate fertility rates. Arriaga, a U.S. Census Bureau demographer, has proposed another method of estimating fertility based on information from two consecutive census classified by mother's age. In contrast to the brass method, which assumes a constant fertility, Arriaga's hypothesis implicitly changes to the hypothesis that the average number of children born per women changes linearly at time intervals that are taken into account. Evidence from Nepal indicates that fertility is declining, so Arriaga's method should be applicable to determine the validity of this trend. For intermediate surveys, the average between the previous and succeeding year's values is taken to determine the fertility rate. This study has based on CEB according to reproductive age group of women in 2001 and 2011 censuses.

Table 4. 1: Estimation of ASFR based on 2001 census by using Arriaga method

Age	ASFR from CEB	Cum. ASFR	ASFR Pattern	Cum. ASFR pattern	Adj factors	Adj. Fertility f*
15-19	0.083	0.083	0.030	0.030	2.735	0.069
20-24	0.192	0.275	0.109	0.139	2.311	0.252
25-29	0.160	0.435	0.092	0.231	1.997	0.213
30-34	0.091	0.526	0.060	0.291	1.884	0.139
35-39	0.048	0.574	0.038	0.329	1.746	0.088
40-44	0.014	0.588	0.020	0.349	1.687	0.046
45-49	0.002	0.590	0.008	0.356	1.657	0.018
TFR						**4.125**

Source*:* Census data files, 2001 and 2011.

Table 4.1 is based on age specified data of reproductive age span of women in 2001 census; the adjusted values are estimated on the basis of cumulative ASFR and cumulative ASFR pattern. The adjusting value for age group was found in decreasing trends with increasing the age group. The adjusting factor of P_2/F_2 values (2.3) has resulted adjusted ASFR for all age group and the adjusted TFR value was 4.1 in December 2000. The mean age of childbearing was 28.3 years. The TFR estimated value (4.1) was found similar to national census value 4.1 (Central Bureau of Statistics, 2003).

Table 4. 2: Estimation of ASFR based on 2011 census by using Arriaga method

Age	ASFR from CEB	Cum. ASFR	ASFR Pattern	Cum. ASFR pattern	Adj factors	Adj. Fertility f*
15-19	0.055	0.055	0.023	0.023	2.395	0.045
20-24	0.171	0.226	0.094	0.117	1.936	0.182
25-29	0.139	0.365	0.081	0.198	1.845	0.157
30-34	0.079	0.444	0.045	0.243	1.829	0.087
35-39	0.040	0.484	0.024	0.267	1.813	0.046
40-44	0.011	0.495	0.011	0.278	1.780	0.021
45-49	0.002	0.497	0.004	0.283	1.758	0.008
TFR						**2.730**

Source: Census data files, 2001 and 2011.

Table 4.2 is based on age specified data of reproductive age span of women in 2011 census; the adjusted values were estimated on the basis of cumulative ASFR and cumulative ASFR pattern. The adjusting value for age group was found in decreasing trends with increasing the age group. The adjusting factor of P_2/F_2 values (1.936) has resulted adjusted ASFR for all age group and the adjusted TFR value was 2.7 in December 2010. The mean age of childbearing was 27.6 years. The estimated TFR value (2.7) was found similar to national census value 2.6 (Central Bureau of Statistics, 2014).

4.2.3 Estimation of fertility for hypothetical inter- survey cohort

Still the available indirect methods of demographic assement are not accurate to predict peroid levels while the hypothetical cohort-based measurements are used to reduce the impacts of trends and estimate the period levels. If fertility rate changes over time, the lifetime fertility and cumulative period fertility rates will not be same and hence an adjustment factor can be used to deterrmine it on the basis of comparison that will refelect not only proable data mistake but also the impacts of changes over time. In the absence of ASFRs at the period's end points, a set of rates corresponding to the period's mid-point could be used instead. Two dates of CEB and births before 12 months are also taken in the changing Brass approach, according to reproductive age groups of women (Census 2001 and 2011).

Table 4. 3a: Estimation of ASFR based on changing P/F ratio method

Age	2001P(i)	2011P(i)	Δ P(i)	P(i,s)	2001 f(i)	2011 f(i)
15-19	0.154	0.080	0.080	0.080	0.031	0.023
20-24	0.970	0.758	0.758	0.758	0.109	0.094
25-29	2.059	1.723	1.568	1.649	0.092	0.081
30-34	2.870	2.444	1.474	2.232	0.060	0.045
35-39	3.442	2.956	0.897	2.546	0.038	0.024
40-44	3.821	3.340	0.469	2.702	0.020	0.011
45-49	4.037	3.583	0.141	2.687	0.008	0.004

Source: Census data files, 2001 and 2011.

Table 4.3b: Estimation of ASFR based on changing P/F ratio method

Age	f(i)	ϕ (i)	F(i)	K	f+	f*(i)
15-19	0.027	0.134	0.038	2.102	0.035	0.069
20-24	0.102	0.639	0.382	1.986	0.104	0.206
25-29	0.086	1.072	0.868	1.899	0.083	0.164
30-34	0.053	1.334	1.213	1.841	0.050	0.099
35-39	0.032	1.489	1.417	1.797	0.030	0.059
40-44	0.016	1.567	1.525	1.772	0.014	0.028
45-49	0.006	1.597	1.588	1.692	0.005	0.009
TFR						**3.172**

Source: Census data files, 2001 and 2011.

At national level, the changing reported average parities P (i, s) were calculated from the reported average parities of 2001 and 2011 censuses. The period ASFR f(i) was obtained from ASFR datasheet of 2001 and 2011 censuses. It was based on medium variant estimation, follows changing reported parities methods with help of manual X procedure in P (i, s)/F (i) ratios. The adjustment factor (K) for registered births and its reciprocal (1 /K) for the estimation of the complete birth registration, with inter-censual birth rate was estimated by summing total births registered during the years 2001-2011 in Nepal. The unadjusted ASFR was multiplied with K. The adjusted value 1.986 was estimated based on data in 2001 and 2011 censuses (Table 4.3a and 4.3b). Finally, national value of adjusted TFR was 3.1 in December 2005. Hence, the TFR value (3.1) was similar to NDHS value 3.1(Ministry of Health, 2006).

4.2.4 Projection of fertility at National Level (reference date 2010)

Fertility estimates by Arriaga method and changing P/F ratio methods was used which is suitable for declining fertility and mortality rate. The estimation of nation level TFR in December 2010 was verified by using logistic curve function on the basis of December 2000 and December 2005 data. The TFR values were estimated by using Arriaga and hypothetical inter survey cohort methods. Trend extrapolation models specifically refer to fairly simplistic models that use past growth patterns to predict future growth patterns. The observation incorporates that during the demographic transition, fertility first changes slowly and it accelerates then finally decelerates. The demographic scenario of Nepal reflects the phase of demographic transition. The adjusted TFR value was 4.1 in December 2000 and 3.2 in December 2005. The estimate of TFR obtained December 2010   was   2.7. The estimation curve shows decreasing trend (slope = -0.2748) and intercept 549.4. The parameter and TFR was obtained from the same value and hence the logistic curve method validated. So, similar method can be applied to project the TFR of reference date December 2015, 2020, 2025 and 2030.

4.2.5 Projection of fertility at National Level (reference date 2031)

In most cases, population growth rates are calculated using historical data and then used in a mathematical formula to predict the population's anticipated future size. Population projections are necessary for development planning and should be as accurate as feasible. The projections will be accurate if the data utilized is correct and the assumptions used in the projections are correct in reality. As a result, before being utilized for projection, data must be thoroughly evaluated and corrected for errors, with the logistic curve being the most likely assumption. The ASFR is an extension of the general fertility rate that calculates the fertility rate for each 5-years cohort of women, starting with the 15-19 years group and continuing through the 40-44 years group. The ASFR is an extension of the general fertility rate that calculates fertility rates for each 5-year age cohort of women, beginning with 15 to 19 age group and continuing through 40 to 44 age group. The estimated TFR values of national data for December 2000, 2005 and 2010 by using logistic function has projected the TFR value up to December 2030.   It was used same slope for future projection. The model in spreadsheet TFRLGSTNew.xls interpolates and extrapolates of TFR.

Finally, 2015, 2020, 2025 and 2030 data were used to interpolate point estimation with medium variant. Fertility decline has been a primary determinant of population ageing and projected levels of fertility have important implications on the age structure of future population, including on the pace of population ageing. In these basis trends of TFR values were projected (Table 4.4).

These dates based on census 2001 and 2011 which points are estimated by linear interpolation and projection is based on time series logistic method. In fact, this research was used point estimation with medium variant interpolation. TFR values were estimated December 2000 and 2010 by using Arriaga method and December 2005 by using hypothetical inter survey cohort. The obtained values were verified and validated by using logistic curve.

Table 4. 4: Projected TFR values in Nepal

Year	**TFR Values**
December 2000	4.1
December 2005	3.2
December 2010	2.7
December 2015	2.4
December 2020	2.2
December 2025	2.2
December 2030	2.1

The projected national level TFR of December 2015, 2020, 2025 and 2030 were obtained 2.4, 2.2, 2.2 and 2.1 respectively (Table 4.4). However, exact date of projected TFR using linear interpolation are 2016, 2021, 2026 and 2031 respectively. The TFR value will near to reach national TFR replacement level.

4.3 Fertility estimation in different caste/ethnic groups

Nepal is a multi-ethnic country with a wide range of languages, religions and cultural practices. The 1991 census is noteworthy because it was the first to include information on caste/ethnic, population size and socioeconomic characteristics of different caste/ethnic groups. Nepal has 1,25 caste/ethnic groups and 207 religious' groups, according to 2011 census, in contrast to the 2001 census, which revealed that Nepal had less than 350 caste/ethnic groupings and eight religious' groupings (Central Bureau of Statistics, 2014).

4.3.1 Fertility estimation by Arriaga method in different caste/ethnic groups

The Arriaga fertility method was used to estimate fertility levels by comparing two or more sets of average CEB in different caste/ethnic. Population Analysis System (PAS) in two dates has implemented in this study to utilize the Arriaga approach for both theoretical approach and through simulations. These estimates are used to adjust observed fertility patterns in a manner similar to the changing Brass P/F ratio method. In case of missing or insufficient crucial event registrations, TFR can be estimated using data of age and gender distribution. Evidence from Nepal suggests that fertility rates are declining, so Arriaga's method should be applicable to determine the relevance of this trend across caste/ethnic groups and the average of the values for the following year. This study is based on CEB according to reproductive age group of women in different caste/ethnic groups using 2001 and 2011 census data set.

Table 4. 5: Estimation of ASFR using Arriaga in different caste/ethnic groups (2001)

Age	Hill Janajati	Newar	Tarai Janajiti	Brahman/ Chhetri	Madheshi Brahman	Madheshi Other Caste	Hill Dalit	Madhesi Dalit	Muslim	Others
15-19	0.075	0.036	0.093	0.058	0.056	0.101	0.095	0.104	0.075	0.090
20-24	0.258	0.170	0.248	0.276	0.218	0.263	0.260	0.252	0.249	0.229
25-29	0.222	0.153	0.190	0.214	0.145	0.207	0.230	0.217	0.262	0.197
30-34	0.176	0.087	0.120	0.124	0.098	0.138	0.148	0.143	0.227	0.139
35-39	0.112	0.044	0.060	0.069	0.030	0.084	0.097	0.088	0.140	0.102
40-44	0.064	0.017	0.030	0.035	0.012	0.039	0.049	0.058	0.092	0.056
45-49	0.020	0.005	0.016	0.012	0.002	0.017	0.023	0.025	0.047	0.016
TFR	**4.633**	**2.563**	**3.788**	**3.940**	**2.810**	**4.242**	**4.508**	**4.437**	**5.468**	**4.149**

Source: Census data files, 2001 and 2011.

Table 4.5 is based on age specified data of reproductive age span of women in 2001 census; the adjusted values are estimated on the basis of cumulative ASFR and cumulative ASFR pattern. The adjusting value for age group was found in decreasing trends with increasing the age group. Here, adjusting factor of P_2/F_2 values has resulted adjusted ASFR for all age group and the adjusted TFR values were Hill

Janajati (4.6), Newar (2.6), Tarai Janajiti (3.8), Brahman/Chhetri (3.9), Madheshi Brahman (2.8), Madheshi Other Caste (4.2), Hill Dalit (4.5), Madhesi Dalit (4.4), Muslim (5.5) and Others Minor Caste (4.1) in December 2000 (Appendix V). The mean ages of childbearing were different in different caste/ethinc. The study shows that the Newar, Brahman/Chhetri, Tarai Janajiti and Madheshi Brahman were lower value than the national census of TFR value (4.1) and Hill Janajati, Madheshi Other Caste, Hill Dalit, Madhesi Dalit, Muslim and Others Minor Caste were found higher than the national census of TFR value 4.1 (Central Bureau of Statistics, 2003).

Table 4. 6: Estimation of ASFR using Arriaga in different caste/ethnic groups (2011)

Age	Hill Janajati	Newar	Tarai Janajiti	Brahman/ Chhetri	Madheshi Brahman	Madheshi Other Caste	Hill Dalit	Madhesi Dalit	Muslim	Others
15-19	0.049	0.019	0.043	0.036	0.019	0.045	0.079	0.063	0.061	0.054
20-24	0.172	0.108	0.188	0.191	0.146	0.202	0.232	0.227	0.219	0.225
25-29	0.150	0.104	0.142	0.174	0.134	0.166	0.176	0.176	0.206	0.214
30-34	0.095	0.072	0.079	0.086	0.067	0.085	0.109	0.111	0.153	0.095
35-39	0.055	0.025	0.029	0.044	0.029	0.044	0.071	0.072	0.092	0.058
40-44	0.026	0.008	0.014	0.017	0.005	0.021	0.037	0.035	0.048	0.035
45-49	0.008	0.002	0.007	0.010	0.002	0.009	0.019	0.012	0.025	0.011
TFR	**2.772**	**1.691**	**2.516**	**2.610**	**2.130**	**2.864**	**3.615**	**3.473**	**4.020**	**3.459**

Source: Census data files, 2001 and 2011.

Table 4.6 is based on age specified data of reproductive age span of women in 2011 census; the adjusted values are estimated on the basis of cumulative ASFR and cumulative ASFR pattern. The adjusting value for age group was found in decreasing trends with increasing the age group. Here, adjusting factor of P_2/F_2 values has resulted adjusted ASFR for all age group and the adjusted TFR values were Hill Janajati (2.8), Newar (1.7), Tarai Janajiti (2.6), Brahman/ Chhetri (2.6), Madheshi Brahman (2.1), Madheshi Other Caste (2.9), Hill Dalit (3.6), Madhesi Dalit (3.5), Muslim (4.0) and others (3.5) in December 2010 (Appendix V). The mean ages of childbearing were different in different caste/ethnic. The study shows that the Newar, Tarai Janajiti, Madheshi Brahman were lower value than the national census of TFR value (2.6) and Hill Janajati, Brahman/ Chhetri, Madheshi Other Caste, Hill Dalit, Madhesi Dalit, Muslim and others minor caste/ethnic was found higher than the national census of TFR value 2.6 (Central Bureau of Statistics, 2014).

4.3.2 Estimation of fertility for hypothetical inter- survey cohort

This study is based on diffrent caste/ethnic based data in national level of Nepal. The indirect method of demographic assessment aviable to date are frequently insufficient to predict levels. However, the use of hypothetical cohort-based measurements is used to reduce the impacts of trends and estimate period levels in different caste/ethnic groups. If fertility rate changes, lifetime fertility and cumulative period fertility rates will not be same and hence an adjustment factor should be used to deterrmine it on the basis of comparison, that will refelect not only probable data mistake but also the impacts of Changes over time. Instead of lacking ASFRs of end points for the given period, a set of rates corresponding to the period's mid-point could be utilized and in case of hypothetical inter- survey cohort method two dates of number of CEB and number of births before 12 months according to reproductive age groups of women can also be taken. The data of censuses 2001 and 2011 were used for the calculation of changing P/F ratio in different caste/ethnic groups.

Table 4. 7: Estimation of ASFR based on P/F hypothetical inter- survey cohort

Age	Hill Janajati	Newar	Tarai Janajiti	Brahman/ Chhetri	Madheshi Brahman	Madheshi Other Caste	Hill Dalit	Madhesi Dalit	Muslim	Others
15-19	0.068	0.032	0.085	0.057	0.050	0.091	0.109	0.107	0.088	0.091
20-24	0.191	0.129	0.210	0.216	0.180	0.234	0.251	0.250	0.257	0.235
25-29	0.157	0.111	0.151	0.166	0.128	0.177	0.197	0.196	0.250	0.198
30-34	0.112	0.067	0.089	0.088	0.073	0.104	0.124	0.127	0.193	0.111
35-39	0.069	0.028	0.040	0.047	0.027	0.060	0.082	0.079	0.118	0.077
40-44	0.035	0.010	0.020	0.022	0.008	0.027	0.041	0.044	0.070	0.041
45-49	0.009	0.002	0.008	0.006	0.002	0.011	0.017	0.016	0.033	0.011
TFR	**3.205**	**1.886**	**3.014**	**3.007**	**2.333**	**3.523**	**4.106**	**4.097**	**5.015**	**3.818**

Source: Census data files, 2001 and 2011.

At national level, the changing reported average parities P (i, s) were calculated from the reported average parities of 2001 and 2011 censuses in different caste/ethnic groups. The period ASFR f(i) was obtained from ASFR datasheet of 2001 and 2011 censuses in different caste/ethnic groups. It was based on medium variant estimation, follows changing reported parities methods with help of manual X procedure in P (i, s)/F (i) ratios.

The adjustment factor (K) for registered births and its reciprocal (1 /K) for the estimation of complete birth registration, with inter-censual birth rate was estimated by summing total births registered during the years 2001-2011 in Nepal. The adjusted values were estimated in different caste/ethnic groups (2001 and 2011). Finally, the value of adjusted TFR were (Appendix V) Hill Janajati (3.2), Newar (1.9), Tarai Janajiti (3.0), Brahman/ Chhetri (3.0), Madheshi Brahman (2.3), Madheshi Other Caste (3.5), Hill Dalit (4.1), Madhesi Dalit (4.0), Muslim (5.0) and others (3.9) in December 2005 (Table 4.7). The study shows that the Newar, Tarai Janajiti Brahmin/ Chhetri, Madheshi Brahman were lower value than the national census of TFR value

(3.1) and Hill Janajati, Madheshi Other Caste, Hill Dalit, Madhesi Dalit, Muslim and Others Minor Caste was found higher than the NDHS value 3.1(Ministry of Health, 2006).

4.3.3 Projection of fertility in different caste/ethnic groups (reference date 2010)

Fertility estimate Arriaga method and changing P/F ratio methods were used. They were suitable for declining fertility and mortality rate. The estimation of caste/ethnic basis TFR in December 2010 was verified by using logistic curve function on the basis of December 2000 and December 2005 data. The TFR values were estimated by using Arriaga and changing P/F ratio methods. Trend extrapolation models specifically mention to fairly basic models that use past growth patterns to predict future growth patterns. The observation incorporates that during the demographic transition, fertility first changes slowly and it accelerates then finally decelerates. The demographic scenario of diffrent caste/ethnic in Nepal reflects the phase of demographic transition.

Table 4. 8: Estimated TFR values in different caste/ethnic groups, Nepal

Age	Hill Janajati	Newar	Tarai Janajiti	Brahman/ Chhetri	Madheshi Brahman	Madheshi Other Caste	Hill Dalit	Madhesi Dalit	Muslim	Others
Dec2000	4.633	2.563	3.788	3.940	2.810	4.242	4.508	4.437	5.468	4.149
Dec2005	3.205	1.886	3.014	3.007	2.333	3.523	4.106	4.097	5.015	3.818
Dec2010	2.772	1.691	2.516	2.610	2.130	2.864	3.615	3.473	4.020	3.459
Trends	-0.161	-0.268	-0.151	-0.284	-0.197	-0.132	-0.055	-0.040	-0.062	-0.038

The adjusted TFR value of December 2000, 2005 and verified value (2010), slope and intercept were shows in Table 4.8. The parameter and TFR was obtained from the same value and hence the logistic curve method validated. So, similar method can be applied to project the TFR of reference date December 2015, 2020, 2025 and 2030.

4.3.4 Projection of fertility in different caste/ethnicity (reference date 2031)

In most cases, population growth rates are calculated from historical data and then used in mathematical formulas to predict the population's anticipated future size. The ASFR is an extension of the general fertility rate that calculates fertility rates for each 5-year age cohort of women, starting with the 15 to 19 age group and continuing through the 40 to 44 age group. Almost all projection approaches extrapolate previous or current trends into the future to some extent. The estimated TFR values of different caste/ethnicity for December 2000, 2005 and 2010 by using logistic function has projected the TFR value up to December 2030. It was used same slope for future projection. The model in spreadsheet TFRLGSTNew.xls interpolates and extrapolates of TFR. Finally, 2015, 2020, 2025 and 2030 data were used to interpolate point estimation with medium variant in different caste/ethnicity. Fertility decline has been a primary determinant of population ageing and projected levels of fertility have important implications on the age structure of future population, including on the pace of population ageing. In these basis trends of TFR values projected (Table 4.9).

Table 4. 9: Projected TFR values in 2001-2031 in different caste/ethnic groups

Age	Hill Janajati	Newar	Tarai Janajiti	Brahman/ Chhetri	Madheshi Brahman	Madheshi Other Caste	Hill Dalit	Madhesi Dalit	Muslim	Others
Dec2000	4.7	2.6	3.8	3.9	2.8	4.2	4.5	4.4	5.5	4.2
Dec2005	3.2	1.9	3.0	3.1	2.3	3.5	4.1	4.1	5.0	3.8
Dec2010	2.8	1.7	2.5	2.6	2.1	2.9	3.6	3.5	4.0	3.5
Dec2015	2.5	1.6	2.3	2.5	2.0	2.6	3.2	3.1	3.5	3.2
Dec2020	2.4	1.6	2.1	2.3	1.9	2.4	2.9	2.8	3.0	2.9
Dec2025	2.3	1.6	2.1	2.2	1.9	2.3	2.6	2.5	2.6	2.7
Dec2030	2.3	1.6	2.0	2.1	1.8	2.2	2.4	2.3	2.4	2.5

These dates based on census 2001 and 2011 which points are estimated by linear interpolation and projection is based on time series logistic method. In fact, this research was used point estimation with medium variant interpolation in different caste/ethnicity. TFR values were estimated December 2000 and 2010 by using Arriaga method in December 2005. The obtained values were verified and valid by using logistic curve.

The projected Hill Janajati's TFR of December 2015, 2020, 2025 and 2030 were obtained 2.5, 2.4, 2.3 and 2.3 respectively.Serially, all major caste were presented in Table 4.9 and mention as; Newar (1.6,), Tarai Janajiti (2.3, 2.1, 2.0 and 2.0), Brahman/Chhetri (2.5, 2.3, 2.2 and 2.0), Madheshi Brahman (2.0, 1.9, 1.9 and 1.8), Madheshi Other Caste (2.6, 2.4, 2.3 and 2.2), Hill Dalit (3.2, 2.9, 2.6 and 2.4), Madhesi Dalit (3.1, 2.8, 2.5 and 2.3), Muslim (3.5, 3.0, 2.6 and 2.4) and Others Minor Caste (3.2, 2.9, 2.7 and 2.5) in December 2015, 2020, 2025 and 2030.

However, exact date of projected TFR using linear interpolation are 2016, 2021, 2026 and 2031 respectively. The study shows that Hill Janajati, Madhesi Dalit, Madheshi Other Caste, Hill Dalit, Madhesi Dalit, Muslim and Others Minor Caste will have high fertility rate which is above the replacement level of fertility at the end of 2031. Likewise, Newar, Tarai Janajiti, and Brahman/Chhetri will have below the replacement level of fertility.

4.4 Chapter summary

This research is based on the applicability of various methods in estimating recent fertility levels in Nepal with different caste/ethnicity. This research is based on the applicability of various methods in estimating recent fertility levels in Nepal with different caste/ethnic groups. The study has undertaken extensive assessment of data and possible corrections of individual variables, to obtain optimal fertility estimates by employing the Arriaga method. The study shows strong evidence of fertility decline in Nepal with respect to the magnitude and pattern of the Arriaga method as like some previous studies. This evidence rendered the Hypothetical inter-survey cohort appropriate for estimation of the fertility level in the country for the period December 2000 to December 2010 (December 2005). Using the fertility levels for December 2000 and December 2005 the fertility level for the year December 2010 is estimated by logistic method. The logistic method with these parameters used to project fertility levels. The logistic method with these parameters is used to estimate fertility levels for 2015, 2020, 2025 and 2030 by linear interpolation. This study has based on CEB according to reproductive age group of women in different caste/ethnicity using 2001 and 2011 census data set. The 2001 census shows that this study shows that the Newar, Tarai Janajiti, Brahman/Chhetri and Madheshi Brahman were lower value than the national census of TFR value (4.1) and Hill Janajati, Madheshi Other Caste, Hill Dalit, Madhesi Dalit, Muslim and Others Minor Caste were found higher than the national census of TFR value 4.1(Central Bureau of Statistics, 2003). Similarly, this study shows that the Newar, Tarai Janajiti, Madheshi Brahman were lower value than the national census of TFR value (2.6) and Hill Janajati, Brahman/ Chhetri, Madheshi Other Caste, Hill Dalit, Madhesi Dalit, Muslim and Others Minor Caste was found higher than the national census of TFR value 2.6 (Central Bureau of Statistics, 2014). In application of hypothetical inter- survey analysis, the Newar, Tarai Janajiti Brahmin/ Chhetri, Madheshi Brahman were lower value than the national census of TFR value (3.1) and Hill Janajati, Madheshi Other Caste, Hill Dalit, Madhesi Dalit, Muslim and Others Minor Caste was found higher than the NDHS value 3.1(Ministry of Health, 2006).The study shows that the Muslim, Hill Janajati, Madhesi Dalit, Madheshi Other Caste, Hill Dalit, Madhesi Dalit and Others Minor Caste will have high fertility rate which is above the replacement level of fertility at the end of 2031. Likewise, Newar, Tarai Janajiti, and Brahman/Chhetri will have below the replacement level of fertility.

CHAPTER 5

FERTILITY ESTIMATION AT THE PROVINCIAL LEVELS

The fertility estimation and projection in provincial level were also based on census data set. The NDHS 2016 and previous NDHS surveys show that the fertility in provincial level. But, information and methodology is not clear. These data also reveal that fertility is higher among women in rural areas than in urban areas (Ministry of Health, 2016). Howerver, this study focused on estimation of fertility at provincial level in diffrent robust methods using census data set.

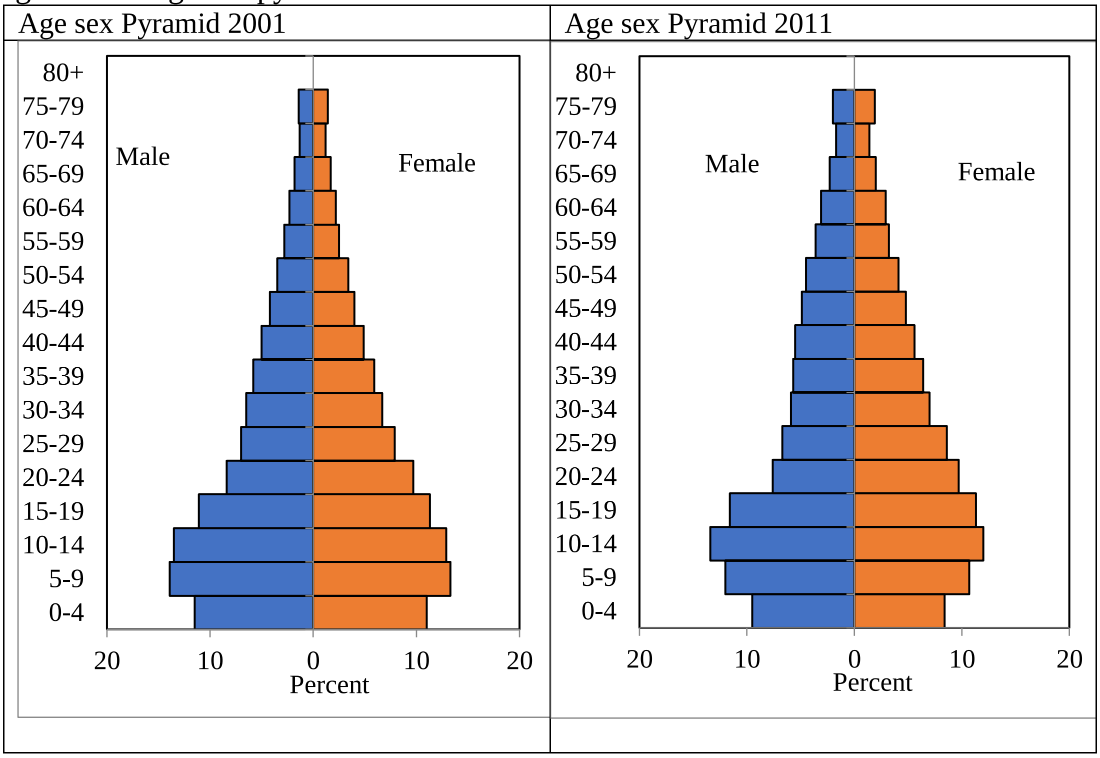
5.1 Household population by age and sex at the provincial level

The age and sex structure of the given population for specific time frame can influence the demographic processes. The demographic factors and the demographic processes are closely linked to one another. Significance of age and sex are the complex matter in demographic analysis, though the division of labor is based on age and sex in the traditional societies (Davis, 1949).

5.1.1 Household population by age and sex at Province 1

The age-sex pyramids of household population clearly represents the population structure of specific time frame. The age-sex pyramid of Province 1 for census 2001 and 2011 are presented in Figure 5.1. Age sex structure analysis of 2001 census for Province 1 (Figure 5.1) shows that the population in the age group 5-9 has the highest proportion followed by the 10-14 and 0-4 age groups. The of age group is lower than subsequent (5-9 and 10-14). Hence, the data clearly indicates declining fertility and mortality. On the other hand, 2011 census shows that the age group 10-14 has highest proportion of the population followed by 5-9 and 0-4 age groups. Population of 0-4 age group is lower (5-9, 10-14 and 15-19). The Figure 5.1 shows that aging index increases from 17.3 to 26.4 and median age increases from 20 to 22.6 accordingly. This means there was a significant increase in life expectancy and decrease in sex ratio at reproductive age group. The child dependency ratio has decreased from 69 to 56, working ratio has increased from 55 to 58, ageing dependency ratio has increased from 12 to 15, child- aged ratio has decreased from 81 to 71, sex ratio has decreased from 99 to 91 and women ratio has decreased from 0.444 to 0.321 during census 2001 to 2011 (Appendix I and Appendix III).

Figure 5. 1: Age sex pyramid 2001 and 2011 at Province 1



Source: Census data files, 2001 and 2011.

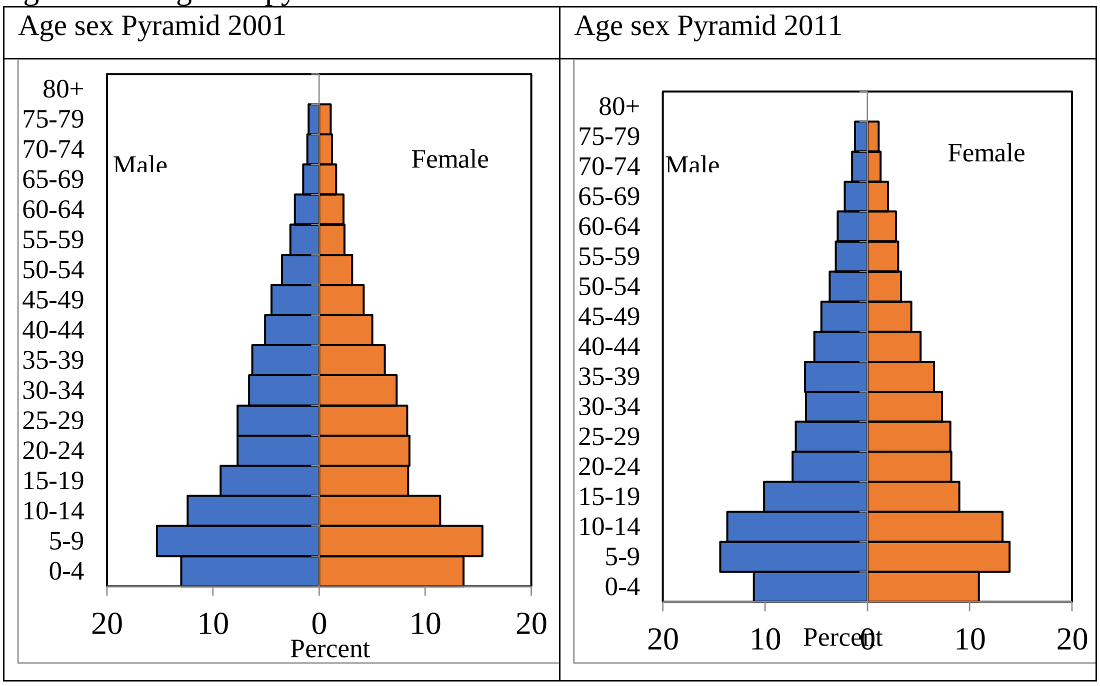
The sex ratio of the study population shows that male population with the age group between 15 to 40 years has declined sharply in comparison to other age groups. It might be the effect of absentee population. The demographic parameters represent the general idea about the child, adults, working age, reproductive age, schooling age and so on. So, it is important to study fertility and effect of migration for more clarity.

5.1.2 Household population by age and sex at Madhesh Province

Age sex structure analysis of 2001 for Madhesh Province (Figure 5.2) shows that the population in the age group 5-9 has the highest proportion followed by 0-4 age group. Age group 0-4 has is lower than 5-9 age group. The data clearly indicates declining fertility and mortality. In other hand, 2011 census shows that highest proportion age group is 5-9 and followed by the 10-14 age groups. In 2001 and 2011 data were smoothed by Arriaga method.

The aging index increases from 15.0 to 19.5 accordingly. This means there was significant increase in life expectancy and decrease in sex ratio at reproductive age. The Figure 5.2 shows that the child dependency ratio has decreased from 76 to 71, working ratio has increased from 53 to 54, ageing dependency ratio has increased from 11 to 14, child dependency ratio has decreased from 76 to 71, child- aged ratio has decreased from 87 to 85, sex ratio has decreased from 107 to 101 and women ratio has decreased from 0.573 to 0.455 during census 2001 to 2011(Appendix I and Appendix III).

Figure 5. 2: Age sex pyramid 2001 and 2011 at Madhesh Province



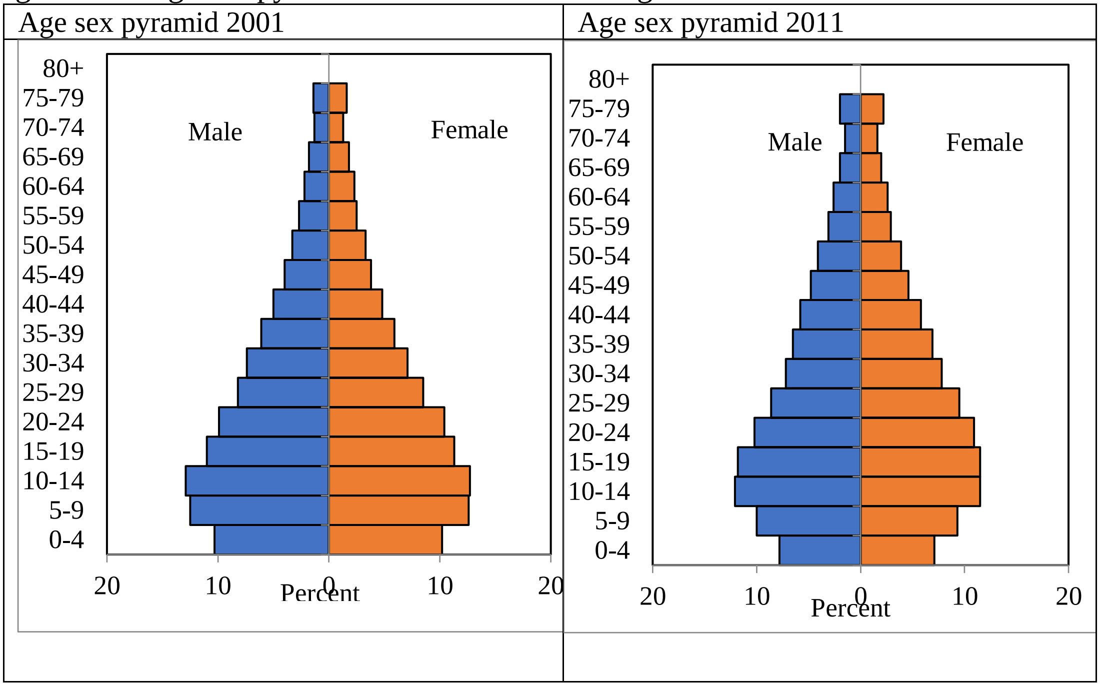
Source: Census data files, 2001 and 2011.

The sex ratio of the study population shows that male population with the age group between 15 to 40 years has declined sharply in comparison to other age groups. It might be the effect of absentee population. The demographic parameters represent the general idea about the child, adults, working age, reproductive age, schooling age and so on. So, it is important to study fertility and effect of migration for more clarity.

5.1.3 Household population by age and sex at Bagmati Province

The age-sex pyramids of household population clearly represents the population structure of specific time frame. The age-sex pyramid of Bagmati Province for census 2001 and 2011 are presented in Figure 5.3. Age sex structure analysis of census for Bagmati Province (Figure 5.3), 2001 has the highest proportion is 10-14 and followed by 5-9 and 0-4 age groups. Hence, the data clearly indicates declining fertility and mortality. Age 0-4 age group has lower than (5-9, 10-14 and 15-19). In other hand, 2011 census shows that highest proportion is 10-14 followed the 15-19 and 20-24 age groups. Age group 0-4 The has lower than subsequent (5-9, 10-14, 15-19 and 20-24) respectively.

Figure 5. 3: Age sex pyramid 2001 and 2011 at Bagmati Province



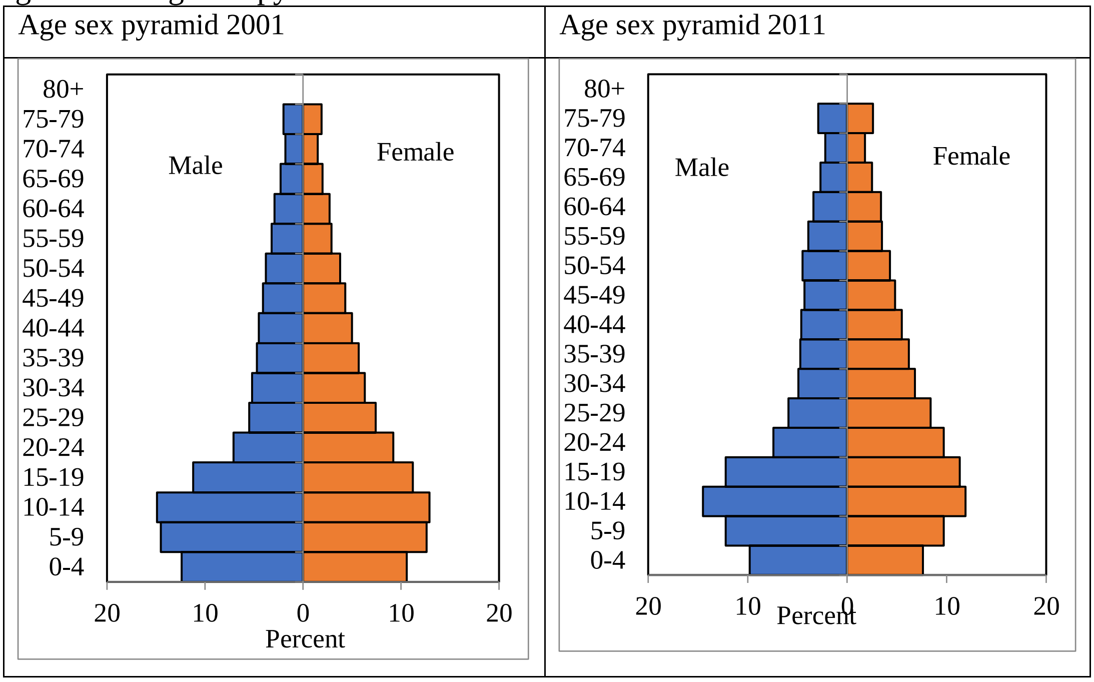
Source: Census data files, 2001 and 2011.

The Figure 5.3 shows that aging index increases from 19.2 to 28.6 accordingly. This means there was significant increase in life expectancy and decrease in sex ratio at reproductive age group. The child dependency ratio has decreased from 62 to 46, working ratio has increased from 58 to 63, ageing dependency ratio has increased from 12 to 13, child- aged ratio has decreased from 74 to 59, sex ratio has decreased from 102 to 99 and women ratio has increased from 0.402 to 0.260 during census 2001 to 2011(Appendix I and Appendix III). The sex ratio of the study population shows that male population with the age group between 15 to 40 years has declined sharply in comparison to other age groups. It might be the effect of absentee population.

5.1.4 Household population by age and sex at Gandaki Province

The age sex structure analysis of 2001 for Gandaki Province (Figure 5.4), 2001 has the highest proportion 10-14 followed by 5-9 with 10-14 followed by the 5-9 age group. In other hand, 2011 census shows that the highest proportion of the population is in the 10-14 age group followed by the 5-9 age group. The data clearly indicates declining fertility and mortality. The 0-4 age group of population is lower than subsequent (5-9 10-14, 15-19 and 20-24). In 2001 and 2011 data were smoothed by Arriaga method. The Figure 5.4 shows that aging index increases from 21.82 to 32.84 accordingly.

Figure 5. 4: Age sex pyramid 2001 and 2011 at Gandaki Province



Source: Census data files, 2001 and 2011.

This means there was significant increase in life expectancy and decrease in sex ratio at reproductive age group. The child dependency ratio has decreased from 74 to 57, working ratio has increased from 53 to 57, ageing dependency ratio has increased from 16 to 19, child dependency ratio has decreased from 90 to 76, sex ratio has decreased from 88 to 83 and women ratio has increased from 0.249 to 0.299 during census 2001 to 2011(Appendix I and Appendix III).

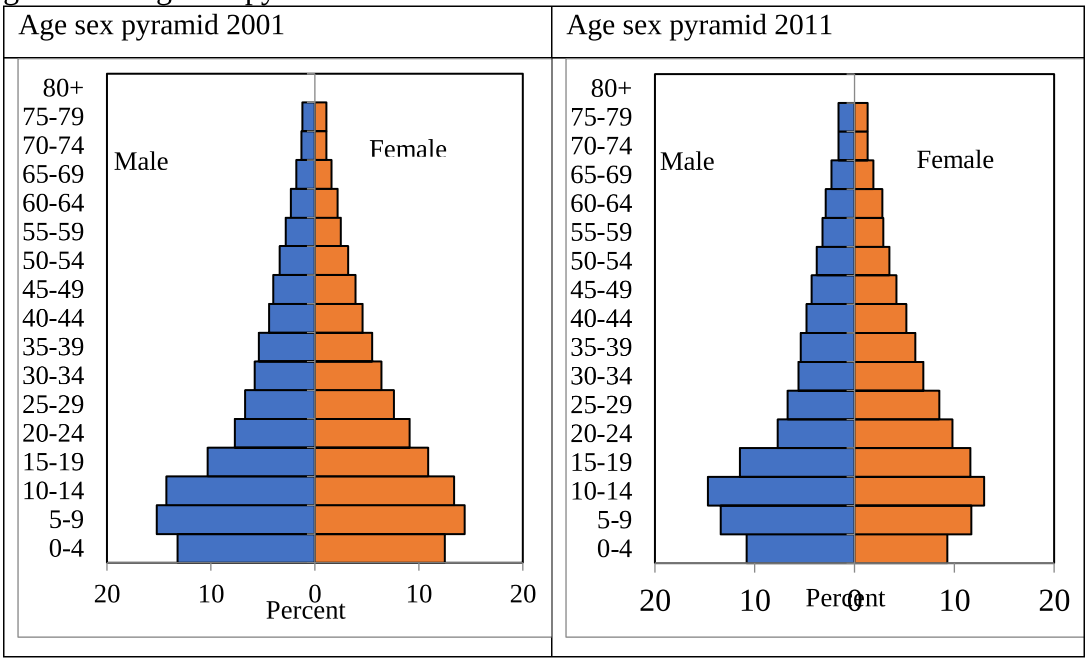
The sex ratio of the study population shows that male population with the age group between 15 to 40 years has declined sharply in comparison to other age groups. It might be the effect of absentee population.

5.1.5 Household population by age and sex at Lumbini Province

The age-sex pyramids of household population clearly represents the population structure of specific time frame. The age-sex pyramid of Lumbini Province for census 2001 and 2011 are presented in Figure 5.5.

The age-sex pyramids of household population clearly represents the population structure of specific time frame. The age-sex pyramid Lumbini Province for census 2001 and 2011 are presented in Figure 5.5.

Figure 5. 5: Age sex pyramid 2001 and 2011 at Lumbini Province



Source: Census data files, 2001 and 2011.

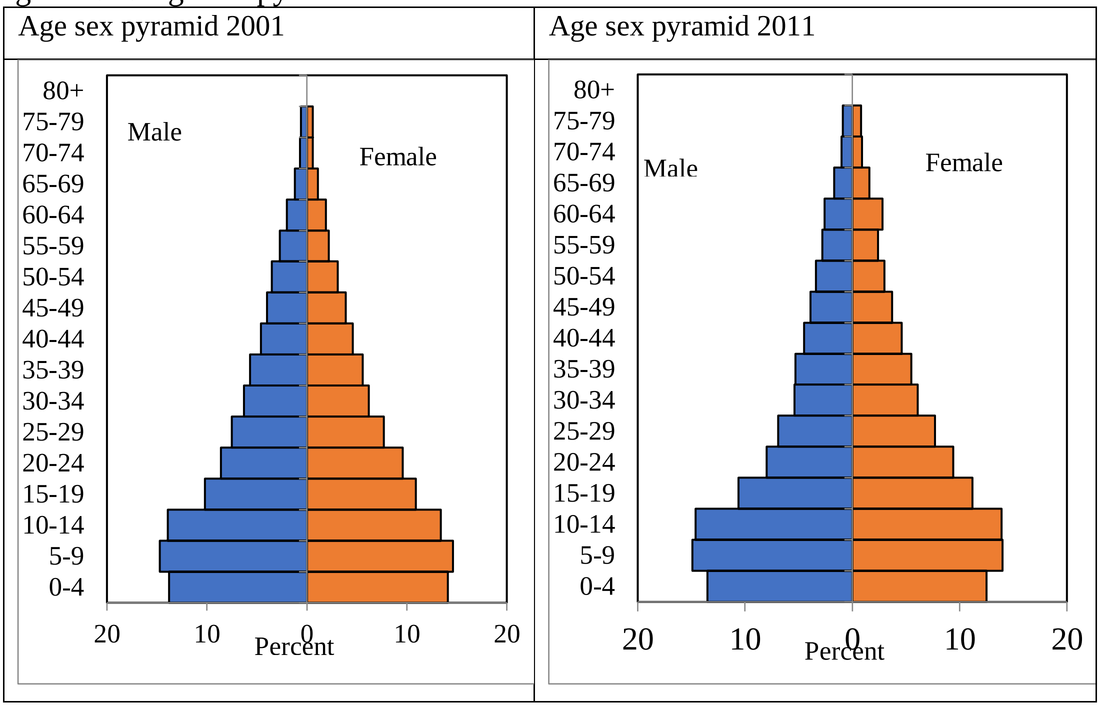
The age sex structure analysis for Lumbini Province (Figure 5.5) 2001 shows that the highest 5-9 age group which is proportion highest of the population followed by the 14 age groups. Hence, age 0-4 of the population is lower than 5-9 and 10-14 (5-9 and 10-14) age groups. In other hand, 2011 census shows that the highest population 10-14 followed by 5-9 and 0-4 age groups. The data clearly indicates declining fertility and mortality. Age 0-4 has lower than subsequent (5-9, 10-14 and 15-19). In 2001 and 2011 data were smoothed by Arriaga method.

The Figure 5.5 shows that aging index increases from 15.3 to 21.6 accordingly. This means there was significant increase in life expectancy and decrease in sex ratio at reproductive age group. The child dependency ratio has decreased from 79 to 65, working ratio has increased from 52 to 56, ageing dependency ratio has increased from 12 to 14, child dependency ratio has decreased from 88 to 76, child- aged ratio has increased from 87 to 91, sex ratio has decreased from 98 to 91 and women ratio has increased from 0.527 to 0.365 during census 2001 to 2011(Appendix I and Appendix III). The sex ratio of the study population shows that male population with the age group between 15 to 40 years has declined sharply in comparison to other age groups.

5.1.6 Household population by age and sex at Karnali Province

Age sex structure analysis of 2001 for Karnali Province (Figure 5.6) shows that the population in the age group 5-9 has the highest proportion followed by 0-4 age group. In other hand, 2011 census shows that the age 0-4 has highest group of population followed by 5-9 and 10-14. The data clearly indicates declining fertility and mortality. The 0-4 population has lower than subsequent (5-9 and 10-14).

Figure 5. 6: Age sex pyramid 2001 and at Karnali Province



Source: Census data files, 2001 and 2011.

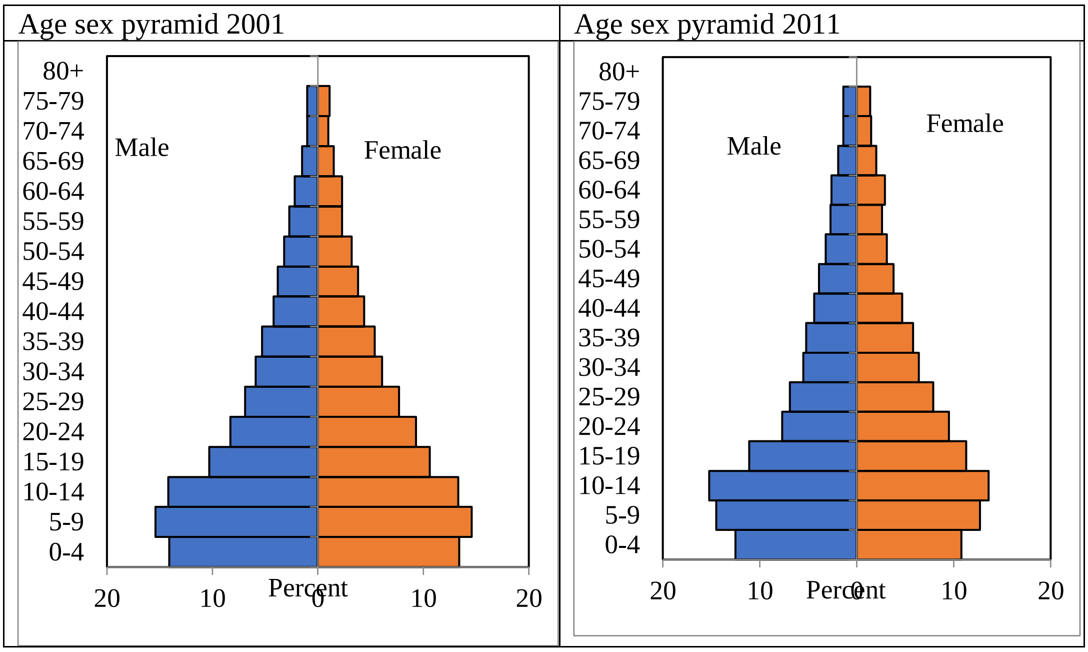
In 2001 and 2011 data were smoothed by Arriaga method. The Figure 5.6 shows that aging index increases from 13.6 to 19.1 accordingly. This means there was a significant increase in life expectancy and decrease in sex ratio at reproductive age group.

The child dependency ratio has increased from 79 to 80, working ratio has increased from 52 to 53, ageing dependency ratio has increased from 8 to 12, child- aged ratio has increased from 87 to 91, sex ratio has decreased from 101 to 96 and women ratio has decreased from 0.579 to 0.356 during census 2001 to 2011(Appendix I and Appendix III). sex ratio of the study population shows that male population with the age group between 15 to 40 years has declined sharply in comparison to other age groups.

5.1.7 Household population by age and sex at Sudurpashchim Province

Age sex structure analysis of 2001 for Sudurpashchim Province (Figure 5.7), 2001 shows that the population in the age group 5-9 has the highest proportion followed by the 0-4 age group. In other hand, 2011 census shows that 10-14 has highest proportion of population 10-14 followed by 5-9 age groups. The data clearly indicates declining fertility and mortality. The 0-4 population has lower than subsequent (5-9 and 10-14) age groups. In 2001 and 2011 data were smoothed by Arriaga method.

Figure 5. 7: Age sex pyramid 2001 and 2011 at Sudurpashchim Province



Source: Census data files, 2001 and 2011.

The Figure 5.7 shows that aging index increases from 13.6 to 19.1 accordingly. This means there was significant increase in life expectancy and decrease in sex ratio at reproductive age group. The child dependency ratio has decreased from 82 to 75, working ratio has increased from 52 to 53, ageing dependency ratio has increased from 11 to 14, child dependency ratio has decreased from 93 to 89, sex ratio has decreased from 98 to 91 and women ratio has decreased from 0.577 to 0.3450 during census 2001 to 2011(Appendix I and Appendix III). The sex ratio of the study population shows that male population with the age group between 15 to 40 years has declined sharply in comparison to other age groups. It might be the effect of absentee population. The demographic parameters represent the general idea about the child, adults, working age, reproductive age, schooling age and so on.

5.2 Estimation of fertility Arriaga method at the provincial level

To estimate fertility levels by comparing two or more sets of average CEB at provinces the Arriaga fertility method was used. The estimates calculated by the Arriaga fertility method were used to adjust observed fertility patterns same as the changing Brass P/F ratio method which was implemented as part of the Population Analysis System in two census data (Bumpass & Tsuya, 2003). Arriaga approach can be used for both theoretical analysis and simulations which has a modern statistical advantage over a traditional deterministic population estimation method. By using data on its age and gender distribution population's TFR can be estimated if crucial event registration is missing or insufficient.

The information of the vital statistics in Nepal is incomplete as like other majority of developing countries, hence, it requires the use of indirect estimation methods to estimate fertility rates. In contrast to the brass method, which assumes a constant fertility, Arriaga's hypothesis implicitly changes to the hypothesis that the average number of children born per women changes linearly at time intervals that are taken into account.

The fertility based data of Nepal indicates that fertility is in declining trend hence Arriaga's technique is applicable to determine the validity of the tendency of fertility at provinces. The fluctuations in the fertility pattern happens when misreporting of children in older ages of the female population takes place. In such case no adjustment is required for comparing CEB with the cumulative pattern of fertility as the Arriaga technique can estimate the fertility with the comparison of two sets of CF rates.

The first set represents the pattern and the second is derived from the data on CEB that represents the level of fertility. Even if the information on the average number of CEB by age of mother and pattern of fertility are available for only one date the Arriaga's technique also be used for fertility estimation. In such situation, the fertility during the past was supposed to be constant, and the results should be practically the same as in the previous two techniques. The averages between the values of the preceding and following years are taken to determine the fertility in case of intermediate surveys.

5.2.1 Estimation of fertility Arriaga method at Province 1

This study has based on CEB according to reproductive age group of women at Province 1 using 2001 and 2011 census data set. Table 5.1 is based on age specified data of reproductive age span of women at Province 1 for 2001 census; the adjusted values were estimated on the basis of cumulative ASFR and cumulative ASFR pattern. The adjusted value for age group was found in decreasing trends with increasing the age group.

Table 5. 1: Estimation of ASFR based on 2001 census at Province 1

Age	ASFR from CEB	Cum. ASFR	ASFR Pattern	Cum. ASFR pattern	Adj factors	Adj. Fertility f*
15-19	0.065	0.065	0.027	0.027	2.427	0.056
20-24	0.180	0.245	0.106	0.132	2.087	0.221
25-29	0.162	0.407	0.100	0.233	1.849	0.209
30-34	0.092	0.499	0.066	0.299	1.769	0.138
35-39	0.048	0.547	0.045	0.344	1.692	0.094
40-44	0.009	0.556	0.022	0.366	1.519	0.046
45-49	0.001	0.557	0.007	0.373	1.493	0.015
TFR						**3.892**

Source: Census data files, 2001 and 2011.

The adjusting factor of P_2/F_2 values (2.087) has resulted adjusted ASFR for all age group and the adjusted TFR value was 3.9 in December 2000. The mean age of childbearing was 28.7 years. The TFR value was (3.9) found lower than national census value 4.1(Central Bureau of Statistics, 2003).

Table 5. 2: Estimation of ASFR based on 2011 census at Province 1

Age	ASFR from CEB	Cum. ASFR	ASFR Pattern	Cum. ASFR pattern	Adj factors	Adj. Fertility f*
15-19	0.046	0.046	0.021	0.021	2.168	0.037
20-24	0.149	0.194	0.088	0.109	1.779	0.157
25-29	0.122	0.317	0.084	0.193	1.640	0.150
30-34	0.065	0.381	0.048	0.241	1.580	0.085
35-39	0.030	0.412	0.024	0.265	1.552	0.043
40-44	0.011	0.423	0.011	0.276	1.529	0.020
45-49	0.003	0.426	0.003	0.279	1.523	0.005
TFR						**2.482**

Source: Census data files, 2001 and 2011.

Table 5.2 is based on age specified data of reproductive age span of women at Province 1 for 2011 census; the adjusted values were estimated on the basis of cumulative ASFR and cumulative ASFR pattern. The adjusted value for age group was found in decreasing trends with increasing the age group. The adjusting factor of

P_2/F_2 values (1.779) has resulted adjusted ASFR for all age group and the adjusted TFR value was 2.5 in December 2010. The mean age of childbearing was 27.7 years. The TFR value estimated (2.5) was found lower than national census value 2.6 (Central Bureau of Statistics, 2014).

5.2.2 Estimation of fertility Arriaga method at Madhesh Province

It is based on age specified data of reproductive age span of women at Madhesh Province (2001 census); the adjusted values are estimated on the basis of cumulative ASFR and cumulative ASFR pattern in Table 5.3. The adjusting value for age group was found in decreasing trends with increasing the age group.

Table 5. 3: Estimation of ASFR based on 2001 census at Madhesh Province

Age	ASFR from CEB	Cum. ASFR	ASFR Pattern	Cum. ASFR pattern	Adj factors	Adj. Fertility f*
15-19	0.111	0.111	0.032	0.032	3.451	0.089
20-24	0.187	0.298	0.093	0.125	2.788	0.259
25-29	0.153	0.451	0.080	0.205	2.204	0.223
30-34	0.071	0.522	0.052	0.257	2.030	0.145
35-39	0.016	0.538	0.031	0.288	1.870	0.086
40-44	0.005	0.543	0.017	0.305	1.778	0.047
45-49	0.002	0.544	0.010	0.315	1.729	0.028
TFR						**4.391**

Source: Census data files, 2001 and 2011.

The adjusting factor of P_2/F_2 values (2.788) has resulted adjusted ASFR for all age group and the adjusted TFR value was 4.4 in December 2000. The mean age of childbearing was 28.3 years. The TFR value was (4.4) found higher than national census value 4.1 (Central Bureau of Statistics, 2003).

Table 5. 4: Estimation of ASFR based on 2011 census at Madhesh Province

Age	ASFR from CEB	Cum. ASFR	ASFR Pattern	Cum. ASFR pattern	Adj factors	Adj. Fertility f*
15-19	0.071	0.071	0.021	0.021	3.397	0.051
20-24	0.185	0.256	0.086	0.106	2.408	0.207
25-29	0.136	0.392	0.071	0.177	2.211	0.171
30-34	0.074	0.466	0.041	0.218	2.138	0.099
35-39	0.019	0.485	0.023	0.241	2.016	0.055
40-44	0.003	0.488	0.011	0.252	1.938	0.026
45-49	0.001	0.489	0.005	0.257	1.906	0.012
TFR						**3.106**

Source: Census data files, 2001 and 2011.

Table 5.4 is based on age specified data of reproductive age span of women at Province 2 (2011 census); the adjusted values were estimated on the basis of cumulative ASFR and cumulative ASFR pattern. The adjusting value for age group was found in decreasing trends with increasing the age group. Here, adjusting factor of P_2/F_2 values (2.4) has resulted adjusted ASFR for all age group and the adjusted TFR value was 3.1 in December 2011. The mean age of childbearing was 27.7 years. The TFR value estimated (3.1) was found higher than national census value 2.6 (Central Bureau of Statistics, 2014).

5.2.3 Estimation of fertility Arriaga method at Bagmati Province

This study is based on CEB according to reproductive age group of women at using 2001 and 2011 census data set at Bagmati Province. Table 5.5 is based on age specified data of reproductive age span of women at Bagmati Province for 2001 census; the adjusted values were estimated on the basis of cumulative ASFR and cumulative ASFR pattern.

Table 5. 5: Estimation of ASFR based on 2001 census at Bagmati Province

Age	ASFR from CEB	Cum. ASFR	ASFR Pattern	Cum. ASFR pattern	Adj factors	Adj. Fertility f*
15-19	0.066	0.066	0.025	0.025	2.589	0.055
20-24	0.160	0.226	0.099	0.125	2.211	0.219
25-29	0.136	0.362	0.080	0.204	1.773	0.177
30-34	0.075	0.437	0.049	0.254	1.722	0.108
35-39	0.037	0.474	0.029	0.283	1.676	0.064
40-44	0.019	0.493	0.014	0.296	1.665	0.031
45-49	0.006	0.499	0.005	0.301	1.658	0.011
TFR						**3.328**

Source: Census data files, 2001 and 2011.

The adjusting factor of P_2/F_2 values (2.211) has resulted adjusted ASFR for all age group and the adjusted TFR value was 3.3 in December 2001. The mean age of childbearing was 27.8 years. The TFR value (3.3) was lower than national census value 4.1 (Central Bureau of Statistics, 2003).

Table 5. 6: Estimation of ASFR based on 2011 census at Bagmati Province

Age	ASFR from CEB	Cum. ASFR	ASFR Pattern	Cum. ASFR pattern	Adj factors	Adj. Fertility f*
15-19	0.035	0.035	0.018	0.018	2.024	0.031
20-24	0.123	0.158	0.075	0.093	1.703	0.128
25-29	0.113	0.271	0.070	0.163	1.664	0.119
30-34	0.059	0.330	0.038	0.200	1.646	0.065
35-39	0.027	0.357	0.016	0.217	1.648	0.027
40-44	0.009	0.366	0.007	0.224	1.634	0.012
45-49	0.002	0.368	0.002	0.226	1.627	0.003
TFR						**1.924**

Source: Census data files, 2001 and 2011.

Table 5.6 is based on age specified data of reproductive age span of women at Bagmati Province for 2011 census; the adjusted values were estimated on the basis of cumulative ASFR and cumulative ASFR pattern. The adjusted value for age group was found in decreasing trends with increasing the age group. The adjusting factor of P_2/F_2 values (1.703) has resulted adjusted ASFR for all age group and TFR value was 1.928 in December 2010. The mean age of childbearing was 27.8 years. The TFR value estimated (1.9) was found lower than national census value 2.6 (Central Bureau of Statistics, 2014).

5.2.4 Estimation of fertility Arriaga method at Gandaki Province

It is based on age specified data of reproductive age span of women at Gandaki Province (2001 census); the adjusted values were estimated on the basis of cumulative ASFR and cumulative ASFR pattern. The adjusting value for age group was found in decreasing trends with increasing the age group. This study has based on CEB according to reproductive age group of women at Gandaki Province using 2001 and 2011 census data set (Table 5.7).

Table 5. 7: Estimation of ASFR based on 2001 census at Gandaki Province

Age	ASFR from CEB	Cum. ASFR	ASFR Pattern	Cum. ASFR pattern	Adj factors	Adj. Fertility f*
15-19	0.077	0.077	0.027	0.027	2.911	0.057
20-24	0.190	0.267	0.122	0.148	2.097	0.256
25-29	0.147	0.413	0.094	0.242	1.707	0.197
30-34	0.077	0.490	0.054	0.296	1.656	0.113
35-39	0.044	0.534	0.032	0.328	1.628	0.067
40-44	0.014	0.548	0.018	0.347	1.580	0.038
45-49	0.003	0.550	0.006	0.353	1.560	0.013
TFR						**3.701**

Source: Census data files, 2001 and 2011.

The adjusting factor of P_2/F_2 values (2.097) has resulted adjusted ASFR for all age group and the adjusted TFR value was 3.7 in December 2000. The mean age of childbearing was 28.8 years. The TFR value estimated (3.7) was found lower than national census value 4.1 (Central Bureau of Statistics, 2003).

Table 5. 8: Estimation of ASFR based on 2011 census at Gandaki Province

Age	ASFR from CEB	Cum. ASFR	ASFR Pattern	Cum. ASFR pattern	Adj factors	Adj. Fertility f*
15-19	0.052	0.052	0.027	0.027	1.895	0.043
20-24	0.155	0.206	0.102	0.129	1.602	0.163
25-29	0.122	0.328	0.078	0.207	1.585	0.125
30-34	0.064	0.392	0.038	0.245	1.603	0.061
35-39	0.030	0.422	0.020	0.265	1.594	0.032
40-44	0.012	0.434	0.007	0.272	1.595	0.011
45-49	0.003	0.438	0.004	0.276	1.585	0.006
TFR						**2.211**

Source: Census data files, 2001 and 2011.

Table 5.8 is based on age specified data of reproductive age span of women at Gandaki Province (2011 census); the adjusted values were estimated on the basis of cumulative ASFR and cumulative ASFR pattern. The adjusting factor of P_2/F_2 values (1.602) has resulted adjusted ASFR for all age group and the adjusted TFR value was 2.2 in December 2010. The mean age of childbearing was 26.8years. The TFR value estimated (2.2) was found lower than national census value 2.6 (Central Bureau of Statistics, 2014).

5.2.5 Estimation of fertility Arriaga method at Lumbini Province

The evidence of Nepal indicates that fertility is declining hence Arriaga's technique should be applicable to determine the validity of this tendency at Lumbini Province. This study is based on CEB according to reproductive age group of women at Lumbini Province using 2001 and 2011 census data set.

Table 5. 9: Estimation of ASFR based on 2001 census at Lumbini Province

Age	ASFR from CEB	Cum. ASFR	ASFR Pattern	Cum. ASFR pattern	Adj factors	Adj. Fertility f*
15-19	0.090	0.090	0.036	0.036	2.512	0.076
20-24	0.206	0.296	0.116	0.152	2.103	0.244
25-29	0.164	0.461	0.095	0.247	1.865	0.200
30-34	0.103	0.563	0.065	0.312	1.803	0.137
35-39	0.059	0.622	0.040	0.352	1.767	0.084
40-44	0.020	0.642	0.022	0.374	1.717	0.046
45-49	0.005	0.648	0.008	0.382	1.697	0.017
TFR						**4.017**

Source: Census data files, 2001 and 2011.

Table 5.9 is based on age specified data of reproductive age span of women at Lumbini Province for 2001 census; the adjusted values were estimated on the basis of cumulative ASFR and cumulative ASFR pattern. The adjusted value for age group was found in decreasing trends with increasing the age group. The adjusting factor of P_2/F_2 values (2.1) has resulted adjusted ASFR for all age group and the adjusted TFR value was 4. 0 in December 2000. The mean age of childbearing was 28.2 years. The TFR value (4.0) was found lower than national census value 4.1 (Central Bureau of Statistics, 2003).

Table 5. 10: Estimation of ASFR based on 2011 census at Lumbini Province

Age	ASFR from CEB	Cum. ASFR	ASFR Pattern	Cum. ASFR pattern	Adj factors	Adj. Fertility f*
15-19	0.059	0.059	0.025	0.025	2.385	0.050
20-24	0.183	0.242	0.096	0.121	2.003	0.192
25-29	0.147	0.389	0.077	0.198	1.970	0.154
30-34	0.089	0.478	0.043	0.240	1.988	0.086
35-39	0.054	0.532	0.025	0.265	2.007	0.050
40-44	0.031	0.563	0.011	0.276	2.040	0.022
45-49	0.010	0.573	0.004	0.280	2.046	0.008
TFR						**2.814**

Source: Census data files, 2001 and 2011.

Table 5.10 is based on age specified data of reproductive age span of women at Lumbini Province for 2011 census; the adjusted values were estimated and the adjusted value for age group was found in decreasing trends with increasing the age group. The adjusting factor of P_2/F_2 values (2.0) has resulted adjusted ASFR for all age group and the adjusted TFR value was 2.8 in December 2010 compared at national census value 2.6 (Central Bureau of Statistics, 2014).

5.2.6 Estimation of fertility Arriaga method at Karnali Province

The information of the vital statistics in Nepal is incomplete as like other majority of developing countries, hence, it requires the use of indirect estimation methods to estimate fertility rates.

In contrast to the brass method, which assumes a constant fertility, Arriaga's hypothesis implicitly changes to the hypothesis that the average number of children born per women changes linearly at time intervals that are taken into account. It is based on age specified data of reproductive age span of women at Karnali Province (2001 census); the adjusted values were estimated on the basis of cumulative ASFR and cumulative ASFR pattern (Table 5.11). The adjusting value for age group was found in decreasing trends with increasing the age group.

Table 5. 11: Estimation of ASFR based on 2001 census at Karnali Province

Age	ASFR from CEB	Cum. ASFR	ASFR Pattern	Cum. ASFR pattern	Adj factors	Adj. Fertility f*
15-19	0.102	0.102	0.038	0.038	2.663	0.089
20-24	0.236	0.338	0.122	0.160	2.314	0.281
25-29	0.231	0.569	0.105	0.265	2.148	0.243
30-34	0.166	0.735	0.078	0.343	2.142	0.181
35-39	0.109	0.844	0.054	0.397	2.125	0.125
40-44	0.066	0.910	0.029	0.426	2.137	0.067
45-49	0.022	0.932	0.011	0.437	2.131	0.027
TFR						**5.061**

Source: Census data files, 2001 and 2011.

The adjusting factor of P_2/F_2 values (2.314) has resulted adjusted ASFR for all age group and the adjusted TFR value was 5.06 in December 2000. The mean age of childbearing was 28.9 years. The TFR value (5.0) was found higher than national census value 4.1 (Central Bureau of Statistics, 2003).

Table 5. 12: Estimation of ASFR based on 2011 census at Karnali Province

Age	ASFR from CEB	Cum. ASFR	ASFR Pattern	Cum.ASFR pattern	Adj factors	Adj. Fertility f*
15-19	0.091	0.091	0.038	0.038	2.387	0.075
20-24	0.268	0.359	0.137	0.175	2.048	0.271
25-29	0.224	0.583	0.119	0.294	1.981	0.236
30-34	0.147	0.731	0.075	0.370	1.976	0.149
35-39	0.107	0.838	0.049	0.419	2.001	0.097
40-44	0.074	0.911	0.027	0.446	2.044	0.054
45-49	0.025	0.936	0.014	0.460	2.035	0.028
TFR						**4.546**

Source: Census data files, 2001 and 2011.

Table 5.12 is based on age specified data of reproductive age span of women at Karnali Province (2011 census); the adjusted values were estimated on the basis of cumulative ASFR. The adjusting factor of P_2/F_2 values (1.981) has resulted adjusted ASFR and adjusted TFR value was 4.5 in December 2010.The TFR value (4.5) was found higher than national census value 2.6 (Central Bureau of Statistics, 2014).

5.2.7 Estimation of fertility Arriaga method at Sudurpashchim Province

In the case of intermediate surveys, the averages between the values of the preceding and following years are taken to determine the fertility. This study has based on CEB according to reproductive age group of women at Sudurpashchim Province using 2001 and 2011 census data set.

Table 5. 13: Estimation of ASFR based on 2001 census at Sudurpashchim Province

Age	ASFR from CEB	Cum. ASFR	ASFR Pattern	Cum.ASFR pattern	Adj factors	Adj. Fertility f*
15-19	0.097	0.097	0.037	0.037	2.630	0.077
20-24	0.237	0.334	0.132	0.169	2.079	0.274
25-29	0.193	0.527	0.114	0.283	1.865	0.237
30-34	0.128	0.656	0.077	0.360	1.821	0.160
35-39	0.088	0.744	0.057	0.417	1.784	0.119
40-44	0.037	0.781	0.027	0.444	1.761	0.056
45-49	0.010	0.791	0.010	0.454	1.744	0.021
TFR						**4.719**

Source: Census data files, 2001 and 2011.

Table 5.13 is based on age specified data of reproductive age span of women at Sudur Pachhim Province (2001 census); the adjusted values are estimated on the basis of cumulative ASFR and cumulative ASFR pattern. The adjusting value for age group was found in decreasing trends with increasing the age group. The adjusting factor of P_2/F_2 values (2.079) has resulted adjusted ASFR for all age group and the adjusted TFR value was 4.7 in December 2000. The mean age of childbearing was 28.7 years.

The TFR value (4.7) was found higher than national census value 4.1 (Central Bureau of Statistics, 2003).

Table 5. 14: Estimation of ASFR based on 2011 census at Sudurpashchim Province

Age	ASFR from CEB	Cum. ASFR	ASFR Pattern	Cum. ASFR pattern	Adj factors	Adj. Fertility f*
15-19	0.067	0.067	0.027	0.027	2.513	0.055
20-24	0.236	0.303	0.123	0.150	2.022	0.249
25-29	0.193	0.496	0.113	0.263	1.888	0.229
30-34	0.125	0.621	0.061	0.324	1.916	0.123
35-39	0.087	0.708	0.038	0.362	1.955	0.077
40-44	0.051	0.760	0.017	0.379	2.003	0.034
45-49	0.017	0.776	0.007	0.387	2.008	0.014
TFR						**3.903**

Source: Census data files, 2001 and 2011.

Table 5.14 is based on age specified data of reproductive age span of women at Sudurpashchim Province (2011 census); the adjusted values were estimated on the basis of cumulative ASFR and cumulative ASFR pattern. The adjusting value for age group was found in decreasing trends with increasing the age group. Here, adjusting factor of P_2/F_2 values (2.022) has resulted adjusted ASFR for all age group and the adjusted TFR value was 3.9 in December 2000. The mean age of childbearing was 28.0 years. The estimated TFR value (3.9) was found lower than national census value 2.6 (Central Bureau of Statistics, 2014).

5.3 Estimation of fertility for hypothetical inter- survey cohort at the provincial level

The indirect method of demographic assement aviable to date are frequently insufficient to predict levels. However, the use of hypothetical cohort-based measurements is used to reduce the impacts of trends and estimate period levels in different caste/ethnic groups. If fertility rate changes, lifetime fertility and cumulative period fertility rates will not be same and hence an adjustment factor should be used to deterrmine it on the basis of comparison, that will refelect not only probable data mistake but also the impacts of changes over time.

Instead of lacking ASFRs of end points for the given period, a set of rates corresponding to the period's mid-point could be utilized and in case of hypothetical inter- survey cohort method two dates of number of CEB and number of births before 12 months according to reproductive age groups of women can also be taken (United Nations, 1983).

5.3.1 Estimation of fertility for inter- survey cohort at Province 1

It was based on medium variant estimation, follows changing reported parities methods at Province 1 procedure in P (i, s)/F (i) ratios. The adjustment factor (K) for registered births and its reciprocal (1 /K) for the estimation of the completeness of birth registration, with inter-censual birth rate was estimated by summing total births registered during the years 2001-2011 at Province 1.

Table 5. 15a: Estimation of ASFR based on inter- survey cohort at Province 1

Age	2001P(i)	2011P(i)	∆ P(i)	P(i,s)	2001 f(i)	2011 f(i)
15-19	0.116	0.067	0.067	0.067	0.027	0.021
20-24	0.803	0.629	0.629	0.629	0.106	0.088
25-29	1.897	1.499	1.383	1.450	0.100	0.084
30-34	2.773	2.191	1.388	2.017	0.066	0.048
35-39	3.459	2.740	0.843	2.293	0.045	0.024
40-44	3.929	3.192	0.419	2.436	0.022	0.011
45-49	4.284	3.517	0.058	2.351	0.007	0.003

Source: Census data files, 2001 and 2011.

Table 5. 15b: Estimation of ASFR based on inter- survey cohort at Province 1

Age	f(i)	ϕ (i)	F(i)	K	f+	f*(i)
15-19	0.024	0.120	0.033	2.000	0.031	0.058
20-24	0.097	0.604	0.352	1.889	0.101	0.190
25-29	0.092	1.064	0.846	1.715	0.089	0.168
30-34	0.057	1.351	1.218	1.656	0.054	0.103
35-39	0.034	1.523	1.443	1.590	0.033	0.062
40-44	0.017	1.606	1.565	1.557	0.015	0.029
45-49	0.005	1.631	1.623	1.448	0.004	0.007
TFR						**3.081**

Source: Census data files, 2001 and 2011.

The changing reported average parities P (i, s) were calculated from the reported average parities of 2001 and 2011 censuses at Province 1. The period ASFR f(i) was obtained from the unadjusted ASFR was multiplied with K. The adjusted value 1.889 was estimated based on data in 2001 and 2011 censuses (Table 5.15a and 5.15b). Finally adjusted TFR value of Province 1 was calculated 3.081 for December 2005. Hence, the estimated TFR value was (3.0) found lower than the national value 3.1(Ministry of Health, 2006).

5.3.2 Estimation of fertility for hypothetical inter- survey cohort at Madhesh Province

The data of censuses 2001 and 2011 were used for the calculation of changing P/F ratio at Madhesh Province. The changing reported average parities P (i, s) were calculated from the reported average parities of 2001 and 2011 censuses at Madhesh

Province. It was based on medium variant estimation, follows changing reported parities methods with P (i, s)/F (i) ratios applied.

Table 5. 16a: Estimation of ASFR based on inter- survey cohort at Madhesh Province

Age	2001P(i)	2011P(i)	∆P(i)	P(i,s)	2001 f(i)	2011 f(i)
15-19	0.233	0.111	0.111	0.111	0.032	0.021
20-24	1.140	0.924	0.924	0.924	0.093	0.086
25-29	2.167	1.886	1.653	1.764	0.080	0.071
30-34	2.892	2.560	1.420	2.343	0.052	0.041
35-39	3.233	2.939	0.772	2.536	0.031	0.023
40-44	3.401	3.106	0.214	2.557	0.018	0.011
45-49	3.371	3.109	0.124-	2.412	0.010	0.005

Source: Census data files, 2001 and 2011.

Table 5. 16b: Estimation of ASFR based on inter- survey cohort at Madhesh Province

Age	f(i)	ϕ (i)	F(i)	K	f+	f*(i)
15-19	0.027	0.132	0.040	2.789	0.034	0.089
20-24	0.089	0.578	0.351	2.631	0.091	0.239
25-29	0.076	0.955	0.778	2.269	0.072	0.191
30-34	0.047	1.188	1.081	2.168	0.044	0.116
35-39	0.027	1.321	1.257	2.017	0.026	0.067
40-44	0.014	1.393	1.348	1.896	0.014	0.036
45-49	0.007	1.429	1.418	1.701	0.006	0.015
TFR						**3.759**

Source: Census data files, 2001 and 2011.

At Madhesh Province, the adjustment factor (K) for registered births and its reciprocal (1 /K) for the estimation of the completeness of birth registration, with inter-censual birth rate was estimated by summing total births registered during the years 2001-2011 in Nepal. The adjusted value 2.631 was estimated based on data in 2001 and 2011 censuses (Table 5.16a and 5.16b). Finally adjusted TFR value of Province 2 was calculated 3.8 for December 2005. Hence, the TFR value (3.8) was found higher than the national value 3.1 (Ministry of Health, 2016).

5.3.3 Estimation of fertility for inter- survey cohort at Bagmati Province

The data of censuses 2001 and 2011 were used for the calculation of changing P/F ratio at Bagmati Province. The changing reported average parities P (i, s) were calculated from the reported average parities of 2001 and 2011 censuses obtained from ASFR datasheet of 2001 and 2011 censuses. It was based on medium variant estimation, changing reported parities methods with P (i, s)/F (i) ratios applied.

Table 5. 17a: Estimation of ASFR based on inter- survey cohort at Bagmati Province

Age	2001P(i)	2011P(i)	∆ P(i)	P(i,s)	2001 f(i)	2011 f(i)
15-19	0.114	0.054	0.054	0.054	0.025	0.018
20-24	0.815	0.528	0.528	0.528	0.099	0.075
25-29	1.803	1.357	1.243	1.297	0.080	0.070
30-34	2.588	2.027	1.212	1.741	0.050	0.038
35-39	3.145	2.527	0.724	2.021	0.029	0.016
40-44	3.613	2.912	0.324	2.064	0.014	0.007
45-49	3.922	3.254	0.108	2.129	0.005	0.002

Source: Census data files, 2001 and 2011.

Table 5. 17b: Estimation of ASFR based on inter- survey cohort at Bagmati Province

Age	f(i)	ϕ (i)	F(i)	K	f+	f*(i)
15-19	0.021	0.107	0.029	1.833	0.028	0.048
20-24	0.087	0.544	0.320	1.654	0.090	0.153
25-29	0.075	0.917	0.742	1.748	0.071	0.122
30-34	0.044	1.135	1.036	1.680	0.041	0.070
35-39	0.023	1.249	1.196	1.689	0.021	0.036
40-44	0.010	1.300	1.273	1.621	0.010	0.016
45-49	0.004	1.318	1.312	1.623	0.003	0.005
TFR						**2.242**

Source: Census data files, 2001 and 2011.

The adjusted value 1.701 (mean value of P_2/F_2 = 1.654 and P3/F3 =1.748) was estimated based on data in 2001 and 2011 censuses (Table 5.17a and 5.17b). Finally adjusted TFR value of Bagmati Province was calculated 2.2 for December 2005. Hence, the TFR value (2.2) was found lower than the national value 3.1 (Ministry of Health, 2006).

5.3.4 Estimation of fertility for inter- survey cohort at Gandaki Province

The data of censuses 2001 and 2011 were used for the calculation of changing P/F ratio at Gandaki Province. The period ASFR f(i) was obtained from ASFR from 2001 and 2011 censuses used medium variant estimation, using P(i, s)/F (i) ratios applied.

Table 5. 18a: Estimation of ASFR based on inter- survey cohort at Gandaki Province

Age	2001P(i)	2011P(i)	∆ P(i)	P(i,s)	2001 f(i)	2011 f(i)
15-19	0.137	0.075	0.075	0.075	0.027	0.027
20-24	0.932	0.696	0.696	0.696	0.122	0.102
25-29	2.022	1.601	1.465	1.539	0.094	0.078
30-34	2.792	2.283	1.352	2.048	0.054	0.038
35-39	3.367	2.775	0.753	2.293	0.032	0.020
40-44	3.789	3.184	0.392	2.440	0.019	0.007
45-49	4.066	3.453	0.086	2.379	0.006	0.004

Source: Census data files, 2001 and 2011.

Table 5. 18b: Estimation of ASFR based on inter- survey cohort at Gandaki Province

Age	f(i)	ϕ (i)	F(i)	K	f+	f*(i)
15-19	0.027	0.134	0.036	2.096	0.036	0.062
20-24	0.112	0.693	0.412	1.741	0.114	0.198
25-29	0.086	1.123	0.924	1.666	0.081	0.141
30-34	0.046	1.352	1.247	1.642	0.043	0.075
35-39	0.026	1.483	1.422	1.613	0.025	0.043
40-44	0.013	1.547	1.512	1.614	0.012	0.021
45-49	0.005	1.573	1.565	1.520	0.004	0.007
TFR						**2.739**

Source: Census data files, 2001 and 2011.

The adjusted value 1.741was estimated based on data in 2001 and 2011 censuses (Table 5.18a and 5.18b). Finally adjusted TFR value of Gandaki Province was calculated 2.7 for December 2005. Hence, the TFR value (2.7) was found lower than the national value 3.1 (Ministry of Health, 2006).

5.3.5 Estimation of fertility for inter- survey cohort at Lumbini Province

The changing reported average parities P (i, s) calculated from the reported average parities of 2001 and 2011 censuses at Lumbini Province. It was based on medium variant estimation, changing reported parities methods using P (i, s)/F (i) ratio.

Table 5. 19a: Estimation of ASFR based on inter- survey cohort at Lumbini Province

Age	2001P(i)	2011P(i)	Δ P(i)	P(i,s)	2001 f(i)	2011 f(i)
15-19	0.166	0.083	0.083	0.083	0.036	0.025
20-24	1.058	0.816	0.816	0.816	0.116	0.096
25-29	2.205	1.850	1.683	1.766	0.095	0.077
30-34	3.050	2.617	1.559	2.376	0.065	0.043
35-39	3.705	3.194	0.989	2.755	0.040	0.025
40-44	4.086	3.669	0.619	2.994	0.022	0.011
45-49	4.323	3.968	0.263	3.018	0.008	0.004

Table 5.19b: Estimation of ASFR based on inter**-** survey cohort at Lumbini Province

Age	f(i)	ϕ (i)	F(i)	K	f+	f*(i)
15-19	0.030	0.151	0.045	1.859	0.039	0.076
20-24	0.106	0.682	0.414	1.970	0.108	0.213
25-29	0.086	1.112	0.909	1.943	0.082	0.162
30-34	0.054	1.382	1.257	1.890	0.051	0.101
35-39	0.032	1.543	1.467	1.878	0.031	0.061
40-44	0.017	1.625	1.582	1.893	0.015	0.030
45-49	0.006	1.655	1.646	1.834	0.005	0.009
TFR						**3.259**

Source: Census data files, 2001 and 2011.

The adjusted value 1.970 was estimated based on data in 2001 and 2011 censuses (Table 5.19a and 5.19b). Finally adjusted TFR value of Lumbini Province was calculated 3.3 for December 2005. Hence the estimated TFR value (3.3) was found higher than the national value 3.1 (Ministry of Health, 2006).

5.3.6 Estimation of fertility for inter- survey cohort at Karnali Province

The data of censuses 2001 and 2011 were used for the calculation of changing P/F ratio at Karnali Province. It was based on medium variant estimation, changing reported parities methods using P (i, s)/F (i) ratios applied. The adjustment factor (K) for registered births and its reciprocal (1 /K) for the estimation of the completeness of birth registration,

Table 5. 20a: Estimation of ASFR based on inter- survey cohort at Karnali Province

Age	2001P(i)	2011P(i)	Δ P(i)	P(i,s)	2001 f(i)	2011 f(i)
15-19	0.186	0.128	0.128	0.128	0.039	0.038
20-24	1.097	1.139	1.139	1.139	0.122	0.137
25-29	2.274	2.396	2.210	2.338	0.105	0.119
30-34	3.242	3.266	2.169	3.308	0.078	0.075
35-39	3.925	3.876	1.603	3.941	0.054	0.049
40-44	4.399	4.424	1.182	4.490	0.029	0.027
45-49	4.656	4.670	0.745	4.686	0.012	0.014

Source: Census data files, 2001 and 2011.

Table 5. 20b: Estimation of ASFR based on inter- survey cohort at Karnali Province

Age	f(i)	ϕ (i)	F(i)	K	f+	f*(i)
15-19	0.038	0.192	0.058	2.195	0.048	0.103
20-24	0.129	0.839	0.511	2.130	0.132	0.282
25-29	0.112	1.398	1.132	2.066	0.108	0.231
30-34	0.077	1.782	1.601	2.067	0.074	0.157
35-39	0.052	2.039	1.916	2.057	0.050	0.106
40-44	0.028	2.180	2.097	2.141	0.026	0.056
45-49	0.013	2.243	2.224	2.107	0.010	0.022
TFR						**4.778**

Source: Census data files, 2001 and 2011.

The adjusted value 2.130 was estimated based on data in 2001 and 2011 censuses (Table 5.20a and 5.20b). Finally adjusted TFR value of Karnali Province calculated 4.8 in December 2005. Hence, the TFR value was (4.8) found higher than the national value 3.1 (Ministry of Health, 2006).

5.3.7 Estimation of fertility for inter- survey cohort at Sudurpashchim Province

The period ASFR f(i) calculated from ASFR datasheet of 2001 and 2011 censuses was based on applied medium variant estimation, changing reported parities methods by using P (i, s)/F (i) ratios. The adjustment factor (K) for registered births and its reciprocal (1 /K) for the estimation of the completeness of birth registration, with inter-censual birth rate was estimated by summing total births registered during the years 2001-2011 in Nepal.

Table 5. 21a: Estimation of ASFR based on inter- survey cohort at Sudurpashchim

Age	2001P(i)	2011P(i)	∆ P(i)	P(i,s)	2001 f(i)	2011 f(i)
15-19	0.174	0.084	0.084	0.084	0.037	0.027
20-24	1.155	0.977	0.977	0.977	0.132	0.123
25-29	2.397	2.220	2.046	2.131	0.114	0.113
30-34	3.254	3.077	1.922	2.899	0.077	0.061
35-39	3.908	3.694	1.297	3.428	0.057	0.038
40-44	4.269	4.156	0.903	3.802	0.027	0.017
45-49	4.389	4.375	0.467	3.895	0.010	0.007

Table 5. 21b: Estimation of ASFR based on inter- survey cohort at Sudurpashchim

Age	f(i)	ϕ (i)	F(i)	K	f+	f*(i)
15-19	0.032	0.159	0.044	1.915	0.041	0.082
20-24	0.128	0.797	0.469	2.083	0.132	0.265
25-29	0.113	1.364	1.097	1.943	0.109	0.219
30-34	0.069	1.711	1.547	1.875	0.066	0.134
35-39	0.048	1.948	1.838	1.865	0.045	0.091
40-44	0.022	2.057	1.996	1.905	0.020	0.041
45-49	0.009	2.101	2.087	1.866	0.007	0.014
TFR						**4.228**

Source: Census data files, 2001 and 2011.

The adjusted value 2.013 (mean of P_2/F_2 = 2.083 and P3/F3 = 1.943) was estimated based on data in 2001 and 2011 censuses (Table 5.21a and 5.21b). Finally adjusted TFR value of Sudurpashchim Province was calculated 4.3 in December 2005. Hence, the TFR value (4.2) was found higher than the national value 3.1 (Ministry of Health, 2016) Ministry of Health, 2006.

5.4 Projection of fertility at the provincial level (reference date 2010)

For declining fertility and mortality rate Arriaga method and changing P/F ratio methods are suitable in estimating fertility. The estimation of caste/ethnic groups based TFR in December 2010 was verified by using logistic curve function on the basis of the data of December 2000 and December 2005. Arriaga and changing P/F ratio methods were used to estimate the TFR values. A trend extrapolation model is a simplistic model that uses the historical growth pattern to project the future growth pattern and the observation incorporates the demographic transition, in which fertility first changes slowly; it accelerates first then decelerates gradually. The phase of demographic transition in Nepal has reflected by the demographic scenario of diffrent caste/ethnic groups.

Table 5. 22: Estimated TFR values at provincial level, Nepal

Age	**Province 1**	**Madhesh**	**Bagmati**	**Gandaki**	**Lumbini**	**Karnali**	**Sudurpashchim**
Dec2000	3.892	4.391	3.33	3.70	4.02	5.06	4.72
Dec2005	3.081	3.759	2.24	2.74	3.26	4.78	4.23
Dec2010	2.482	3.106	1.92	2.21	2.81	4.55	3.90
Trends	-0.266	-0.130	-0.373	-0.273	-0.213	-0.099	-0.179

The adjusted TFR value of December 2000, 2005 and verified value (2010), slope and intercept were shows in Table 5.22. The parameter and TFR was obtained from the same value and hence the logistic curve method validated. So, similar method can be applied to project the TFR of reference date December 2015, 2020, 2025 and 2030.

5.5 Projection of fertility at the provincial level (reference date 2031)

Generally, the population growth rates are calculated from historical data by using certain mathematical formulas to predict the future size of the population. Population predictions in different caste/ethnicity are necessary for development planning. The estimates could be accurate for accurate data use and assumptions made in true reality. Prior to the projection, data must be adequately reviewed and adjusted for mistakes and the logistic curve being the most likely assumption. The ASFR is the modification of the general fertility rate in which fertility rates for each 5-year age cohort of women is calculated with the starting age group of 15 to 19 years and continuation up to the age group of 40 to 44 years. Most of the projection approaches extrapolate previous or current trends into the future to some degree. The estimated TFR values of different caste/ethnicity for December 2000, 2005 and 2010 by using logistic function has projected the TFR value up to December 2030.

It was used same slope for future projection. The model in spreadsheet TFRLGSTNew.xls interpolates and extrapolates of TFR. Finally, 2015, 2020, 2025 and 2030 data were used to interpolate point estimation with medium variant in different caste/ethnic groups. Fertility decline has been a primary determinant of population ageing and projected levels of fertility have important implications on the age structure of future population, including on the pace of population ageing. On these basis trends of TFR values projected (Table 5.23).

These dates based on census 2001 and 2011 points are estimated by linear interpolation and projection is based on time series logistic method. In fact, this research was used point estimation with medium variant interpolation in different caste/ethnic groups. TFR values were estimated on December 2000 and 2010 by using Arriaga method on December 2005.

Table 5. 23: Projected TFR values at the provincial level

Year	**Province 1**	**Madhesh**	**Bagmati**	**Gandaki**	**Lumbini**	**Karnali**	**Sudurpashchim**
Dec2000	3.89	4.39	3.33	3.70	4.02	5.06	4.72
Dec2005	3.08	3.76	2.24	2.74	3.26	4.78	4.23
Dec 2010	2.48	3.11	1.92	2.21	2.81	4.55	3.90
Dec2015	2.18	2.62	1.90	2.12	2.44	4.22	3.43
Dec2020	2.07	2.34	1.90	2.10	2.27	3.93	3.09
Dec2025	2.03	2.19	1.90	2.10	2.18	3.67	2.81
Dec 2030	2.01	2.10	1.90	2.10	2.14	3.42	2.59

The obtained values were verified and valid by using logistic curve. The projected Province 1 TFR of December 2015, 2020, 2025 and 2030 were obtained 2.2, 2.1, 2.0 and 2.0 respectively. Serially, all provinces were presented in Table 5.23 and mention as; Madhesh Province (2.6, 2.3, 2.2 and 2.1), Bagmati (1.9 for all dates), Gandaki (2.1 for all dates), Lumbini (2.4, 2.3, 2.2 and 2.1), Karnali (4.2, 3.9, 3.7 and 3.4), Sudurpashchim (3.4, 3.1, 2.8 and 2.6) in December 2015, 2020, 2025 and 2030.

However, exact date of projected TFR using linear interpolation are 2016, 2021, 2026 and 2031 respectively. The study shows that Lumbini, Karnali and Sudurpashchim and will have high fertility rate which is above the replacement level of fertility at the end of 2031. Similarly, the fertility rate of Madhesh Province and Gandaki will almost near to replacement level of fertility at the end of 2031. Then, Province 1 and Bagmati province will have high fertility rate which is above the replacement level of fertility at the end of 2031.

5.6 Chapter summary

This research is based on the applicability of various methods in estimating recent fertility levels in provincial level in Nepal. This evidence rendered the Hypothetical inter-survey cohort appropriate for estimation of the fertility level in the country for the period December 2000 to December 2010 (December 2005) in provincial level. Using the fertility levels for December 2000 and December 2005 the fertility level for the year December 2010 is estimated by logistic method. The logistic method with these parameters used to project fertility levels. The logistic method with these parameters is used to estimate fertility levels for 2015, 2020, 2025 and 2030 by linear interpolation at provincial level.

This study is based on CEB according to reproductive age group of women in provincial level using 2001 and 2011 census data set. The 2001 census shows that the Province 1, Bagmati Province, Gandaki Province, Lumbini Province had a lower value than the national census of TFR. Madhesh Province, Karnali Province, Sudurpashchim Province were found higher than the national census of TFR value 4.1(Central Bureau of Statistics, 2003). Similarly, this study shows that Province 1, Bagmati Province, Gandaki Province were lower value than the national census of TFR and Madhesh Province, Lumbini Province, Karnali Province Sudurpashchim Province were found higher than the national census of TFR value 2.6 (Central Bureau of Statistics, 2014). In application of hypothetical inter survey analysis, Province 1, Bagmati Province, Gandaki Province had a lower value than the national census of TFR value. Madhesh Province, Lumbini Province, Karnali Province, Sudurpashchim Province were found higher than the NDHS value 3.1 (Ministry of Health, 2006).

This study shows that Lumbini, Karnali and Sudurpashchim will have a high fertility rate which is above the replacement level of fertility at the end of 2031. Similarly, the fertility rate of Madhesh Province and Gandaki will almost near to replacement level of fertility at the end of 2031. Then, Province 1 and Bagmati Province will have a high fertility rate which is above the replacement level of fertility at the end of 2031.

CHAPTER 6

ESTIMATION AND PROJECTION OF FERTILITY AT LOCAL LEVEL

This chapter reflects the results of estimates and projection of TFR at local level. For doing so, the study has considered 753 local levels (municipalities and rural municipalities) for the 2011 census, and has been compared to 742 local levels in 2001. Robustness for the estimation of fertility has been checked through determination of standard error and Bayes procedure in comparison with NDHS 2016.

This study creates a unique neighborhood for each small customized subnational area. Each area needs to be small enough not only to portray small geographical variability in the rates of demographic characteristics but also to represent huge sample size to determine reliable outputs of downscaling.

EB estimations adjust entirely local level data with sufficient information from the neighborhood. This uses plentiful of neighbors' data. With the homogenous neighbor data, the local sample of the desired area becomes small. Among 100 smallest municipalities (< 550 reproductive age women), variability falls, and only a small increase in the mean and modal TFR estimates occurs due to the shrinkage effect of the Empirical Bayes step that appears to dominate.

In such small areas, TFR of EBB method concentrate in mode, with fewer lower and higher values compared to estimations from census. Among the municipalities with 550-2021 reproductive age women, the impact of downscaling and parity adjustment becomes complex and EBB increases with small scales in comparison to the census estimates, reflecting high estimate values. These estimations show balance in between downward shrinkage effects and upward parity effects. This results in positively skewed EBB distribution with higher mean and mode compared to the census TFR.

Among 100 large municipalities (2021-35,872) **l**ike those in the medium-sized**,** the effects of EBB appear qualitatively similar but vary largely in magnitude. Large municipalities, however, showed very small EB shrinkage effects and small parity adjustment effects. In those municipalities, local samples are many, therefore, local level estimates are less noisy. This condition, therefore, results in the identical estimations from large area EBB and census estimates.

Numerical differences have been depicted in summary statistics. Considering the pairs of adjacent municipalities EBB estimated mean for absolute difference in neighbours (MADN) is 0.28 children/woman, while it is 0.61 for the Census data of the same quantity. The correlation of 0.83 obtained between neighbouring values also depicts the similarity between local and neighbourhood data. The study has tried to explain how EB estimators borrow information from neighbours selectively with comparison among the three municipalities.

There is no actual local information on which estimates, viz. local, medium and big sample sizes, can be made. The approach borrows data from neighbours in which estimation of EB are nearer to the neighbourhood mean. In case of very large the local sample size as in Kathmandu Metropolitan City is, the study has tried to explain how EB estimators borrow information from neighbors selectively in comparing the three municipalities. There is no actual local information on which estimates viz. local, medium and big sample sizes, can be made. Hence, the method has been used to borrow data from neighbors' data in which EB estimates are close to the neighborhood average. In the case of very large areas like Kathmandu Metropolitan City, the EB estimate essentially ignores the local sample size and data from neighbors in favor of consistent local information. In Dhanushadham Municipality, with medium density of reproductive age women, the estimated EB fell in between the local level and neighborhood estimates. EB estimations usually alter the age pattern and its level. In the estimation context, strong priori assumptions are not required as there are backup datasets from other neighbourhood stations (Assunção et al., 2005).

This study has focused on local bodies of Nepal, so small area estimation is useful and reliable. The P/F regressions and TFR adjustments are representative patterns of the three municipalities, Kathmandu, Dhanusadam and Kanda, for the fits and levels of 2011 Census data.

6.1 Distribution of women and birth in 2011 and 2001 census

With the combination of five-year age category and a large census data (greater than 1,091,337 women aged 15–49, reporting greater than 49539 births in a previous year), majority of the 753 × 7 = 5271 (municipality age) cells have very few women or births from which is estimation period fertility rates, therefore census long-form questionnaires were used for the making data adequate for the analysis.

Table 6.1 shows the available sample sizes for women and births by different age groups. The data has presented the distribution of the total local level sample size according to the five-year age group category and combined all of the age groups. Most of the local level samples include less than 600 sampled women and less than 60 births during last year for the estimation for the TFR.

Table 6. 1: Sample size distributions for women and births by age groups, 2011

Age Group	Sampled Women			Sampled Births Last Year		
	5%ile	**Median**	**95%ile**	**5%ile**	**Median**	**95%ile**
15–19	81	188	1004	1	5	20
20–24	65	152	1002	5	17	83
25–29	52	134	835	4	13	59
30–34	43	112	683	1	6	27
35–39	40	104	600	0	3	12
40–44	34	91	490	0	1	5
45–49	33	77	403	0	0	2
15–49	368	841	5073	18	46	216

Source*:* Census data files, 2011.

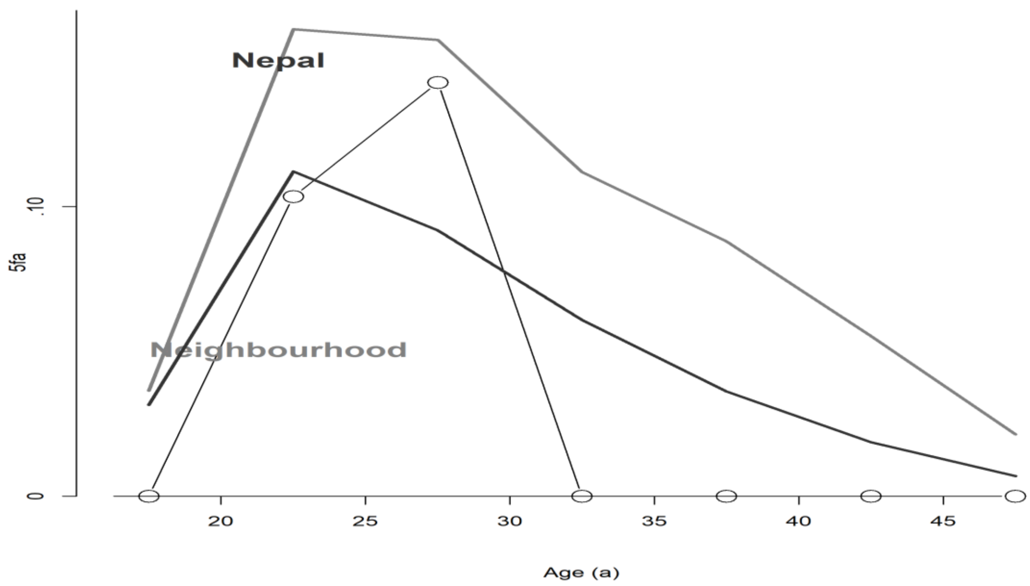
Table 6.1 shows sampled birth from the sampled women and its 5th percentile, 95th percentile and median in 2011 census. The estimated ASFR obtained from census (local births in the last year/local women) gives noisy and unreliable estimates with only 25 percent to 30 percent reliability for different age groups. In addition, for many cells having a minimum sampled woman produces implausibly high or low-rate estimates with small random fluctuations in local births.

Similarly, 2001 states that distributions of total local level sample size with all age's women combined. Most of the local level samples have less than 500 sampled women with less than 40 births in the last year. This was used for the estimation of the TFR. Particularly, problems of small samples for fertility rate estimation for births to women 30+ years old were more acute within some age groups.

6.2 Estimation of fertility (births last year/women) during 2011 and 2001

Kanda Rural Municipality in Sudurpashchim was the smallest local body having the lowest number of women samples in 2011.The Kanda Rural Municipality has only *n*=61women from the age group 15–49, and reported 7 births of the previous year of the census. The direct estimation of ASFRs gives value above 0.4 for 15-19 and 25-29 age groups and zero values for the last three age groups. The direct estimation of Kanda's TFR is extremely high (6.2). However, the value is unlikely because TFR in the municipalities near Kanda Rural Municipality was observed to be low compared to the national average in all the age groups (Figure 6.1).

Figure 6. 1: Estimation of ASFR ($_5f_a$) at local levels during 2011



During the 2001 census, the Kanda Rural Municipality has only *n*=30women from the age group 15–49, and reported 4 births of the previous year of the census. The direct estimation of ASFRs gives value above 0.3 for 15-19 and 25-29 age groups and zero values for the last three age groups. The direct estimation of Kanda's TFR is extremely high (7.3). However, the value is unlikely because TFR in the municipalities near Kanda Rural Municipality was observed to be low compared to the national average in all the age groups.

The small local level with error data has created the first major difficulty to produce a complete set of local level estimated TFR. This method has used EB smoothing for both ASFR and age-specific parity schedules. This model is based on (Schmertmann et al., 2013) which is used for the estimation of the fertility in a small area.

6.3 Local level fertility estimation based on 2011 census

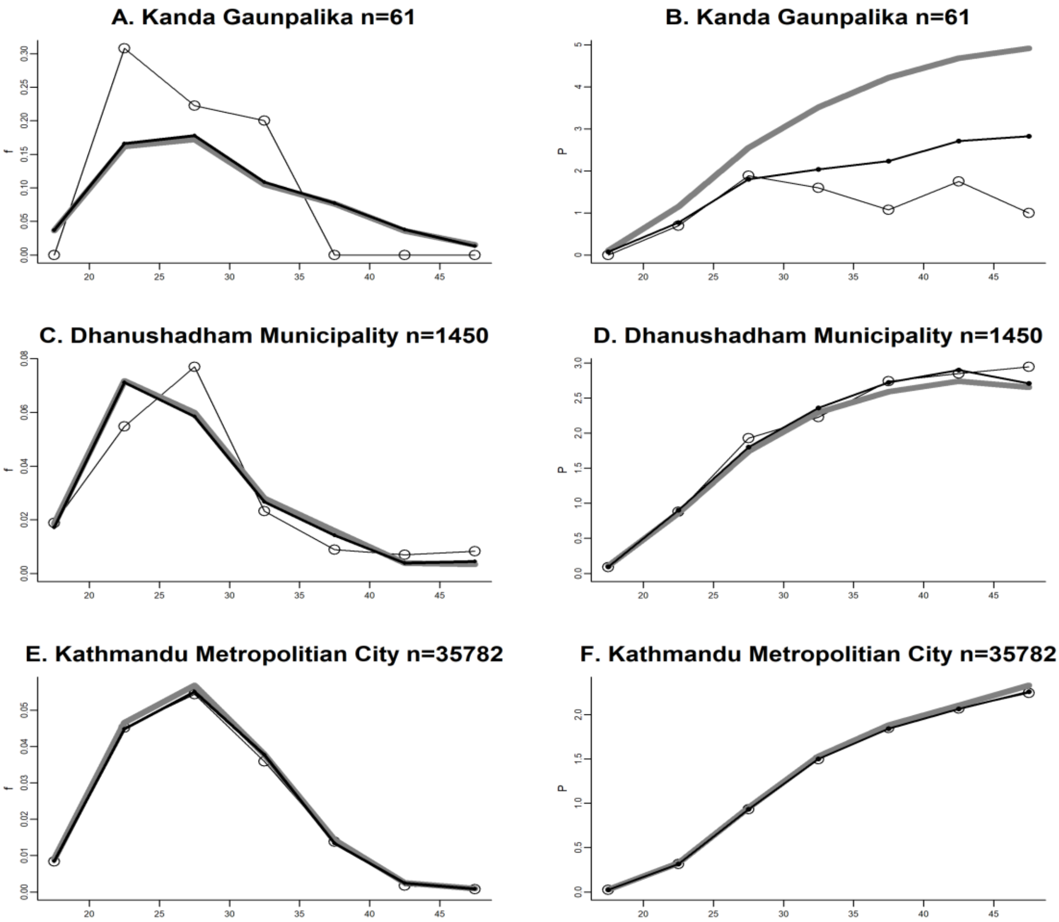
Three sample locations were selected on the basis of the population of reproductive aged women (15-49) according to 2011 census. Hence, for the estimation of fertility of smallest population size Kanda Rural Municipality of Banhjang, for middle population size Dhanushadham Municipality of Dhanusha, district and for largest population size Kathmandu Metropolitan City were considered for 2011 census data set.

Kanda Rural Municipality (with n=61) has been represented in Panels A (fertility) and B (parity). The data of Panels C and D for Dhanushadham Municipality, a municipality with 1450 women, median municipal sample size of n=1449.3 National. The Panels E and F represent data for Kathmandu Metropolitan City with a sample of 35782 women.

Figure 6.2 shows how EB estimators borrow information from neighbors selectively by comparing three municipalities. In this study, there is little local information on which to base the estimation (i.e., small local sample size and large Ω), and the method depend on heavily on neighborhood data, resulting in EB estimates close to neighborhood averages. When the local sample size is very large, as, in Kathmandu Metropolitan City, the EB estimate essentially does not consider information from neighbors favoring liable local information. For intermediate cases, such as Dhanushadham Municipality (Figure 6.2) the estimated EB schedule often falls between the local and neighborhood estimates (Schmertmann, 2003).

Figure 6.2 shows the results of EB estimation for complete set of 753 municipalities. The direct estimates in which only local birth/woman ratios are used are represented on the horizontal axis, and the EB estimates that combine local and neighborhood data are shown on y-axis of Figure 6.2. The left-hand panel shows how the EB method removed TFR outliers, especially those with very low local level estimation. The range of EB estimated TFRs was 0.577-4.53, while it was 0.25-4.83 when using purely local data.

Figure 6. 2: Comparison of fertility smallest, middle and largest municipality

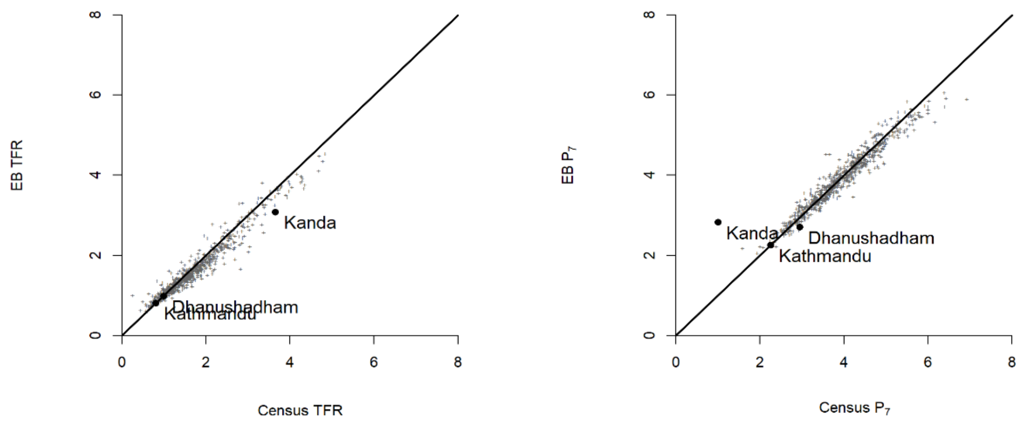


Source*:* Census data files, 2011.

The major variation due to EB smoothing of fertility rates is a regression where the mean effect with low TFR levels pulled upwards toward the (unweighted) municipal mean of 1.71 and high levels pushed downwards. The absolute mean difference between a municipality's EB and census estimates of TFR was 0.4.

The adjustment was highest for the areas with low number of local samples as suggested by the three municipalities. Figure 6.3 shows census versus Empirical Bayes (Schmertmann, 2014) estimates for 753 municipalities of Nepal in 2011. Each point corresponds to a municipality with three sample locations, Left-hand panel shows the TFR and parity at ages 45–49 in the right-hand panel. The census and EB estimate both are equal along the diagonal lines. The right-hand panel (Figure 6.3) displays census and EB estimates for parity among 45–49 years of women. The smoothing method matches, but EB-census differences are smaller for parity than for fertility.

Figure 6. 3: Comparison of EB and census estimates of TFR



Source*:* Census data files, 2011.

Figure 6.3 shows census versus Empirical Bayes (Schmertmann, 2014) estimates for 753 municipalities of Nepal in 2011. Each point corresponds to a municipality with three sample locations, Left-hand panel shows the TFR and parity at ages 45–49 in the right-hand panel. The census and EB estimate both are equal along the diagonal lines. The right-hand panel (Figure 6.3) displays census and EB estimates for parity among 45–49 years of women. The smoothing method matches, but EB-census differences are smaller for parity than for fertility.

This is mainly due to the low error and low smoothing of the local census estimator of the cumulative quantities. Although the change induced by EB smoothing is smaller for cohort measurements, it is important to note that this method requires stronger prior assumptions about spatial patterns than required for period data. In order for cohorts from neighboring regions to have similar cumulative experiences, must assume that neighboring regions are likely to have similar recent history and circumstances. Indirect estimation (Brass, 1996; Moultrie & Dorrington, 2008) uses a parametric strategy, assuming that a set of parameters (α, β) describe the regional period and the shape of the cohort fertility schedule. Parametric models have strong prior assumptions that are used in the absence of other data.

6.4 Estimation of fertility at local levels (Kanda Rural Municipality, Dhanushadham Municipality, Kathmandu Metropolitan City) in 2011

The following sections show the estimation of fertility at local levels, viz. Kanda Rural Municipality (smallest women fertility size), Dhanushadham Municipality (middle women population size) and Kathmandu Metropolitan City (largest women population size).

6.4.1 Estimation of fertility at Kanda Rural Municipality (2011)

Kanda Rural Municipality represents the smallest population size with only 61 women in reproductive age group. The regression model for smallest municipality, Kanda Rural Municipality, has used EB smoothed values for f_i and P_i. The values act as inputs for the projection of CF and time, as mean birth estimated birth parity equivalent with group and moments of interpolation. The hypothetical inter survey cohort are calculated considering TFR= $F_\omega(P_i/F_i)$, multiplied with μ_i-(12.5+5i) are considered by all weights.

Table 6. 2: Estimation of total fertility rate at Kanda Rural Municipality, 2011

Ages	**15–19**	**20–24**	**25–29**	**30–34**	**35–39**	**40–44**	**45–49**
Index (i)	**1**	**2**	**3**	**4**	**5**	**6**	**7**
Empirical Bayes Estimates							
P_{EB}	0.072	0.767	1.800	2.041	2.237	2.714	2.829
f_{EB}	0.037	0.166	0.178	0.109	0.077	0.038	0.013
Interpolated Moments							
F_i	0.036	0.541	1.503	2.213	2.666	2.959	3.054
μ_i	16.360	20.345	23.332	25.400	27.010	28.272	28.765
Regression Inputs							
(Pi/Fi)	1.976	1.419	1.197	0.922	0.839	0.917	0.927
(Yi=$F\omega$ Pi/Fi)	6.101	4.382	3.696	2.848	2.591	2.832	2.861
Avg (μ_x-$x)_i$	-1.140	-2.155	-4.168	-7.100	-10.490	-14.228	-18.735
Weight	0.024	0.353	1.115	1.618	2.007	2.615	2.801

Source: Census data files, 2011.

Table 6.2 reveals that P/F ratios of Kanda Rural Municipality is above unity at 15-49 age groups. The underreporting for older women during 2011 for current fertility estimation led to constant increase in adjustment factor in and above the age groups. This study reflected an increasing proportion with fast declining fertility at the Kanda Rural Municipality. This hypothetical inter-survey method for TFR estimate was estimated using adjusted factor, K (P/F). The TFR for second age group (20-24) was 4.4 (Y_2) and last age group (45-49) was 2.9 (Y_7). The second age group corresponds approximately 2.2 years before census and last age group (45-49) corresponds 18.7 years before the census.

The adjusted TFR estimated using regression model for all age group i=2…..7, obtained an estimated equation as: lnTFR =1.218+0.012t (Brass approach, TFR (0) = Y_2, where, r=0 for 20-24 age only positive weight.). The modified Brass estimate of TFR at Kanda Rural Municipality at time t=0 is the $e^{1.218}$ = 3.4. This shows significant increasing correction on the EB estimate indicating that the reference periods are crucial factor for downward bias in Kanda Rural Municipality. Increasing the upward correction from the EB estimate of 3.1 reflects that reference periods are important source of downward bias in the census data of Kanda Rural Municipality.

Generally, second age group (20-24) has mostly the absence of coverage errors due to which past trends analysis has shown greater fertility value in P_2/F_2; $F_\omega(P_2/F_2)$ (Y_2 =4.38), the value greater than unity. This study has depicted rapidly decreasing overall fertility compared to younger women who have high fertility values, thereby showing the non-negligible effects. The case study of Dhanushadham Municipality estimated TFR (45-49) to be about 2.2(Y_2) years earlier. The currently fertility was found decreasing with 22 percent and that for TFR to be 1.2 ($e^{.012(-2.155)}$ = 2.2) which is greater than current TFR due to rapidly decreasing fertility levels.

Similarly, 2001 (Appendix VI) reveals that P/F ratios of Kanda Rural Municipality is above unit earlier reproductive age group of women 15-34 and above. The underreporting for older women during 2001 for current fertility estimation led to constant increase in adjustment factor in and above the age groups. This study reflected an increasing proportion with fast declining fertility at the Kanda Rural Municipality. This hypothetical inter-survey method for TFR estimate was estimated using adjusted factor, K (P/F). The TFR for second age group (20-24) was 3.39 (Y_2) and last age group (45-49) was 4.65(Y_7). The second age group corresponds approximately 2.215 years before census and last age group (45-49) corresponds 18.399 years before the census.

The adjusted TFR estimated using regression model for all age group i=2…..7, obtained an estimated equation as: lnTFR =1.426–.006t (Brass approach, TFR (0)

= Y_2, where, r=0 for 20-24 age only positive weight.). The modified Brass estimate of TFR at Kanda Rural Municipality.at time t=0 is the $e^{1.426}$ = 4.16. This shows significant increasing correction on the EB estimate indicating that the reference periods are crucial factor for downward bias in Kanda Rural Municipality. Increasing the upward correction from the EB estimate of 2.44 reflects that reference periods are important source of downward bias in the census data of Kanda Rural Municipality.

Generally, second age group (20-24) has mostly the absence of coverage errors due to which past trends analysis has shown greater fertility value in P_2/F_2; $F_\omega(P_2/F_2)$ (Y_2 =3.399), the value greater than unity. This study has depicted rapidly decreasing overall fertility compared to younger women who have high fertility values, thereby showing the non-negligible effects. The case study of Dhanushadham Municipality estimated TFR (45-49) to be about 2.215 (Y_2) years earlier. The currently fertility was found decreasing with 0.6 percent and that for TFR to be 2.2 $e^{-.006(-2.215)}$ = 2.201 which is greater than current TFR due to rapidly decreasing fertility levels. The value of P_2/F_2 has been used inverse variance regression weights. Then, TFR for age group 20-24(Y_2) estimation for all age groups are very difficult to estimate the inverse relationship with $1/F_2$ accurately. The adjustment factor has been calculated by TFR(Y) values averages Y_2 and Y_3.

6.4.2 Estimation of fertility at Dhanushadham Municipality (2011)

Dhanushadham Municipality represents medium population size of women in reproductive age 1450 closer to 1449.3 (median value) women. Dhanushadham Municipality, has used EB smoothed values for f_i and P_i. The values act as inputs for the projection of CF and time, as mean birth estimated birth parity equivalent with group and moments of interpolation. The hypothetical inter survey cohort are calculated considering TFR= $F_\omega(P_i/F_i)$, multiplied with μ_i-(12.5+5i) are considered by all weights.

Table 6.3 reveals that P/F ratios of Dhanushadham Municipality is above unit earlier reproductive age group of women 15-34 and above. The underreporting for older women during 2011 for current fertility estimation led to constant increase in adjustment factor in and above the age groups.

Table 6. 3: Estimation of total fertility rate at Dhanushadam Municipality, 2011

Ages	**15–19**	**20–24**	**25–29**	**30–34**	**35–39**	**40–44**	**45–49**
Index (i)	**1**	**2**	**3**	**4**	**5**	**6**	**7**
Empirical Bayes Estimates							
P_{EB}	0.095	0.903	1.802	2.357	2.720	2.899	2.709
f_{EB}	0.017	0.071	0.059	0.027	0.014	0.004	0.004
Interpolated Moments							
F_i	0.012	0.252	0.612	0.816	0.911	0.956	0.966
μ_i	16.632	20.398	23.050	24.703	25.747	26.396	26.579
Regression Inputs							
(Pi/Fi)	8.018	3.590	2.944	2.888	2.986	3.034	2.805
(Yi=$F\omega$ Pi/Fi)	7.861	3.520	2.887	2.832	2.928	2.974	2.751
Avg $(\mu_x - x)_i$	-0.868	-2.102	-4.450	-7.797	-11.753	-16.104	-20.921
Weight	0.011	0.246	0.856	1.588	2.243	2.692	2.598

Source: Census data files, 2011.

This study reflected an increasing proportion with fast declining fertility at the Dhanushadham Municipality. This hypothetical inter-survey method for TFR estimate was estimated using adjusted factor, K (P/F). The TFR for second age group (20-24) was 3.5 (Y_2) and last age group (45-49) was 2.8(Y_7). The second age group corresponds approximately 2.1 years before census and last age group (45-49) corresponds 20.9 years before the census.

The adjusted TFR estimated using regression model for all age group i=2…..7, obtained an estimated equation as: lnTFR =1.218+0.012t (Brass approach, TFR (0) = Y_2, where, r=0 for 20-24 age only positive weight.). The modified Brass estimate of TFR at Dhanushadham Municipality at time t=0 is the $e^{1.218}$ = 3.1. This shows significant increasing correction on the EB estimate indicating that the reference periods are crucial factor for downward bias in Dhanushadham Municipality. Increasing the upward correction from the EB estimate of 3.1and correction factor 0.968 reflects that reference periods are important source of downward bias in the census data of Dhanushadham Municipality.

Generally, second age group (20-24) has mostly the absence of coverage errors due to which past trends analysis has shown greater fertility value in P_2/F_2; $F_\omega(P_2/F_2)$ (Y_2 =3.5), the value greater than unity. This study has depicted rapidly decreasing overall fertility compared to younger women who have high fertility values, thereby showing the non-negligible effects. The case study of Dhanushadham Municipality estimated

TFR (45-49) to be about 2.2(Y_2) years earlier. The currently fertility was found decreasing with 1.2 percent and that for TFR to be 2.1 ($e^{0.004(-2.1.02)} = 2.1$), which is greater than current TFR due to rapidly decreasing fertility levels.

Similarly, 2001 (Appendix VI) reveals that P/F ratios of Dhanushadham Municipality is above unit earlier reproductive age group of women 15-34 and above. The underreporting for older women during 2011 for current fertility estimation led to constant increase in adjustment factor in and above the age groups. This study reflected an increasing proportion with fast declining fertility at the Dhanushadham Municipality. This hypothetical inter-survey method for TFR estimate was estimated using adjusted factor, K (P/F). The TFR for second age group (20-24) was 7.358 (Y_2) and last age group (45-49) was 3.7457(Y_7). The second age group corresponds approximately 2.41 years before census and last age group (45-49) corresponds 18.281 years before the census.

The adjusted TFR estimated using regression model for all age group i=2…..7, obtained an estimated equation as: lnTFR =1.703+0.022t (Brass approach, TFR (0) = Y_2, where, r=0 for 20-24 age only positive weight.). The modified Brass estimate of TFR at Dhanushadham Municipality at time t=0 is the $e^{1.703}$ = 5. 492. This shows significant increasing correction on the EB estimate indicating that the reference periods are crucial factor for downward bias in Dhanushadham Municipality. Increasing the upward correction from the EB estimate of 1.964 reflects that reference periods are important source of downward bias in the census data of Dhanushadham Municipality.

Generally, second age group (20-24) has mostly the absence of coverage errors due to which past trends analysis has shown greater fertility value in P_2/F_2; $F_\omega(P_2/F_2)$ (Y_2 =7.358), the value greater than unity.

This study has depicted rapidly decreasing overall fertility compared to younger women who have high fertility values, thereby showing the non-negligible effects. The case study of Dhanushadham Municipality estimated TFR (45-49) to be about 2.410 (Y_2) years earlier. The currently fertility was found decreasing with 24 percent and that for TFR to be 2.2 $e^{-.022(-2.410)}$ = 2.35 which is greater than current TFR due to rapidly decreasing fertility levels.

6.4.3 Estimation of fertility at Kathmandu Metropolitan City (2011)

Kathmandu Metropolitan City is the largest population size 35782 with women in reproductive age. Kathmandu Metropolitan City, has used EB smoothed values for f_i and P_i. The values act as inputs for the projection of CF and time, as mean birth estimated birth parity equivalent with group and moments of interpolation. The hypothetical inter survey cohort are calculated considering TFR= $F_\omega(P_i/F_i)$, multiplied with μ_i-(12.5+5i) are considered by all weights.

Table 6.4 reveals that P/F ratios of Kathmandu Metropolitan City is above unit earlier reproductive age group of women 15-34 and above. The underreporting for older women during 2011 for current fertility estimation led to constant increase in adjustment factor in and above the age groups. This study reflected an increasing proportion with fast declining fertility at the Kathmandu Metropolitan City. This hypothetical inter-survey method for TFR estimate was estimated using adjusted factor, K (P/F). The TFR for second age group (20-24) was 1.9 (Y_2) and last age group (45-49) was 2.3 (Y_7). The second age group corresponds approximately 2.0 years before census and last age group (45-49) corresponds 19.7 years before the census.

The adjusted TFR estimated using regression model for all age group i=2…..7, obtained an estimated equation as: lnTFR =0.531–.014t (Brass approach, TFR (0) = Y_2, where, r=0 for 20-24 age only positive weight.). The modified Brass estimate of TFR at Kathmandu Metropolitan City at time t=0 is the $e^{0.531}$ = 1.7. This shows significant increasing correction on the EB estimate indicating that the reference periods are crucial factor for downward bias in Kathmandu Metropolitan City. Increasing the upward correction from the EB estimate of 0.82 reflects that reference periods are important source of downward bias in the census data of Kathmandu Metropolitan City.

Generally, second age group (20-24) has mostly the absence of coverage errors due to which past trends analysis has shown greater fertility value in P_2/F_2; $F_\omega(P_2/F_2)$ (Y_2 =1.9), the value greater than unity. This study has depicted rapidly decreasing overall fertility compared to younger women who have high fertility values, thereby showing the non-negligible effects.

The case study of Kathmandu Metropolitan City estimated TFR (45-49) to be about 1.9 (Y_2) years earlier. The currently fertility was found decreasing with 3.7 percent and that for TFR to be 2.1 ($e^{-.014(-1.959)}$ = 1.93), which is greater than current TFR due to rapidly decreasing fertility levels.

Table 6. 4: Estimation of total fertility rate at Kathmandu Metropolitan City, 2011

Ages	**15–19**	**20–24**	**25–29**	**30–34**	**35–39**	**40–44**	**45–49**
Index (i)	**1**	**2**	**3**	**4**	**5**	**6**	**7**
Empirical Bayes Estimates							
P_{EB}	0.024	0.316	0.932	1.498	1.841	2.062	2.256
f_{EB}	0.009	0.045	0.055	0.038	0.013	0.002	0.001
Interpolated Moments							
F_i	0.005	0.138	0.409	0.653	0.776	0.809	0.812
μ_i	17.113	20.541	23.552	25.899	27.272	27.757	27.823
Regression Inputs							
(Pi/Fi)	5.282	2.287	2.276	2.293	2.373	2.551	2.779
(Yi=$F\omega$ Pi/Fi)	4.297	1.861	1.852	1.865	1.930	2.075	2.261
Avg $(\mu_x - x)_i$	-0.387	-1.959	-3.9481	-6.6009	-10.228	-14.743	-19.677
Weight	*0.004*	*0.109*	*0.437*	*1.033*	*1.659*	*2.031*	*2.244*

Source: Census data files, 2011.

Similarly, 2001 (Appendix VI) reveals that P/F ratios of Kathmandu Metropolitan City is above unit earlier reproductive age group of women 15-34 and above. The underreporting for older women during 2011 for current fertility estimation led to constant increase in adjustment factor in and above the age groups. This study reflected an increasing proportion with fast declining fertility at the Kathmandu Metropolitan City This hypothetical inter-survey method for TFR estimate was estimated using adjusted factor, K (P/F). The TFR for second age group (20-24) was 1.861 (Y_2) and last age group (45-49) was 2.261 (Y_7). The second age group corresponds approximately 1.959 years before census and last age group (45-49) corresponds 18.281 years before the census.

The adjusted TFR estimated using regression model for all age group i=2…..7, obtained an estimated equation as: lnTFR =0.531–.014t (Brass approach, TFR (0) = Y_2, where, r=0 for 20-24 age only positive weight.). The modified Brass estimate of TFR at Kathmandu Metropolitan City at time t=0 is the $e^{0.531}$ = 1.70. This shows significant increasing correction on the EB estimate indicating that the reference periods are crucial factor for downward bias in Kathmandu Metropolitan City.

Increasing the upward correction from the EB estimate of 0.8135 reflects that reference periods are important source of downward bias in the census data of Kathmandu Metropolitan City.

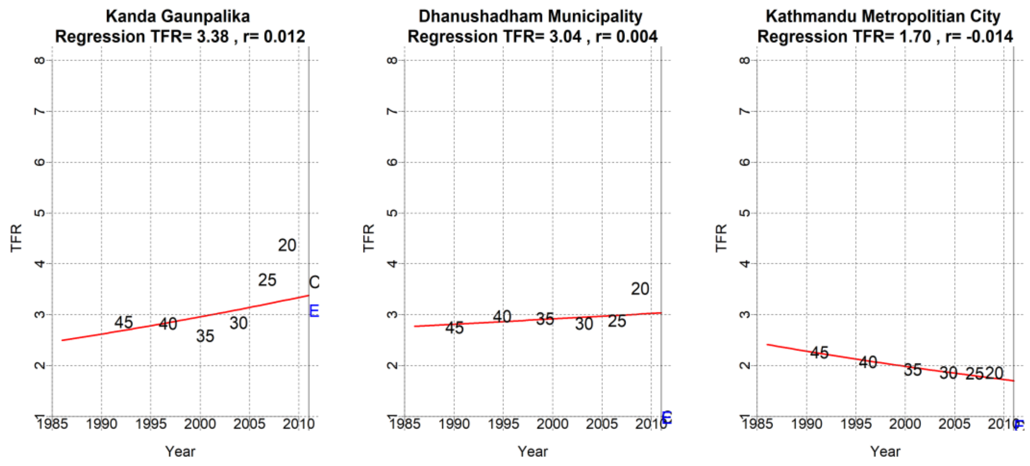
Generally, second age group (20-24) has mostly the absence of coverage errors due to which past trends analysis has shown greater fertility value in P_2/F_2; $F_\omega(P_2/F_2)$ (Y_2 =1.959), the value greater than unity. This study has depicted rapidly decreasing overall fertility compared to younger women who have high fertility values, thereby showing the non-negligible effects. The case study of Kathmandu Metropolitan City estimated TFR (45-49) to be about 1.959 (Y_2) years earlier. The currently fertility was found decreasing with 20 percent and that for TFR to be 2.2 $e^{-.014(-1.959)}$ = 1.93 which is greater than current TFR due to rapidly decreasing fertility levels. The value of P_2/F_2 has been used inverse variance regression weights. Then, TFR for age group 20-24(Y_2) estimation for all age groups are very difficult to estimate the inverse relationship with $1/F_2$ accurately. The adjustment factor has been calculated by TFR(Y) values averages Y_2 and Y_3.

6.5 Brass regression model of fertility in 2011

The Brass regression model was fitted at the small local levels' municipalities like smallest (Kanda Rural Municipality), middle (Dhanushadam Municipality) and largest (Kathmandu Metropolitan City). In Figure 6.4, six points represent the time allocated TFR estimates *exp* (Omideyi, 1987) for age groups i=2…7.
The *C* and *E* labels on the right-hand vertical axes represent the local census and Empirical Bayes estimates of municipality TFR in the year prior to the census (2011). The regression line in the year 2011 and Brass regression estimate of current TFR where the points in each panel correspond to time allocated TFR estimates for age groups *i*=2……7, with the youngest age in each five-year group.

The EB procedure the regression procedure generally smooth more at small sample cases. The P/F patterns that are strongly consistent with falling fertility and hence reflects the model of exponential change over the reproductive age of women. Fertility decline over 1991–2011 at Kathmandu Metropolitan City, appears to have been much more rapid than Dhanushadam Municipality and Kanda Rural Municipality.

Figure 6. 4: Brass regression model of fertility in 2011



Source: Census data files, 2011.

Figure 6.4 shows that Brass P/F regression adjustment for three sample local levels are detailed description. The vertical positions of C, E and the regression intercept at year 2011 represent TFR_{Cens} (Census estimate), TFR_{EB} (Empirical Bayes), and the modified Brass estimate for TFR, respectively.

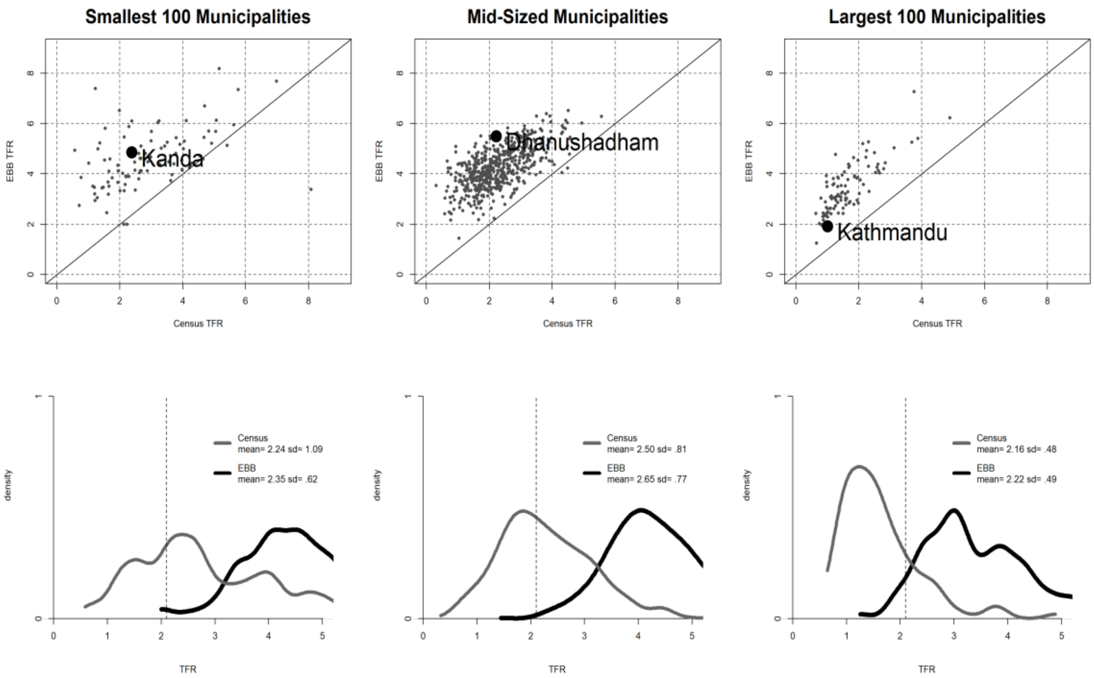
The Kathmandu Metropolitan City has TFR (1.7), Dhanushadam Municipality (3.0) and Kanda Rural Municipality (3.4). Generally, P/F regressions and TFR adjustments discussed Figure 6.4 are shows that fits and levels found in Nepal's 2011 census data. It is based on two-stage methodology (EB smoothing of local data, followed by P/F regression adjustment) and broader analysis of the complete set of 753 local level calculations (Appendix ID).

6.6 Empirical Bayes plus Brass results based on 2011 and 2001 census

EBB methods were used by the census of 2011 in the determination of total fertility rate in municipality. However, the EBB was found to be less mottled and smoother looking compared to the census. The EBB estimator removes some of the sampling errors which are likely to make many census TFR estimates unreliable and hence increases the smoothness. EBB considers information from similar surrounding small areas (small population and samples) to generate lower mean absolute errors estimates. The small area estimations do not generate numerous implausible outliers.

Figure 6.5 shows the joint distributions of census and EBB estimates across municipalities of top panels, and marginal distributions of each set estimates of bottom panels. A total of 100 local bodies have been disaggregated by the size of their 2011 census samples; where the sample size falling in the range of 61-550 women appear in the left panels. The 100 local bodies with the largest samples in the right panels (n from 2050 to 35782). Similarly, central panels show for all other municipalities.

Figure 6. 5: EBB estimates TFR at 2011 by size of local bodies



Sources: Census data files, 2011.

Top panels exhibit scatter plots with pairs of alternative estimates with one point per local bodies in 2011 census. The variations in marginal distributions obtained from census and each size class EBB estimates have been verified by a density in the lower panels. The horizontal scales in the bottom and top panels are different. EBB approach has desirable features. Implausible low TFR are eliminated virtually. For example, census TFR is below 1.4 in case of small and medium-sized municipalities. The EBB behaves census results of small area almost entirely as sampling error and noise, for example raising TFR estimates to minimum of 1.6 based on 2011 census. It also ensures to local bodies parity and neighborhood fertility data that raises local TFR estimates to much more confident levels.

The result is a distribution based on the census of 2011 for large area EBB estimates which is as approximate as the distribution of census estimates. The small local area has high standard deviation and large local area has low standard deviation with calibrated with P/F changing ratio method. The lowest rural municipality Kanda EBB estimation means TFR 2.4 and standard deviation 0.6 while comparing census means TFR 2.2 and standard deviation 1.1. Similarly, middle municipality Dhanushadam Municipality EBB estimation means TFR 2.7 and standard deviation 0.8 while comparing census means TFR 2.50 and standard deviation 0.8. At last comparing, largest municipality Kathmandu EBB estimation means TFR 2.2 and standard deviation 0.49 while comparing census mean TFR 2.2 and standard deviation 0.48.

6.7 Estimation of total fertility rate in local level based on 2011 census

The EBB smoothing method was applied for estimation of TFR. Brass P/F regression (adjustment) procedure was followed for a broader analysis of the complete set of 753 municipal-level by using the dataset of 2011 census and the dataset of NDHS 2016. Based on the trend analysis and growth rate the TFR was estimated and verified by applying statistical model (Appendix II).

A total of 137 local level consists at Province 1, among them 58 local level has low fertility and 79 local level has high fertility in comparisons to the national TFR. Similarly, among 136 local level of Madhesh Province, 9 local level has low fertility and 127 local level has high fertility in comparison to the national TFR. Now, among 119 local level of Bagmati Province, 47 local level has low fertility and 72 local level has high fertility in comparison to the national TFR. A total of 85 local level consists at Gandaki Province, among them 51 local level has low fertility and 34 local level has high fertility in comparison to the national TFR. Similarly, among 119 local level of Lumbini Province, 29 local level has low fertility and 80 local level has high fertility in comparison to the national TFR.

Now, among 79 local level of Karnali Province, 3 local level has low fertility and 76 local level has high fertility in comparison to the national TFR. Similarly, among 88 local level of Sudurpashchim Province, 4 local level has low fertility and 84 local level has high fertility in comparison to the national TFR value 2.6 (Central Bureau of Statistics, 2014). The description of fertility estimation district wise at all provinces are detailed in Table 6.5.

Table 6. 5: Distribution of TFR in local level based on 2011 census

SN	District	Low	High	Total	SN	District	Low	High	Total
Province: 1-14-137					4	Myagdi	2	4	6
1	Taplejung	3	6	9	5	Kaski	5	0	5
2	Panchthar	3	5	8	6	Lamjung	6	2	8
3	Ilam	10	0	10	7	Tanahun	1	9	10
4	Jhapa	13	2	15	8	Nawalpur	6	2	8
5	Morang	13	4	17	9	Syangja	10	1	11
6	Sunsari	6	6	12	10	Parbat	5	2	7
7	Dhankuta	4	3	7	11	Baglung	3	7	10
8	Terhathum	2	4	6	**Lumbini Province: 12-109**				
9	Sankhuwasabha	1	9	10	1	Rolpa	0	10	10
10	Bhojpur	2	7	9	2	Pyuthan	0	9	9
11	Solukhumbhu	1	7	8	3	Gulmi	2	10	12
12	Okhaldhunga	0	8	8	4	Arghakhanchi	1	5	6
13	Khotang	0	10	10	5	Palpa	8	2	10
14	Udayapur	0	8	8	6	Parasi	4	3	7
Madhesh Province: 8-136					8	Rupendhi	8	8	16
1	Saptari	6	12	18	8	Kapilvastu	1	9	10
2	Siraha	0	17	17	9	Dang	1	9	10
3	Dhanusa	2	16	18	10	Banke	1	7	8
4	Mahottari	0	15	15	11	Bardiya	3	5	8
5	Sarlahi	0	20	20	12	EasRukum	0	3	3
6	Rautahat	0	18	18	**Karnali Province: 10-79**				
7	Bara	0	16	16	1	Dolpa	2	6	8
8	Parsa	1	13	14	2	Mugu	0	4	4
Bagmati Province: 13-119					3	Humla	0	7	7
1	Dolakha	1	8	8	4	Jumla	0	8	8
2	Sindhupalchok	2	10	9	5	Kalikot	0	9	9
3	Rasuwa	1	4	6	6	W Rukum	0	6	6
4	Dhading	1	12	13	7	Dailekh	1	10	11
5	Nuwakot	6	6	12	8	Jajarkot	0	7	7
6	Kathmandu	11	0	11	9	Surkhet	1	8	9
7	Bhaktapur	4	0	4	10	Salyan	0	10	10
8	Lalitpur	5	1	6	**Sudurpashchim Province: 9-88**				
9	Kavrepalanchok	6	7	13	1	Kailali	4	9	13
10	Ramechhap	2	6	8	2	Kanchanpur	0	9	9
11	Sindhuli	0	9	9	3	Bajura	0	9	9
12	Makwanpur	3	7	10	4	Bajhang	0	12	12
13	Chitwan	5	2	7	5	Darchula	0	9	9
Gandaki Province: 11-85					6	Baitadi	0	10	10
1	Gorkha	4	7	11	7	Dadeldhura	0	7	7
2	Manang	4	0	4	8	Doti	0	9	9
3	Mustang	5	0	5	9	Achham	0	10	10

6.8 Comparison of Empirical Bayes plus Brass of alternative estimators as NDHS 2016

The comparison of EBB estimator with sets of municipal level projections and estimates performed during Demographic Health Survey 2016 are crucial. Several possibilities are described in table 6.6 which shows the national population-weighted means. The direct estimators are shown in first row. The row shows the local births/woman by age group and sum of the rates to calculate total fertility in local level. The method however produces high variability in the estimates and do not use parity data for a consistency check leading to sampling error and low TFR values at the micro-levels.

Table 6. 6: Comparison of TFR based on 2011 census with 2016 NDHS

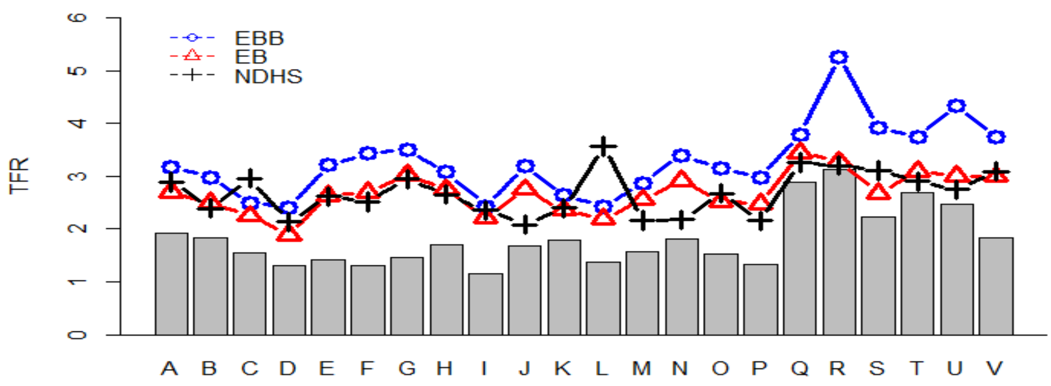
Estimator	**Smoothing**	**Parity Adjustment**	**2.5% to 97.5% ile**	**Weighted Mean**
Census	None	None	0.25-5.836	1.71
Empirical Bayes (Brass)	Spatial smoothing	None	0.786-4.586	1.83
Empirical Bayes +Brass (EBB)	Spatial smoothing	P/F regression	1.354-6.333	2.59
NDHS	Spatial smoothing	P2/F2	0.000-4.501	2.45

The average reported parity in the municipality to those in micro (local level) region is the multiplier (Victora et al., 2005). The empirical Bays smoothening on the 2nd row constricts the distribution to estimates TFR, pulling the low and high extremes values towards the mean. This leads to elevated levels of means determined from regression, compared to observed mean values. In this context, EB smoothing progresses the values for estimators by disregarding incredibly smaller values of TFR estimates in local levels. However, in the absence of parity corrections EB estimates are likely to decrease. Parity correction is estimated by EBB estimates (Table 6.6) with two step procedures. The municipal sample sizes regulate the estimates depending on the different procedures. The regression correction in this regard raises the EB levels population weighted national average TFR from 1.7 to 2.6.

In table 6.6, the last rows summaries TFR estimates from NDHS-2016. The estimates were produced using two identical estimation algorithms for municipalities. The results obtained were from Brass P_2/F_2 determinations, which particularly uses local level data for micro level municipalities and estimated following Brass P_2/F_2 estimates of TFR at local level, and multiplication of the local levels TFR with the ratio of sum of local P_2 and P_3 over the sum of P_2 and P_3 of the municipality.

Figure 6.6 provides summary of many municipal estimators as presented in Table 6.6 and aggregated up to the level of district of Nepal (A to Z like Taplejung to Baitadi). NDHS estimations are usually higher than estimations of EBB by 0.15 to 0.20 children/woman using P_2/F_2 correction.

Figure 6. 6: Alternative estimation methods compare NDHS



An alternative estimation method regarding municipal fertility are aggregated to district level using population weight in Nepal which are direct estimates from Census (bars), empirical Bays spatial smoothening (small triangle), empirical Bays along with Brass regression correction (solid line), NDHS-2016 (++ line). Population weighted rates of TFR change estimated from regression shows percentage which are shown in the Figure 6.6.

6.9 Fertility transition model based on census 2011

The transition is simulated by the changing period ASFR which is quadratic spline schedules (Schmertmann, 2013) with linear change in parameters. The integer having t = 0 before (t = – 35, –34, ….., +75), the fertility remains unchanged at the upper dark curve (Figure 6.7) and shows TFR 6.0.

The time period gets changed as verified which reach the lower part for the dark curve. The remaining constant values after TFR will reach below 2.5. The fertility f(a,t) assumptions of the regression model observed as in the figure due to non-constant the shape of the period fertility (Schmertmann & Rau, 2018). The fertility declined is observed at old age for women such that the mean period and child bearing age with decreases with the progress in the transitions period.

Figure 6. 7: Age specific fertility rate pattern with compare P/F ratio in NDHS 2016

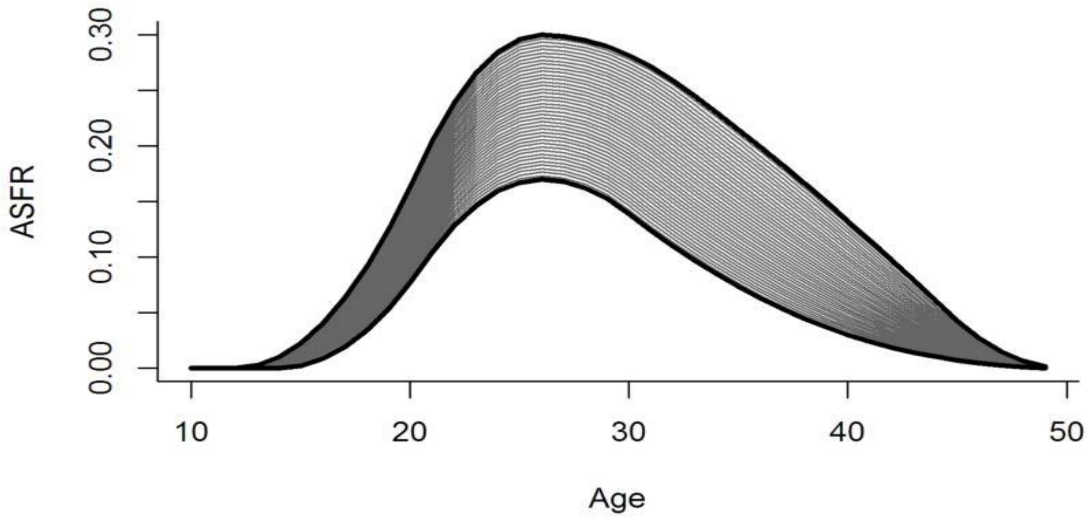


Figure 6.7 shows that reproductive age (15 to 49) of women at any time (ts) contains N women. Random birth counts Bat ~Poisson (N f (a,t)) with relevant (a,t) combinations and with respective parity (1Px) and period fertility (1fx). The five-year age groups using a data (5Px, 5fx) from which TFR (ts) is estimated using both regression and standard P2/F2 method (United Nations, 1983). This study presumed accurate reporting of fertility period such that any errors arise from changing rates instead of differential misreporting by age. Repeating systems generates 100 independent TFR (t = – 5 through +75) estimates every year.

Monte Carlo sampling-based quantitative study having top panels A and B which corresponds to the sampling output of N = 100 women with respect to single year of age compared with NDHS data set of 2011 (MOH, 2016). The panels C and D shows that behavior of the sizes grows high and sampling variance becomes zero. The panels A and C verifies rms errors to the right-hand panels B and D (Figure 6.8). B and D shows the estimated transition patterns of fertility. The regression analysis depicts lower values with gain over P_2/F_2 adjustment. This condition holds true in case of transition elevates 20 years. P_2/F_2 decreases from 8% to 0% in the period of about 5 years. From (0% to 8%) over about 10 to 25 years during the post transition period by regression method. The panel A exhibits finite samples, which are much larger than the commonly used for local geographic region. If rates are declining, the regression methods are measured as average errors than that in P_2/F_2 correction. The rms errors output appears in the panels A and C. No additional information for large samples in Panel C as variance reaches zero or becomes equal to absolute values (Figure 6.8). The P/F ratios are crudely estimated, the P_2/F_2 becomes less stable compared to that of regression method. The hundred samples simulated with expected errors of P_2/F_2 correction is greater than regression estimator. Fertility estimates using P_2/F_2 correction during the late stage of transition are larger than the regression errors.

Figure 6. 8: Regression represents RMSE

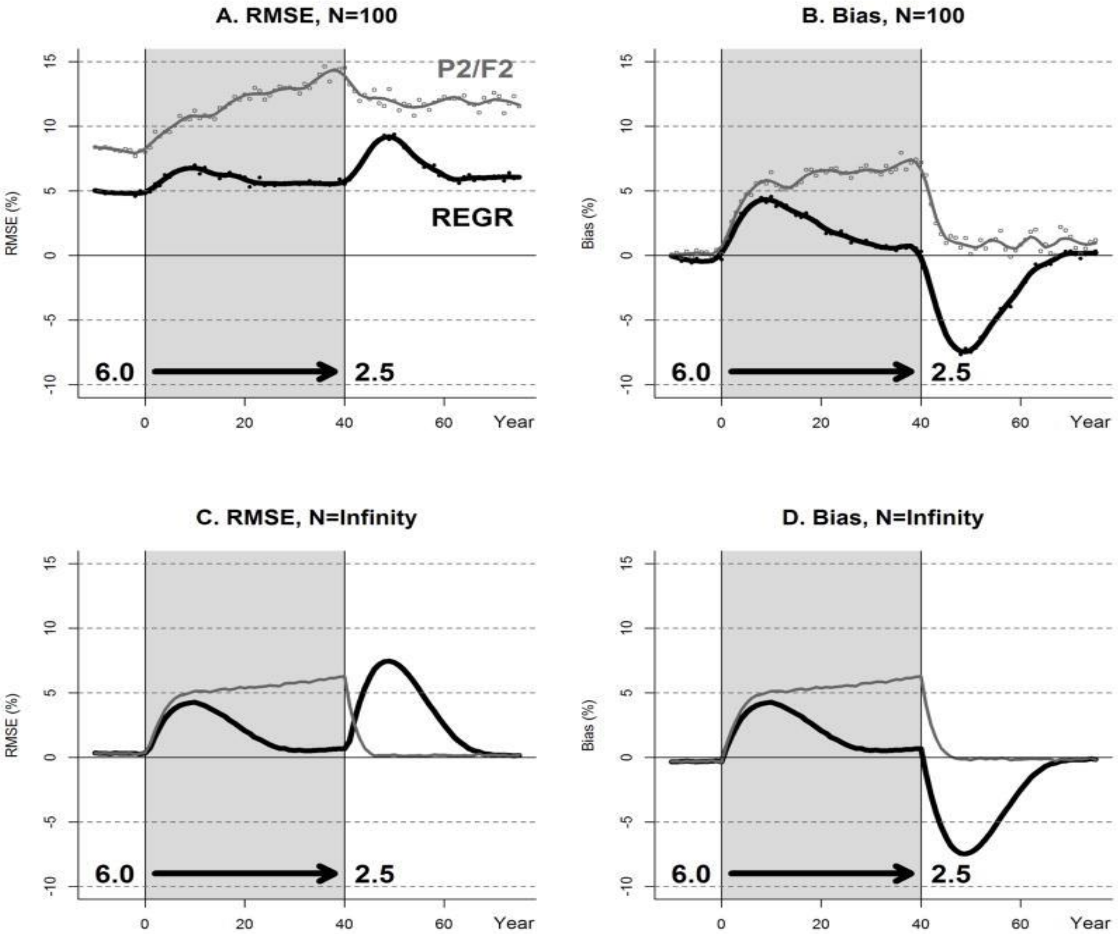


Figure 6.8 shows the transition during the study periods, with TFR decreasing from 6.0 to 2.5 (t=0 to 40) on horizontal axis. The Panel A and B shows errors of samples with 100 reproductive age of women in each single year age (Panel C and D) are the limiting (N tends to ∞) and sampling variance approaches zero. Each transition year errors are measured percent of period TFR with smoothed 100 Monte Carlo samples.

6.10 Projection of fertility local level in 2031

Basically, population growth rates are determined from historical data, which are then employed in certain mathematical formulas to forecast the population's likely future size. Population predictions are basic requirements of development planning and hence should be as precise as possible at local level. The study has tried to predict various population features of the three different local level on the basis of their population size (Kanda Rural Municipality, Dhanushadham Municipality and Kathmandu Metropolitan City). The estimates become accurate if data used are accurate and assumptions involved in the projections held true in reality. Hence, data must be reviewed adequately and should be adjusted for mistakes before being used for projection, and logistic curve is the most likely assumption.

The ASFR is an extension of the general fertility rate that calculates fertility rates for each 5-year age cohort of women, starting with the 15 to 19 age group and continuing through the 40 to 44 age group. Almost all projection approaches extrapolate previous or current trends into the future to some extent. The estimated TFR values of local level (Kanda Rural Municipality, Dhanushadham Municipality and Kathmandu Metropolitan City) for December 2000, 2005 and 2010 by using logistic function has projected the TFR value up to December 2030. It was used same slope for future projection. The model in spreadsheet TFRLGSTNew.xls interpolates and extrapolates of TFR.

Finally, 2015, 2020, 2025 and 2030 data were used to interpolate point estimation with medium variant at local level (Kanda Rural Municipality, Dhanushadham Municipality and Kathmandu Metropolitan City). Fertility decline has been a primary determinant of population ageing and projected levels of fertility have important implications on the age structure of future populations, including on the pace of population ageing. In these basis trends of TFR values projected (Table 6.7).

Table 6. 7: Local level projected TFR values in 2001-2031

Time	Kanda	Dhanushadam	Kathmandu
Dec2000	4.16	5.5	1.9
Dec2010	3.38	3.0	1.7
Dec2015	3.06	2.4	1.7
Dec2020	2.80	2.1	1.6
Dec2025	2.60	2.0	1.6
Dec2030	2.44	2.0	1.6

These dates based on census 2001 and 2011 points are estimated by linear interpolation and projection is based on time series logistic method. In fact, this research was used to point estimation with medium variant interpolation in local level (Kanda Rural Municipality, Dhanshadham Municipality and Kathmandu Metropolitan City). TFR values were estimated December 2000 and 2010 by using Arriaga method and December 2005 by using hypothetical inter survey cohort. The obtained values were verified and valid by using logistic curve.

The projected the smallest rural municipality Kanda TFR of December 2015, 2020, 2025 and 2030 were obtained 3.1, 2.8, 2.6 and 2.4 respectively. Then, the projected medium Dhanushadham Municipality TFR of December 2015, 2020, 2025 and 2030 were obtained 2.4, 2.1, 2.1 and 2.0 respectively. The projected the largest Kathmandu Municipality TFR of December 2015, 2020, 2025 and 2030 were obtained 1.7, 1.6, 1.6 and 1.6 respectively. However, exact date of projected TFR using linear interpolation are 2016, 2021, 2026 and 2031 respectively. The study shows that the smallest rural municipality Kanda will have high fertility rate which is above the national level of fertility at the end of 2031. Similarly, the fertility rate of medium Dhanushadham Municipality and the largest Kathmandu Metropolitan City will almost below the national level of fertility at the end of 2031. Likewise, the smallest rural municipality Kanda will have above the replacement level of fertility; medium Dhanushadham Municipality and the largest Kathmandu Metropolitan City will have below the replacement level of fertility.

CHAPTER 7

SUMMARY, DISCUSSION, CONCLUSION AND RECOMMENDATIONS FOR FURTHER RESEARCH

This study has a significant new application of indirect estimation and projection of fertility at national, provincial and local levels. This chapter presents a summary of the major findings of the study along with study objectives, methodology including study sample and data analysis. The chapter also presents conclusions and future research needs based on the study findings.

7.1 Summary of major findings

Fertility levels and patterns provide an important demographic information regarding the population change, as well as socio-economic development and human well-being. The research was focused to highlight the essential steps for the optimal estimation of fertility levels in Nepal using Arriaga's method. The plausibility of the estimate depends on the form of the original data. In this study, data on fertility from 2001 to 2011 was evaluated and relevant corrections were made to improve the quality of data making the usability of the fertility data for the application of Arriaga's method and changing P/F ratio method. It is evident that there were huge under reporting of recent births, the possibility of fertility levels is portrayed by the increasing Arriaga's with age (Feeney & Noller, 1996). It is useful relative to Brass changing P/F ratio, the Arriaga's method is a better method to estimate fertility levels in Nepal as it does not presume constant fertility in the past. Indirect demographic techniques have been used in this research and has contributed to adjust the substantial defectiveness in the fertility data of Nepal.

This study focused on estimation and projection of fertility to verify and validate at national and Provincial level and application of small area estimation for the local level has completed. It has indirect estimation of fertility by Arriaga's method and P/F ratio method at provincial level and different caste/ethnic; is justified and the SAE using indirect estimation of changing P/F ratio method in rural and urban municipality level. The SAE was applied in local level whereas indirect estimation was used in different caste/ethnic groups which is contribution of the study.

This aim of this study is to estimate and project fertility to verify and validate at national, provincial and local levels, including different caste/ethnic group. The study has also assessed the fertility at local level using small area estimation.

These national household censuses were carried out in 12.5 percent of total household. From census data files 649,476 (2001 census) and 1,091,337 (2011 census) with calibration of NDHS data set 2016 number of reproductive age group of women were identified through analysis. This study assumes objective reality aiming to test available literature; the epistemological standing is positivist approach.

Various implausible outliers cannot to be generated by the small area method. This increases the smoothness arises plainly due to the EBB estimator which purges some of the sampling noise and imparts TFR estimates unreliable. The correlation of 0.83 obtained between neighbouring values also depicts the similarity between local and neighbourhood data. The study has tried to explain how EBB estimators borrow information from neighbours selectively with comparison among these municipalities.

(a) Fertility estimation at national level

In 2001 census data, estimate adjusting factor values of TFR was 4.1 in December 2000. Similarly, TFR values were 3.2 (December 2005) and 2.7 (December 2010) which is similar to NDHS values in 2011. The study shows that Hill Janajati, Madheshi Other Caste, Hill Dalit, Madhesi Dalit Muslim and Others Minor Caste has high fertility rate and Newar, Tarai Janajiti, Brahman/Chhetri and Madheshi Brahman has below national level TFR (4.125) in December 2001. Similarly, Hill Janajati, Madheshi Other Caste, Hill Dalit, Madhesi Dalit, Muslim and Others Minor Caste has high fertility rate Newar, Tarai Janajiti Brahmin/ Chhetri, Madheshi Brahman has below the national TFR (3.1) in December 2005. In December 2010 shows that Hill Janajati, Brahman/ Chhetri, Madheshi Other Caste, Hill Dalit, Madhesi Dalit, Muslim and Others Minor Caste has high fertility and Newar, Tarai Janajiti, Madheshi Brahman has low fertility in compare to national was TFR 2.6.

(b) Fertility estimation at provincial level

The study shows that the Madhesh Province, Karnali Province, Sudurpashchim Province have a high fertility rate and Province 1, Bagmati Province, Gandaki Province, Lumbini Province have below national level TFR (4.1) in December 2001.

Similarly, Madhesh Province, Lumbini Province, Karnali Province, Sudurpashchim Province have a high fertility rate and Province 1, Bagmati Province, Gandaki Province have below the national TFR (3.1) in December 2005. In December 2010 shows that Madhesh Province, Lumbini Province, Karnali Province, Sudurpashchim Province have a high fertility and Province 1, Bagmati Province, Gandaki Province have low fertility in compare to national TFR (2.6).

(c) Fertility estimation at local level

SAE is crucial when vital registration is incomplete and fertility samples are unreliable, applying 742 (2001) and 753 (2011) in household census; mainly standardizing the EBB method. Three sample locations were selected on the basis of the population of reproductive aged women. Hence, for the estimation of fertility Kanda Rural Municipality of Banhjang as the smallest population size, Dhanushadham Municipality of Dhanusha District as the middle population size and Kathmandu Metropolitan City as the largest population size were used for 2001 and 2011 census data set. Fertility estimations from SAE is also important for analysing demographic change. The dissection of the fertility is an important component for local planning and development programme. In December 2010 shows that the 202 number of municipalities has a high fertility and 551 number municipality of has low fertility in compare to national TFR (2.6).

(d) Fertility estimation in future time period

This study was used to measure estimation with medium variant interpolation. TFR values were estimated December 2000 and 2010 by using Arriaga method and December 2005 by using hypothetical inter survey cohort. The obtained values were verified and validated by using logistic curve. The projected national level TFR of December 2015, 2020, 2025 and 2030 were obtained 2.35, 2.21, 2.15 and 2.12, respectively. The TFR values will near to reach national TFR replacement level.

The study shows that the Muslim, Hill Janajati, Madhesi Dalit, Madheshi Other Caste, Hill Dalit, Madhesi Dalit and Others Minor Caste will have high fertility rate which is above the replacement level of fertility at the end of 2031. Likewise, Newar, Tarai Janajiti, and Brahman/Chhetri will have below the replacement level of fertility. In Province level, Karnali (3.42), Sudurpashchim (2.59) and Lumbini (2.14) will have high fertility rate; Madhesh and Gandaki will reach to 2.1; Province 1(2.05), Bagmati (1.9) will be below the replacement level in the same period.

The study shows that the smallest Kanda Rural Municipality will have a high fertility rate which is above the national level of fertility at the end of 2031. Similarly, the fertility rate of medium Dhanushadham Municipality and the largest Kathmandu Metropolitan City will almost below the national level of fertility at the end of 2031. Likewise, the smallest rural municipality Kanda will have above the replacement level of fertility; medium Dhanushadham Municipality and the largest Kathmandu Metropolitan City will have below the replacement level of fertility. The projected Kanda TFR, smallest rural municipality of December 2015, 2020, 2025 and 2030 were obtained 3.1, 2.8, 2.6 and 2.4, respectively. Then, the projected medium Dhanushadham Municipality were obtained 2.4, 2.1, 2.1 and 2.0 respectively. The projected the largest Kathmandu Metropolitan City TFR were obtained 1.7, 1.6, 1.6 and 1.6 respectively as same dates.

7.2 Discussion

Estimates have been generated from this study from large spatial data to small spatial extent by using automated, reproducible algorithms which address the challenges such as high sampling variability and possible errors from census respondents. The EBB approach presents two problems in chance. First smooth the survey data by borrowing strengths across age groups and spatial neighborhoods, then apply the appropriate variant of parity correction to the smoothed local fertility rates (Alkema et al., 2011). This study has adopted EBB method with the identifiable census data by age and by the geographic areas which is most useful in case the vital registration is incomplete, and when difficulty is made by small local fertility samples to estimate rates consistently. As Nepal is one of the countries to meet both criteria, it is rapidly approaching complete birth registration. Empirical evaluation can only be undertaken in broad terms, if a method produces sensible results and avoids obvious errors. Therefore, EBB results appear to be quite worthy (Schmertmann et al., 2013).

Full birth registration is still a rare phenomenon in many countries in Africa, Latin America, and Asia as works the best (Assunção et al., 2005). Fertility change has not followed assumed pattern, the simulations use multiple data points rather than one or two data points as in the usual Brass approach, and using P/F regression to reduce variances well recompenses for the resulting bias. shows that it is possible. The EBB used estimates at a rougher local level than using census and survey data (Frias et al., 2013). It has been realized that state-level is unclear many features of Nepal's current fertility patterns. For the uses in government level and in local agencies, the standardization of EBB data requires further work. This perspective on the processes underlying fertility change from more geographically estimate in policy formulation (Brown & Guinnane, 2002; Potter et al., 2010). Valuable information is gained by the policy makers which allows more accurate targeting of program expenditures, and improved local population predictions.

For many countries, the nationwide sample is so large that it does not represent a large enough sample size to produce good estimates at a detailed geographic level. Over time, a significant registration system could improve his damage-model-based SAE method described in Bayes and Brass: Estimating TFR for Many Small Areas from Sparse Census Data. Their discussion of the growing demand for small-scale estimates and forecasts may rapid a 21st-century demographer to revive some of his 20th-century roots and develop new methodological variations based on old themes (Schmertmann et al., 2013).

In Nepal, better data for more effective policies and programmes to produce municipality/VDC level estimates of family planning indicators using data from the 2011 NDHS and the 2011 population census use microdata sample (PUMS) data. Using SAE individual level probabilities of contraceptive use are estimated using logistic regression models with variables that are common in the two datasets included as predictor variables (United Nations Population Fund, 2020).

The SAE was based mainly on information from Nepal Living Standards Survey 2010-11 and Nepal Census 2011, estimates for 967 Ilakas, for development planning purposes used combined with the spatial distribution of correlates of poverty and its indicators (Central Bureau of Statistics, 2013).

Fertility estimates for local municipalities where adolescent girls estimates has decreased first, to estimate adolescent fertility rate (AFR) in Nepal during 2011 and 2016 educational attainment and marital status; second, to examine the changes in adolescent fertility rates at municipality-level across Nepal between 2011 and 2016 to identify any areas experiencing little change between 2011 and 2016 and high adolescent fertility in 2016; third, to facilitate interpretation and increase the accessibility of the results by producing municipality-level AFR (KC et al., 2017).

It is very crucial, critical and important and noted that 156 countries and areas around the world, the estimated number of births that the estimates of the approximately 230 million, which is more than the estimated 129 million births that actually 81 percent variants (Liu, 2015).

The TFR 6.0 in Afghanistan and lowest 1.8 which is below the replacement level in Sri Lanka Global health Matrices data and TFR 2.2 in Nepal which is medium change of fertility in SAARC countries. Sri Lanka, Maldives, Bhutan and Bangladesh have lowered the replacement level (TFR touching 2.1). Afghanistan, Pakistan, Nepal and India have above the replacement level being considered as a demographic success story in the region (Vollset et al., 2020).

This study sates that the highest fertility rate (TFR) 6.0 in Afghanistan and lowest fertility rate (TFR) 2.1 which reached the replacement level in Sri Lanka world population data and NDHS give same TFR 2.6 in Nepal which is medium change of fertility in SAARC countries, which also resemble the indirect estimates of TFR for 2001 and 2011 using Arraiga's method.

The analysis of 174 out of 621 has fertility levels below 2.1, in Indian districts level and majority of them are located in the five Southern States and Union Territories and in the North-western States of Punjab and Himachal Pradesh. East India is represented by West Bengal, where almost half of districts in West Bengal fall into the below-replacement category, as well as Odisha and Tripura. West India consists mostly of Maharashtra and Goa, with less than 10 per cent of districts in Gujarat reporting TFR level below 2.1(Guilmoto et al., 2013).

The TFR is approximately 4.1 in 2001, which declines to 2.6 in 2011, a decline of slightly less than one child per woman over a decade (Central Bureau of Statistics, 2014). The TFR in Nepal is 2.3 children per woman (Ministry of Health, 2016). Nepal fertility has TFR (3.8) using Arriaga's modified P/F ratio method 2001 and TFR (3.25) using Arriaga's modified P/F ratio method (Ministry of Health, 2001).

7.3 Conclusion

Fertility levels are important factors which determines the population size and structure. The Government of Nepal has classified authorized the local levels into urban and rural municipalities so as to provide the responsibility to register the vital demographic statistics. Still the vital events are undervalued and the fertility gained below the true fertility level. The CBR and TFR are estimated at national level on the basis of information collected from census and surveys. This study has applied latest indirect techniques of fertility estimation model (Arriaga and Changing P/F ratio method) at the national, provincial and local levels for fertility estimation and projection on the basis for 2001 and 2011 census. The determination for the fertility, for national, provincial and local levels as well as different caste/ethnic groups, by the indirect methods were also verified and validated using logistic models. However, the unavoidable errors in the census fertility data remains to compromise the fertility estimates whereas, indirect methods are considered to be strong to data errors.

The caste/ethnic group fertility analysis shows that Hill Janajati, Brahman/ Chhetri, Madheshi Other Caste, Hill Dalit, Madhesi Dalit, Muslim and Others Minor Caste have a high fertility and Newar, Tarai Janajiti, Madheshi Brahman have a low fertility in comparison to national fertility level. Similarly, Madhesh Province, Lumini Province, Karnali Province and Sudurpashchim Province have a high fertility. Province 1, Bagmati Province and Gandaki Province have a low fertility in comparison to national TFR 2.6 in 2011. Fertility rate of Newar, Tarai Janajiti, and Brahman/Chhetri and Madheshi Brahman will have below the replacement level of fertility at the end of 2031. At province level, Karnali, Sudurpashchim and Lumbini will have high fertility rate; Madhesh Province and Gandaki will reach to 2.1; Province 1, Bagmati will be below the replacement level in the same period. This study shows the variation of fertility estimation among different caste/ethnic group and provincial levels.

Analysis for the smallest municipalities showed the shrinkage effect of the Empirical Bayes: Variability decreases with slight increase in the mean and modal estimates of TFR. The net effect in those smallest areas in an EBB TFR distribution results to considerably more intense around the mode width far fewer low and high values than the census estimates. The medium sized municipalities show the complex parity adjustment and net effect of shrinkage. The EBB method therefore adjusted complex parity adjustment and net effect of shrinkage elevating the very low census estimates. The result is positively skewed EBB distribution having high levels of mean and mode compared to the census TFR estimates.

The EBB estimation approach produces estimates which are reliable and valid. It is obvious state level determination obscures different features of Nepal's current fertility patterns. The effect of EBB is quantitatively similar to those in medium-sized areas in the case of large municipalities but it differs largely in magnitude. As the samples from local levels are less noisy, the EB shrinkage effects are minimal. In addition, parity adjustment effects are very small and positive for large areas and resembles the distribution of census estimates.

Among 753 local levels, 202 local units have a low fertility and 551 local units has a high fertility in comparison to the national TFR. Projection of fertility has a variation at different local levels in 2031, reflecting the need of different fertility management policies across different geographical areas.

7.4 Recommendations for further research

This study has attempted to analyze and estimate fertility at national, provincial and local level. Further, in-depth research both qualitative and quantitative, which addresses the social and economic diversity, is recommended to be implemented. The valuable information gained by policy makers provides opportunity to be precise on targeted programs and improved local population forecasts. Demographic surveys and census data must fill the breach when vital registration is incomplete. Even in most countries, large national samples may not be appropriate to produce precise estimates at finer spatial extent.

The standardized EBB methods used by governments and local agencies need further detailing. However, it is valuable to develop program to improve ease of application further. Fertility of SAE is useful for analyzing demographic change and is important for local planning and development program. When VRS is not sufficient, model-based methods can be used for the long run.

In addition, small area estimation has the increasing demand among demographers to rediscover some of their roots of indirect techniques to develop new methodological variations on old themes in the short run. For future research estimation of fertility to adjust data all age especially reproductive age, with group of women should be studied. The focus on the study of socio-cultural consequences health and family planning method should be studied in depth. Estimated fertility measurement tools should be identified separately in the further research. If the studies in future can be replicated in ward levels, it would provide more effective applications.

APPENDIX IA

Percent Age Distribution of Census 2001 and 2011

Age group	Nepal 2001(%)	Nepal 2011(%)	Province 1 2001(%)	Province 1 2011(%)	Madhesh 2001(%)	Madhesh 2011(%)	Bagmati 2001(%)	Bagmati 2011(%)	Gandaki 2001(%)	Gandaki 2011(%)	Lumbini 2001(%)	Lumbini 2011(%)	Karnali 2001(%)	Karnali 2011(%)	Sudurpashchim 2001(%)	Sudurpashchim 2011(%)
00-04	12.1	9.7	11.3	8.9	13.2	11.0	10.3	7.4	11.4	8.6	12.8	10.0	14.0	13.0	13.8	11.6
05-09	14.2	11.9	13.6	11.3	15.3	14.1	12.6	9.6	13.5	10.8	14.8	12.5	14.6	14.4	15.0	13.6
10-14	13.1	13.1	13.2	12.6	11.9	13.5	12.8	11.8	13.9	13.1	13.8	13.8	13.6	14.2	13.7	14.3
15-19	10.5	11.1	11.2	11.4	8.9	9.5	11.1	11.6	11.2	11.7	10.6	11.5	10.5	10.9	10.5	11.2
20-24	8.8	8.8	9.0	8.7	8.1	7.8	10.2	10.5	8.2	8.7	8.4	8.8	9.1	8.7	8.8	8.6
25-29	7.5	7.8	7.4	7.7	8.0	7.5	8.4	9.1	6.5	7.3	7.2	7.7	7.6	7.3	7.3	7.4
30-34	6.5	6.6	6.6	6.5	6.9	6.7	7.3	7.5	5.8	5.9	6.1	6.3	6.2	5.8	6.0	6.0
35-39	5.7	6.1	5.8	6.1	6.3	6.3	6.0	6.7	5.3	5.5	5.5	5.8	5.6	5.4	5.3	5.5
40-44	4.8	5.2	5.0	5.5	5.1	5.2	4.9	5.8	4.8	5.1	4.5	5.0	4.6	4.5	4.3	4.6
45-49	4.1	4.5	4.1	4.8	4.4	4.4	3.9	4.7	4.2	4.6	4.0	4.2	3.9	3.8	3.8	3.8
50-54	3.4	3.8	3.5	4.3	3.3	3.5	3.3	4.0	3.8	4.4	3.3	3.6	3.3	3.2	3.2	3.1
55-59	2.7	3.1	2.7	3.4	2.6	3.0	2.6	3.0	3.0	3.7	2.7	3.1	2.4	2.6	2.5	2.6
60-64	2.3	2.8	2.3	3.0	2.3	2.9	2.3	2.6	2.8	3.4	2.3	2.8	1.9	2.7	2.2	2.8
65-69	4.2	5.3	1.7	2.2	1.6	2.1	1.8	2.0	2.2	2.6	1.7	2.1	1.2	1.6	1.5	2.0
70-74	--	-	1.2	1.5	1.1	1.4	1.3	1.5	1.6	2.0	1.2	1.5	0.7	0.9	1.0	1.4
75-79	-	-	1.4	1.0	1.1	0.6	1.5	1.1	1.9	1.4	1.2	0.8	0.6	0.5	1.0	0.7

APPENDIX IB: Sex ratio of 2001 and 2011

Age group	Nepal 2001(%)	Nepal 2011(%)	Province 1 2001(%)	Province 1 2011(%)	Madhesh 2001(%)	Madhesh 2011(%)	Bagmati 2001(%)	Bagmati 2011(%)	Gandaki 2001(%)	Gandaki 2011(%)	Lumbini 2001(%)	Lumbini 2011(%)	Karnali 2001(%)	Karnali 2011(%)	Sudurpashchim 2001(%)	Sudurpashchim 2011(%)
00-04	103	105	103	104	103	103	103	108	103	107	103	106	99	103	103	105
05-09	103	104	103	102	107	105	102	106	102	104	103	104	101	101	103	104
10-14	106	103	103	102	116	106	104	104	102	101	105	102	105	100	105	102
15-19	99	97	97	94	118	114	100	101	89	90	92	90	94	91	95	90
20-24	88	79	86	72	97	90	98	92	69	63	82	71	91	82	88	74
25-29	91	79	87	72	100	88	99	89	66	58	87	72	97	86	89	80
30-34	95	80	95	77	97	83	107	92	73	60	90	73	101	85	95	78
35-39	99	86	97	82	110	95	106	94	72	62	95	80	103	92	96	83
40-44	99	91	99	89	108	101	106	100	78	69	93	84	102	94	93	85
45-49	104	96	104	94	116	107	108	103	83	75	101	93	104	100	97	92
50-54	105	101	103	100	122	112	104	105	90	86	103	97	111	109	100	95
55-59	112	102	110	102	120	107	112	106	99	91	113	97	124	112	115	97
60-64	101	95	105	99	108	106	97	95	94	84	105	95	106	91	93	80
65-69	103	100	104	102	102	109	99	97	99	92	111	106	115	101	95	88
70-74	107	102	108	105	105	116	102	93	106	98	116	109	122	107	104	86

APPENDIX IC

Number of women by five years' age group, 2001 and 2011

Age group	Nepal 2001	Nepal 2011	Province 1 2001	Province 1 2011	Madhesh 2001	Madhesh 2011	Bagmati 2001	Bagmati 2011	Gandaki 2001	Gandaki 2011	Lumbini 2001	Lumbini 2011	Karnali 2001	Karnali 2011	Sudurpashchim 2001	Sudurpashchim 2011
15-19	1203176	1488789	235900	267111	186821	241034	252527	319377	134741	144048	221969	276605	54091	89772	117127	150842
20-24	1070026	1314090	201718	229715	189316	220818	232863	303293	110077	124360	185961	233716	47644	75399	102447	126789
25-29	904464	1162111	164616	203168	183479	216949	190119	264468	88530	107366	154694	203514	38642	61549	84385	105097
30-34	763463	964728	139848	165909	162149	196607	158293	215885	75024	86493	129684	165341	31019	48790	67447	85703
35-39	659302	864119	122647	150915	137196	174625	131333	191317	68984	79551	112356	146722	27703	44134	59083	76854
40-44	548051	725831	102948	132603	111978	139570	107200	160399	59896	69900	94898	123763	22594	36616	48537	62980
45-49	453678	597858	83899	112572	92964	114476	84186	128324	51917	61176	79558	100139	19076	30079	42078	51092

Number of Children Ever Born by five years' age group, 2001 and 2011

Age group	Nepal 2001	Nepal 2011	Province 1 2001	Province 1 2011	Madhesh 2001	Madhesh 2011	Bagmati 2001	Bagmati 2011	Gandaki 2001	Gandaki 2011	Lumbini 2001	Lumbini 2011	Karnali 2001	Karnali 2011	Sudurpashchim 2001	Sudurpashchim 2011
15-19	185473	119741	27354	17818	43558	26851	28839	17087	18403	10794	36914	22966	10061	11506	20344	12719
20-24	1037340	995862	161954	144494	215862	203976	189690	160258	102554	86607	196740	190798	52257	85853	118283	123876
25-29	1862655	2001689	312233	304618	397534	409087	342693	358929	179000	171902	341118	376395	87852	147454	202226	233304
30-34	2191436	2357635	387841	363479	468967	503267	409666	437609	209445	197502	395523	432723	100554	159362	219439	263693
35-39	2269140	2554511	424282	413490	443612	513231	413073	483403	232291	220774	416271	468663	108735	171077	230876	283874
40-44	2093923	2424123	404484	423309	380825	433470	387287	467017	226968	222544	387772	454033	99396	161978	207191	261772
45-49	1831506	2141962	359452	395936	313362	355950	330147	417524	211113	211245	343933	397337	88818	140464	184681	223505

Number of before12 month by five years' age group, 2001 and 2011

Age group	Nepal 2001	Nepal 2011	Province 1 2001	Province 1 2011	Madhesh 2001	Madhesh 2011	Bagmati 2001	Bagmati 2011	Gandaki 2001	Gandaki 2011	Lumbini 2001	Lumbini 2011	Karnali 2001	Karnali 2011	Sudurpashchim 2001	Sudurpashchim 2011
15-19	36651	34424	6308	5660	5983	5038	6400	5594	3576	3916	7983	6785	2081	3433	4320	3998
20-24	116329	123074	21325	20237	17542	18886	23116	22839	13420	12634	21602	22499	5791	10347	13533	15632
25-29	82928	94106	16484	17020	14669	15399	15141	18471	8303	8399	14672	15639	4050	7320	9609	11858
30-34	45798	43380	9288	8009	8503	7965	7833	8137	4048	3257	8488	7076	2425	3672	5213	5265
35-39	25032	21021	5502	3623	4214	3951	3809	3123	2203	1619	4452	3613	1499	2159	3353	2933
40-44	10822	8105	2270	1465	1957	1566	1459	1127	1105	512	2087	1370	652	1001	1292	1065
45-49	3465	2621	591	339	893	556	398	289	329	231	603	411	219	417	432	378

APPENDIX ID

Average CEB in 2001

Age	Hill Janajati	Newar	Tarai Janajiti	Brahman/ Chhetri	Madheshi Brahman	Madheshi other Caste	Hill Dalit	Madhesi Dalit	Muslim	Others
15-19	0.108	0.048	0.183	0.080	0.082	0.202	0.181	0.250	0.192	0.158
20-24	0.886	0.576	1.192	0.874	0.889	1.237	1.236	1.209	1.187	1.073
25-29	1.936	1.473	2.272	2.029	1.870	2.317	2.416	2.265	2.377	2.126
30-34	2.827	2.237	3.060	2.811	2.650	3.057	3.322	2.899	3.395	2.853
35-39	3.454	2.788	3.589	3.396	3.111	3.488	3.927	3.330	3.951	3.387
40-44	3.938	3.167	3.854	3.778	3.292	3.652	4.336	3.393	4.173	3.793
45-49	4.225	3.426	4.113	4.071	3.413	3.565	4.610	3.296	4.050	3.808

Average ASFR in 2001

Age	Hill Janajati	Newar	Tarai Janajiti	Brahman/ Chhetri	Madheshi Brahman	Madheshi Other Caste	Hill Dalit	Madhesi Dalit	Muslim	Others
15-19	0.034	0.015	0.040	0.025	0.024	0.041	0.050	0.045	0.030	0.039
20-24	0.117	0.070	0.107	0.120	0.093	0.107	0.137	0.109	0.100	0.099
25-29	0.101	0.063	0.082	0.093	0.062	0.084	0.121	0.094	0.104	0.085
30-34	0.080	0.036	0.052	0.054	0.042	0.056	0.078	0.062	0.091	0.060
35-39	0.051	0.018	0.026	0.030	0.013	0.034	0.051	0.038	0.057	0.044
40-44	0.029	0.007	0.013	0.015	0.005	0.016	0.026	0.025	0.037	0.024
45-49	0.009	0.002	0.007	0.005	0.001	0.007	0.012	0.011	0.019	0.007

Average CEB in 2011

Age	Hill Janajati	Newar	Tarai Janajiti	Brahman/ Chhetri	Madheshi Brahman	Madheshi Other Caste	Hill Dalit	Madhesi Dalit	Muslim	Others
15-19	0.075	0.031	0.070	0.057	0.039	0.096	0.133	0.149	0.121	0.111
20-24	0.679	0.372	0.752	0.674	0.526	0.933	1.055	1.045	0.952	0.917
25-29	1.555	1.053	1.719	1.682	1.428	1.945	2.172	1.998	2.043	1.957
30-34	2.299	1.665	2.402	2.397	2.022	2.634	2.995	2.656	2.909	2.543
35-39	2.860	2.124	2.880	2.892	2.483	2.993	3.572	3.031	3.699	3.130
40-44	3.365	2.411	3.280	3.285	2.642	3.207	4.043	3.189	3.970	3.365
45-49	3.695	2.742	3.514	3.563	2.664	3.206	4.272	3.186	4.067	3.358

Average ASFR in 2011

Age	Hill Janajati	Newar	Tarai Janajiti	Brahman/ Chhetri	Madheshi Brahman	Madheshi Other Caste	Hill Dalit	Madhesi Dalit	Muslim	Others
15-19	0.025	0.010	0.018	0.019	0.008	0.020	0.042	0.027	0.024	0.025
20-24	0.087	0.056	0.078	0.100	0.061	0.092	0.124	0.098	0.086	0.104
25-29	0.076	0.054	0.059	0.091	0.056	0.076	0.094	0.076	0.081	0.099
30-34	0.048	0.037	0.033	0.045	0.028	0.039	0.058	0.048	0.060	0.044
35-39	0.028	0.013	0.012	0.023	0.012	0.020	0.038	0.031	0.036	0.027
40-44	0.013	0.004	0.006	0.009	0.002	0.010	0.020	0.015	0.019	0.016
45-49	0.004	0.001	0.003	0.004	0.001	0.004	0.010	0.005	0.010	0.005

APPENDIX II

Fertility Estimation in Local level

Province: 1-14-137

District: 1. Taplejung (9)

SN	Name	tfrCens	tfr.EBB	r
1	Phungling M.	1.371	2.407	-0.025
2	Aathrai Tribeni R. M.	1.176	3.088	-0.006
3	Sidingwa R. M.	1.596	2.504	-0.030
4	Phaktanglung R. M.	2.569	3.610	-0.008
5	Mikkwakhola R. M.	2.207	2.954	-0.018
6	Meringden R. M.	2.804	3.597	-0.007
7	Maiwakhola R. M.	2.816	2.954	-0.018
8	Pathibhara Yangwarak R. M.	1.493	2.507	-0.030
9	Sirijangha R. M.	1.711	3.065	-0.017

District: 2. Panchthar (8)

SN	Name	tfrCens	tfr.EBB	r
1	Phidim M.	1.393	2.149	-0.031
2	Hilihang R. M.	1.961	3.057	-0.023
3	Kummayak R. M.	1.101	2.827	-0.020
4	Miklajung R. M.	1.291	2.623	-0.017
5	Phalelung R. M.	1.284	2.150	-0.033
6	Phalgunanda R. M.	1.503	2.399	-0.030
7	Tumbewa R. M.	2.686	3.231	-0.020
8	Yangawarak R. M.	1.746	3.044	-0.021

District: 3. Ilam (10)

SN	Name	tfrCens	tfr.EBB	r
1	Chulachuli R.M.	1.430	2.107	-0.036
2	Deumai M.	1.110	1.920	-0.033
3	Fakphokthum R.M.	1.502	2.319	-0.029
4	Illam M.	1.013	1.642	-0.023
5	Mai M.	0.977	2.260	-0.028
6	Maijogmai R.M.	1.176	2.002	-0.027
7	Mangsebung R.M.	1.064	2.520	-0.019
8	Rong R.M.	1.258	2.210	-0.021
9	Sandakpur R.M	0.984	2.069	-0.019
10	Suryodaya M.	0.835	1.716	-0.024

District: 4. Jhapa (15)

SN	Name	tfrCens	tfr.EBB	r
1	Mechinagar M.	1.257	1.863	-0.026
2	Buddhashanti R.M.	0.948	1.700	-0.029
3	Arjundhara M.	1.564	2.038	-0.023
4	Kankai M.	0.936	1.876	-0.029
5	Shivasatakshi M.	1.215	1.943	-0.027
6	Kamal R.M.	0.992	1.963	-0.024
7	Damak M.	1.178	1.673	-0.031
8	Gauradaha M.	1.281	2.027	-0.025
9	Gauriganj R.M.	1.516	2.399	-0.017
10	Jhapa R.M.	2.171	3.539	-0.003
11	Barhadashi R.M.	1.518	2.744	-0.017
12	Birtamod M.	1.091	2.029	-0.022
13	Haldibari R.M.	1.096	2.125	-0.020
14	Bhadrapur M.	1.161	1.964	-0.024
15	Kachanakawal R.M.	1.640	3.086	-0.012

District: 5. Morang (17)

SN	Name	tfrCens	tfr.EBB	r
1	Miklajung R.M.	1.984	2.331	-0.020
2	Letang M.	0.956	1.991	-0.024
3	Kerabari R.M.	1.551	2.267	-0.020
4	Sundarharaicha M.	0.964	1.987	-0.021
5	Belbari M.	1.234	2.031	-0.023
6	Kanepokhari R.M.	1.030	1.942	-0.027
7	P. Shanishchare M.	1.072	1.781	-0.030
8	Urlabari M.	1.492	1.887	-0.027
9	Ratuwamai M.	1.329	2.218	-0.018
10	Sunwarshi M.	1.354	2.950	-0.002
11	Rangeli M.	1.019	2.536	-0.012
12	Gramthan R.M.	0.762	1.881	-0.014
13	Budhiganga R.M.	0.945	2.361	-0.011
14	Biratnagar M.C.	1.048	2.285	-0.012
15	Katahari R.M.	1.297	2.865	-0.004
16	Dhanapalthan R.M.	1.436	2.896	-0.005
17	Jahada R.M.	1.780	3.174	-0.003

District: 6. Sunsari (12)

SN	Name	tfrCens	tfr.EBB	r
1	Dharan S.M.C.	0.717	1.652	-0.025
2	Baraha M.	1.324	2.140	-0.023
3	Koshi R.M.	1.807	4.234	0.012
4	Bhokraha R.M.	1.571	3.398	-0.002
5	Ramdhuni M.	1.197	2.070	-0.016
6	Itahari S.M. C.	0.956	1.871	-0.022
7	Duhabi M.	1.025	2.333	-0.006
8	Gadhi R.M.	1.496	2.743	-0.007
9	Inaruwa M.	1.002	2.496	-0.008
10	Harinagara R.M.	2.256	3.566	-0.005
11	Dewangunj R.M.	1.363	3.008	-0.009
12	Barju R.M.	1.479	2.908	-0.005

District: 7. Dhankuta (7)

SN	Name	tfrCens	tfr.EBB	r
1	Mahalaxmi M.	1.846	3.217	-0.015
2	Pakhribas M.	1.153	2.610	-0.018
3	Chhathar Jorpati R.M	1.757	2.384	-0.023
4	Dhankuta M.	1.205	1.770	-0.027

SN	Name	tfrCens	tfr.EBB	r
5	K. Sahidbhumi RM.	2.508	3.080	-0.014
6	Sangurigadhi RM.	1.370	2.370	-0.021
7	Chaubise RM.	1.671	2.031	-0.027

District: 8. Terhathum (6)

SN	Name	tfrCens	tfr.EBB	r
1	Aatharai RM.	1.913	2.927	-0.016
2	Phedap RM.	1.358	2.703	-0.016
3	Menchhayayem RM.	3.042	3.329	-0.013
4	Myanglung M.	1.345	2.261	-0.026
5	Laligurans M.	1.890	2.814	-0.018
6	Chhathar RM.	1.797	2.312	-0.021

District: 9. Sankhuwasabha (10)

SN	Name	tfrCens	tfr.EBB	r
1	Bhotkhola RM.	3.002	3.867	-0.008
2	Makalu RM.	2.694	4.394	-0.007
3	Silichong RM.	2.856	3.627	-0.012
4	Chichila RM.	2.093	3.039	-0.012
5	Sabhapokhari RM.	2.061	3.338	-0.021
6	Khandabari M.	1.434	2.539	-0.013
7	Panchakhapan M.	2.136	3.225	-0.015
8	Chainapur M.	1.945	2.819	-0.021
9	Madi M.	1.409	3.014	-0.012
10	Dharmadevi M.	1.670	2.900	-0.017

District: 10. Bhojpur (9)

SN	Name	tfrCens	tfr.EBB	r
1	Arun R.M.	1.881	3.135	-0.015
2	Pauwa Dunma R.M.	1.541	2.213	-0.022
3	Ramprasad Rai R.M.	1.653	2.855	-0.013
4	Hatuwagadhi R.M.	1.978	3.058	-0.013
5	Aamchowk R.M.	2.659	4.173	-0.005
6	Shadananda M.	1.994	3.106	-0.013
7	Salpa Silichho R.M.	1.878	3.345	-0.021
8	Tyamke Maiyum R.M.	1.784	3.082	-0.014
9	Bhojpur M.	1.235	2.269	-0.020

District: 11. Solukhumbhu (8)

SN	Name	tfrCens	tfr.EBB	r
1	K. Pasanglhamu R.M.	1.758	2.570	-0.015
2	Mahakulung R.M.	2.860	4.529	-0.010
3	Sotang R.M.	1.550	3.164	-0.019
4	Dhudhakoshi R.M.	2.436	3.507	-0.008
5	Dhudha Kousika R.M.	1.971	3.465	-0.014
6	Necha Salyan R.M.	2.290	2.995	-0.014
7	S. DhudhakundaM.	0.926	2.633	-0.019
8	Likhu Pike R.M.	1.878	3.372	-0.012

District: 12. Okhaldhunga (8)

SN	Name	tfrCens	tfr.EBB	r
1	ChishankhuGadi R.M.	2.063	3.759	-0.008
2	Siddhicharan M.	1.541	3.041	-0.005
3	Molung R.M.	1.207	3.443	-0.009
4	Khiji Demba R.M.	1.279	2.950	-0.018
5	Likhu R.M.	2.105	3.294	-0.015
6	Champadevi R.M.	1.848	3.637	-0.008
7	Sunkoshi R.M.	1.809	3.378	-0.013
8	Manebhanjyang R.M.	1.332	2.917	-0.009

District: 13. Khotang (10)

SN	Name	tfrCens	tfr.EBB	r
1	Kepilasgadhi R.M.	3.371	4.225	0.000
2	Aiselukharka R.M.	1.739	2.905	-0.013
3	Lamidanda R.M.	2.095	3.658	-0.009
4	H. TuwachungM.	1.760	3.432	-0.017
5	Rupakot Ma. M.	1.898	3.015	-0.013
6	Sakela R.M.	0.829	2.692	-0.021
7	Diprung R.M.	1.820	3.297	-0.012
8	Khotehang R.M.	2.360	3.728	-0.008
9	Jante Dhunga R.M.	2.082	3.577	-0.011
10	Baraha Pokhari R.M.	2.207	3.749	-0.006

District: 14. Udayapur (8)

SN	Name	tfrCens	tfr.EBB	r
1	Belaka M.	1.255	2.850	-0.020
2	Chaudandigadhi M.	1.497	2.902	-0.013
3	Triyuga M.	1.470	2.696	-0.014
4	Rautamai RM	2.149	3.795	-0.013
5	Sunkoshi RM	3.329	3.798	-0.023
6	Tapli RM	1.322	3.107	-0.016
7	Katari M.	2.189	3.986	-0.004
8	Udayapurgadhi G.	2.540	3.826	-0.008

Madhesh Province: 8-136

District: 1. Saptari (18)

SN	Name	tfrCens	tfr.EBB	r
1	Saptakoshi M.	1.120	2.429	-0.011
2	Kanchanrup M.	0.574	2.799	-0.001
3	Agmisair K.S RM	1.000	2.703	0.002
4	Rupani RM	0.958	2.885	0.000
6	Khadak M.	1.236	3.158	0.002
7	Surunga M.	0.863	2.556	0.000
7	Surunga M.	0.863	2.556	-0.004
8	Balan-Bihul RM	1.244	2.919	0.004
9	Bode Barsain M.	0.698	2.689	0.002
10	Dakneshwori M.	1.272	3.092	0.002
11	BelhiChapena RM	0.647	2.766	0.003

12	Bishnupur RM	1.050	3.530	0.008
13	Rajbiraj M.	0.570	2.226	-0.002
14	Mahadewa RM	0.671	2.556	0.003
15	Tirahut RM	0.982	2.460	0.006
16	Hanumannagar K.M.	0.889	2.917	0.007
17	Tilathi Koiladi G RM	1.605	3.061	0.002
18	Chhinnamasta RM	1.239	2.887	0.001

District: 2. Siraha (17)

SN	Name	tfrCens	tfr.EBB	r
1	Lahan M.	0.876	2.895	0.004
2	Dhangadhimai M.	1.026	3.056	0.008
3	Golbazar M.	1.047	3.325	0.007
4	Mirchaiya M.	1.488	3.434	0.013
5	Karjanha M.	1.095	3.329	0.001
6	Kalyanpur M.	1.607	3.569	0.011
7	Naraha RM	1.721	3.629	0.007
8	Bishnupur RM.	1.257	3.452	0.011
9	Arnama RM	1.560	3.781	0.010
10	Sukhipur M.	1.223	3.600	0.009
11	Laxmipur Patari RM	1.087	3.677	0.011
12	S. Nankarkatti RM	1.506	3.210	0.008
13	Bhagawanpur RM	1.104	3.529	0.010
14	Nawarajpur RM.	1.456	3.739	0.011
15	Bariyarpatti RM	1.868	3.924	0.012
16	Aurahi RM	1.416	3.638	0.010
17	Siraha M.	1.314	3.447	0.007

District: 3. Dhanusa (18)

1	Ganeshman C.M.	0.439	2.916	0.011
2	Dhanushadham M.	0.990	3.036	0.004
3	Mithila M.	0.742	3.286	0.009
4	Bateshwor RM	0.869	2.673	-0.002
5	Chhireshwornath M.	0.964	2.894	-0.001
6	Laxminiya RM	1.140	3.018	0.004
7	Mithila Bihari M.	0.910	2.434	-0.001
8	Hansapur M.	1.033	3.143	0.010
9	Sabaila M.	0.930	2.795	0.002
10	Shahidnagar M.	1.387	2.886	0.006
11	Kamala M.	1.227	3.194	0.012
12	Janak Nandini RM	1.424	3.009	0.010
13	Bideha M.	1.375	2.994	0.010
14	Aurahi RM	0.565	2.628	0.006
15	Janakpur S. M. C.	0.845	2.770	0.003
16	Dhanauji RM	1.148	2.543	0.007
17	Nagarain M.	1.182	3.331	0.007
18	Mukhiyapatti M. RM	0.575	3.065	0.004

District: 4. Mahottari (15)

SN	Name	tfrCens	tfr.EBB	r
1	Bardibas M.	1.269	2.935	-0.008
2	Gaushala M.	1.580	3.401	-0.004
3	Sonama RM	1.774	4.276	0.009
4	Aurahi M.	1.342	3.322	-0.001
5	Bhangaha M.	1.499	3.453	0.009
6	Loharpatti M.	1.579	3.692	0.006
7	Balawa M.	2.049	4.359	0.012
8	Ram Gopalpur M.	2.590	4.739	0.016
9	Samsi RM	2.088	4.398	0.011
10	Manara Shisawa M.	1.470	3.786	0.007
11	Ekadara RM	1.379	3.705	0.007
12	Mahottari RM	1.621	3.588	0.010
13	Pipara RM	1.553	3.518	0.010
14	Matihani M.	2.038	4.116	0.009
15	Jaleshwor M.	1.037	3.185	0.006

District: 5. Sarlahi (20)

SN	Name	tfrCens	tfr.EBB	r
1	Lalbandi M.	1.563	2.987	-0.010
2	Hariwan M.	0.759	2.975	-0.006
3	Bagmati M.	0.887	3.082	-0.009
4	Barahathawa M.	1.486	4.032	0.008
5	Haripur M.	1.765	3.563	-0.003
6	Ishworpur M.	1.240	3.295	-0.001
7	Haripurwa M.	1.270	3.426	0.003
8	Parsa RM	1.523	3.639	0.004
9	Brahmapuri RM	1.375	3.560	0.001
10	Chandranagar RM	1.506	3.998	0.002
11	Kabilashi M.	1.371	3.117	-0.002
12	Chakraghatta RM	1.909	4.042	0.008
13	Basbariya RM	2.654	3.784	0.002
14	Dhanakaul RM	1.901	3.894	0.007
15	Ramnagar RM	1.375	3.665	0.000
16	Balara M.	1.210	3.912	0.007
17	Godaita M.	1.904	4.307	0.015
18	Bishnu RM	2.070	4.208	0.010
19	Kaudena RM.	1.700	4.210	0.009
20	Malangawa M.	1.237	3.777	0.008

District: 6. Rautahat (18)

SN	Name	tfrCens	tfr.EBB	r
1	Chandrapur M.	0.647	2.953	-0.0003
2	Gujara M.	1.706	3.536	-0.001
3	PhatuwaBijayapuM	1.581	3.591	0.000
4	Katahariya M.	1.557	3.932	0.011

5	Brindaban M.	1.520	3.488	0.002
6	Gadhimai M.	1.539	3.623	0.006
7	Madhav N. M.	0.789	3.140	0.002
8	Garuda M.	1.429	4.511	0.015
9	Dewahi Gonahi M.	2.135	3.703	0.006
10	Maulapur M.	1.234	3.739	0.009
11	Boudhimai M.	1.206	4.014	0.008
12	Paroha M.	1.771	4.038	-0.003
13	Rajpur M.	1.784	4.216	0.003
14	Yamunamai RM	1.849	4.069	0.006
15	Durga Bhagawati G.	1.874	4.096	0.005
16	Rajdevi M.	0.694	2.898	-0.003
17	Gaur M.	0.910	2.993	0.002
18	Ishanath M.	1.323	3.722	0.001

District: 7. Bara (16)

SN	Name	tfrCens	tfr.EBB	r
1	Nijagadh M.	1.106	2.817	-0.013
2	Kolhabi M.	1.163	3.216	-0.002
3	Jitpur Simara S.M.	1.006	2.969	-0.010
4	Parawanipur RM	0.858	3.397	0.006
5	Prasauni RM	1.472	3.670	0.002
6	Bishrampur RM	1.533	4.075	0.005
7	Pheta RM	1.355	3.887	0.003
8	Kalaiya S.M. C.	1.002	3.195	-0.002
9	Karaiyamai RM	1.659	3.793	0.004
10	Baragadhi RM	1.892	3.483	-0.006
11	AadarshaKotwal RM	1.777	4.361	0.007
12	Simroungadh M.	1.807	3.948	0.008
13	Pacharauta M.	1.936	4.163	0.012
14	Mahagadhimai M.	1.375	3.577	0.001
15	Devtal RM	0.727	3.197	-0.004
16	Subarna RM	1.262	3.454	-0.006

District: 8. Parsa (14)

SN	Name	tfrCens	tfr.EBB	r
1	Thori RM	1.218	2.112	-0.024
2	Jirabhawani RM	0.675	3.571	0.005
3	Jagarnathpur RM	1.620	4.692	0.022
4	Paterwa Sugauli RM	0.860	4.197	0.017
5	Sakhuwa Prasauni RM	1.912	4.519	0.012
6	Parsagadhi M.	2.515	3.756	0.006
7	Birgunj M.C.	1.107	3.350	0.001
8	Bahudarmai M.	1.136	3.981	0.011
9	Pokhariya M.	1.033	3.510	0.007
10	Kalikamai RM	1.509	3.488	0.004
11	Dhobini RM.	1.137	3.555	0.002
12	Chhipaharmai RM	1.567	4.322	0.016
13	Pakaha Mainpur RM	0.873	3.555	0.005
14	Bindabasini RM	0.961	4.561	0.022

Bagmati Province: 13-119

District: 1. Dolakha (9)

SN	Name	tfrCens	tfr.EBB	r
1	Gaurishankar RM	1.833	3.160	-0.013
2	Bigu RM	2.402	3.534	-0.010
3	Kalinchowk RM	2.224	3.509	-0.011
4	Baitedhar RM	1.438	2.805	-0.011
5	Jiri M.	1.634	2.881	-0.018
6	Tamakoshi RM	1.489	3.399	-0.009
7	Melung RM	1.679	3.395	-0.002
8	Shailung RM	1.634	3.037	-0.012
9	Bhimeshwor M.	1.057	2.342	-0.015

District: 2. Sindhupalchok (12)

SN	Name	tfrCens	tfr.EBB	r
1	Bhotekoshi RM	1.081	2.654	-0.013
2	Jugal RM	1.903	3.315	-0.012
3	Panchpokhari RM	1.786	2.894	-0.013
4	Helambu RM	1.559	3.329	-0.004
5	Melanchi M.	1.547	2.783	-0.014
6	Indrawoti RM	1.827	3.135	-0.014
7	Choutara S. M.	1.416	2.565	-0.019
8	Balephi RM	1.191	2.673	-0.018
9	Bahrabise M.	1.471	2.764	-0.015
10	Tripurasundari RM	1.677	3.011	-0.008
11	Lisankhu Pakhar RM	1.302	2.274	-0.026
12	Sunkoshi RM	1.248	2.546	-0.016

District: 3. Rasuwa (5)

SN	Name	tfrCens	tfr.EBB	r
1	Gosaikunda RM	1.549	2.642	-0.011
2	Parbatikunda RM	2.367	4.578	0.009
3	Uttargaya RM	1.043	2.883	-0.016
4	Kalika RM	1.307	2.349	-0.022
5	Naukunda RM	2.111	3.985	-0.001

District: 4. Dhading (13)

SN	Name	tfrCens	tfr.EBB	r
1	Rubi Valley RM	4.328	4.857	0.007
2	Khaniyabas RM	2.157	3.553	-0.003
3	Ganga Jamuna RM	1.466	2.768	-0.015
4	Tripurasundari RM	1.258	2.710	-0.016
5	Netrawati RM	2.084	2.795	-0.011
6	Nilkhantha M.	1.449	2.634	-0.023
7	Jwalamukhi RM	1.534	2.660	-0.017

8	Siddhalek RM	2.072	3.167	-0.013
9	Benighat Rorang RM	2.197	4.039	-0.010
10	Gajuri RM	2.219	3.136	-0.022
11	Galchhi RM	1.497	2.911	-0.021
12	Thakre RM.	1.374	2.895	-0.021
13	Dhunibenshi M.	1.062	2.393	-0.023

District: 5. Nuwakot (12)

SN	Name	tfrCens	tfr.EBB	r
1	Dupcheshwor RM	2.460	4.491	0.002
2	Tadi RM	1.254	3.151	-0.001
3	Suryagadhi RM	0.989	2.595	-0.015
4	Bidur M.	0.672	2.041	-0.019
5	Kispang RM	1.058	2.453	-0.023
6	Meghang RM	1.118	2.507	-0.015
7	Tarakeshwor RM	1.328	2.671	-0.020
8	Belkotgadhi M.	1.335	2.785	-0.020
9	Likhu RM	1.155	2.467	-0.020
10	Panchakanya RM	1.570	2.855	-0.012
11	Shivapuri RM	1.245	2.749	-0.021
12	Kakani RM	0.817	2.297	-0.013

District: 6. Kathmandu (11)

SN	Name	tfrCens	tfr.EBB	r
1	Shankharapur M.	0.916	2.068	-0.015
2	Kageshwori M. M.	0.840	1.771	-0.021
3	Gokarneshwor M.	0.808	1.804	-0.019
4	Budhanilkhantha M.	0.946	1.669	-0.020
5	Tokha M.	0.996	1.928	-0.015
6	Tarakeshwor M.	1.035	1.986	-0.018
7	Nagarjun M.	1.200	1.948	-0.014
8	Kathmandu M.C.	0.801	1.701	-0.014
9	Kirtipur M.	0.844	1.643	-0.015
10	Chandragiri M.	0.991	1.894	-0.015
11	Dakshinkali M.	1.046	1.786	-0.025

District: 7. Bhaktapur (4)

SN	Name	tfrCens	tfr.EBB	r
1	Changunarayan M.	0.974	1.626	-0.027
2	Bhaktapur M.	0.622	1.678	-0.026
3	Madhyapur Thimi M.	1.025	1.716	-0.021
4	Suryabinayak M.	0.804	1.592	-0.024

District: 8. Lalitpur (6)

SN	Name	tfrCens	tfr.EBB	r
1	Mahalaxmi M.	0.846	1.727	-0.016
2	Lalitpur M. C.	0.722	1.727	-0.013
3	Godawari M.	1.119	1.638	-0.025
4	Konjyosom RM	1.667	2.012	-0.028
5	Mahankal RM	1.233	2.278	-0.024
6	Bagmati RM	1.437	2.928	-0.015

District: 9. Kavrepalanchok (13)

SN	Name	tfrCens	tfr.EBB	r
1	Chauri Deurali RM	0.872	2.678	-0.019
2	Bhumlu RM	1.044	2.435	-0.018
3	Mandan Deupur M.	1.547	2.707	-0.013
4	Banepa M.	0.716	1.648	-0.017
5	Dhulikhel M.	0.978	1.931	-0.020
6	Panchkhal M.	0.843	2.027	-0.024
7	Temal RM	1.804	3.157	-0.014
8	Namobuddha M.	1.200	2.172	-0.024
9	Panauti M.	0.837	1.868	-0.023
10	Bethanchowk RM	1.339	2.734	-0.016
11	Roshi RM	1.091	2.734	-0.016
12	Mahabharat RM	1.868	4.614	-0.009
13	Khanikhola RM	2.435	4.667	-0.010

District: 10. Ramechhap (8)

SN	Name	tfrCens	tfr.EBB	r
1	Umakunda RM	1.617	2.621	-0.021
2	Gokulganga RM	1.412	2.929	-0.015
3	Likhu RM	1.109	3.077	-0.011
4	Ramechhap M.	1.798	2.818	-0.010
5	Manthali M.	1.374	2.654	-0.015
6	Khandadevi RM	1.114	2.549	-0.020
7	Doramba RM	1.155	2.644	-0.017
8	Sunapati RM	0.906	2.205	-0.019

District: 11. Sindhuli (9)

SN	Name	tfrCens	tfr.EBB	r
1	Dudhouli M.	1.444	3.712	-0.007
2	Phikkal RM	2.530	3.774	-0.017
3	Tinpatan RM	1.959	3.369	-0.021
4	Golanjor RM	2.194	3.354	-0.017
5	Kamalamai M.	1.419	2.733	-0.021
6	Sunkoshi RM	1.149	3.045	-0.016
7	Ghyanglekha RM	2.690	4.549	-0.008
8	Marin RM	2.119	3.914	-0.019
9	Hariharpurgaghi RM	2.372	4.670	-0.012

District: 12. Makwanpur (10)

SN	Name	tfrCens	tfr.EBB	r
1	Indrasarowar RM	1.107	2.475	-0.032
2	Thaha M.	1.585	2.508	-0.027
3	Kailash RM	2.645	4.181	-0.011
4	Raksirang RM	2.482	4.750	-0.007
5	Manahari RM	1.746	2.942	-0.024

6	Hetauda S.M. C.	1.196	2.219	-0.023
7	Bhimphedi RM	0.783	2.727	-0.027
8	Makawanpurgadhi RM	1.897	2.971	-0.022
9	Bakaiya RM	1.677	3.563	-0.012
10	Bagmati RM	2.289	3.833	-0.010

District: 13. Chitwan (7)

SN	Name	tfrCens	tfr.EBB	r
1	Rapti M.	1.652	2.881	-0.015
2	Kalika M.	1.340	2.546	-0.021
3	Ichchha Kamana RM	2.021	3.367	-0.017
4	Bharatpur M. C.	0.949	1.929	-0.025
5	Ratnanagar M.	0.996	2.199	-0.017
6	Khairahani M.	0.822	1.831	-0.028
7	Madi M.	1.555	2.177	-0.025

Gandaki Province: 11-85

District: 1. Gorkha (11)

SN	Name	tfrCens	tfr.EBB	r
1	Chumanubri RM	1.305	2.865	-0.017
2	Ajirkot RM	2.009	2.617	-0.010
3	Sulikot RM	1.535	2.734	-0.014
4	Dharche RM	2.523	3.664	-0.005
5	Aarughat RM	1.804	3.023	-0.019
6	Bhimsen RM	1.881	2.834	-0.019
7	Siranchowk RM	1.513	2.449	-0.014
8	Palungtar M.	1.659	2.310	-0.012
9	Gorkha M.	1.105	2.220	-0.017
10	Shahid Lakhan RM	1.557	2.480	-0.019
11	Gandaki RM	1.694	2.934	-0.023

District: 2. Manang (4)

SN	Name	tfrCens	tfr.EBB	r
1	Naraphu RM	0.250	1.452	-0.031
2	Neshang RM.	0.891	1.379	-0.024
3	Chame RM	1.885	1.939	-0.020
4	Nashong RM	1.578	1.601	-0.029

District: 3. Mustang (5)

SN	Name	tfrCens	tfr.EBB	r
1	Lo-GhekarDalomer RM	1.621	1.704	-0.029
2	Gharpajhong RM	1.570	2.030	-0.011
3	Bahragaun M. RM	1.291	1.724	-0.019
4	Lomanthang RM	0.797	1.273	-0.036
5	Thasang RM	2.003	2.576	-0.002

District: 4. Myagdi (6)

SN	Name	tfrCens	tfr.EBB	r
1	Annapurna RM	2.090	2.301	-0.011
2	Raghuganga RM	1.668	2.655	-0.010
3	Dhawalagiri RM	2.426	3.386	-0.011
4	Malika RM	2.992	2.819	-0.017
5	Mangala RM	2.786	2.911	-0.011
6	Beni M.	2.023	2.500	-0.015

District: 5. Kaski (5)

SN	Name	tfrCens	tfr.EBB	r
1	Machhapuchchhre RM	1.739	2.318	-0.018
2	Annapurna RM	1.798	2.401	-0.021
3	Madi RM	1.92	2.306	-0.016
4	Pokhara Lek.M.C.	1.058	1.994	-0.021
5	Rupa RM	2.188	2.514	-0.015

District: 6. Lamjung (8)

SN	Name	tfrCens	tfr.EBB	r
1	Dordi RM	1.544	2.615	-0.010
2	Marshyangdi RM	1.884	2.494	-0.008
3	Kwhola Sothar RM	2.220	2.650	-0.009
4	Madhya Nepal M.	1.002	2.344	-0.016
5	Bensi Shahar M.	1.066	2.262	-0.011
6	Sundarbazar M.	1.413	2.182	-0.014
7	Rainas M.	1.682	2.326	-0.016
8	Dudhapokhari RM	0.977	2.350	-0.014

District: 7. Tanahun (10)

SN	Name	tfrCens	tfr.EBB	r
1	Bhanu M.	1.352	2.153	-0.019
2	Byas M.	1.040	2.369	-0.013
3	Myagde RM	1.071	2.399	-0.017
4	Shuklagandaki M.	1.540	2.234	-0.020
5	Bhimad M.	1.293	2.566	-0.019
6	Ghiring RM	0.992	2.641	-0.024
7	Rhishing RM	1.799	2.573	-0.027
8	Devghat RM	1.363	2.362	-0.027
9	Bandipur RM	1.108	2.167	-0.023
10	AanbuKhaireni RM	1.794	2.398	-0.019

District: 8. Nawalpur (8)

SN	Name	tfrCens	tfr.EBB	r
1	Gaidakot M.	1.053	2.118	-0.022
2	Bulingtar RM	1.836	2.779	-0.028
3	Bungdikali RM	1.077	2.547	-0.028
4	Hupsekot RM	1.970	3.633	-0.012
5	Devchuli M.	0.981	2.547	-0.028
6	Kawasoti M.	1.141	2.032	-0.025
7	Madhya Bindu M.	1.138	2.213	-0.026
8	BinayiTribeni RM	1.233	2.327	-0.023

District: 9. Syangja (11)

SN	Name	tfrCens	tfr.EBB	r
1	Putalibazar M.	0.967	2.443	-0.011
2	Phedikhola RM	1.181	2.121	-0.022
3	Aandhikhola RM	2.151	2.679	-0.017
4	Arjun Choupari RM	1.833	2.483	-0.019
5	Bhirkot M.	1.377	2.267	-0.022
6	Biruwa RM	1.392	2.300	-0.019
7	Harinas RM	1.300	2.435	-0.022
8	Chapakot M.	1.632	2.492	-0.024
9	Walling M.	0.943	2.175	-0.020
10	Galyang M.	0.966	2.578	-0.023
11	Kaligandaki RM	1.137	2.367	-0.022

District: 10. Parbat (7)

SN	Name	tfrCens	tfr.EBB	r
1	Modi RM	1.953	2.536	-0.015
2	Jaljala RM	1.404	2.470	-0.019
3	Kushma M.	1.314	2.363	-0.018
4	Phalebas M.	1.454	2.474	-0.022
5	Mahashila RM	1.643	2.609	-0.017
6	Bihadi RM	2.149	2.536	-0.015
7	Paiyu RM	1.482	2.737	-0.018

District: 11. Baglung (10)

SN	Name	tfrCens	tfr.EBB	r
1	Baglung M.	0.929	2.187	-0.010
2	Kathekhola RM	1.420	2.354	-0.017
3	Tarakhola RM	1.091	2.692	-0.020
4	Tamankhola RM	2.431	2.812	-0.009
5	Dhorpatan M.	0.962	2.735	-0.020
6	Nisikhola RM	1.945	3.512	-0.010
7	Badigad RM	2.559	3.476	-0.011
8	Galkot M.	1.762	2.566	-0.016
9	Bareng RM	1.419	2.724	-0.017
10	Jaimuni M.	1.739	2.857	-0.018

Lumbini Province: 12-109

District: 1. Rolpa (10)

SN	Name	tfrCens	tfr.EBB	R
1	Runtigadhi RM	1.495	2.680	-0.019
2	Subarnabati RM	1.450	3.073	-0.016
3	Lungri RM	3.030	4.192	-0.012
4	Sunilsmiriti RM	2.603	3.493	-0.012
5	Thawang RM	2.347	3.206	-0.012
6	Paribartan RM	2.369	4.033	-0.007
7	Gangadev RM	2.247	4.596	-0.006
8	Madi RM	2.192	3.446	-0.013
9	Tribeni RM	1.859	3.806	-0.016
10	Rolpa M.	1.629	2.905	-0.016

District: 2. Pyuthan (9)

SN	Name	tfrCens	tfr.EBB	r
1	Pyuthan M.	1.706	3.156	-0.014
2	Swargadwari M	1.632	3.680	-0.008
3	Gaumukhi R.M.	3.403	4.511	-0.005
4	Mandwi R. M	1.396	3.840	-0.012
5	Sarumarani R. M	2.508	4.760	-0.004
6	Mallarani R. M	1.970	3.369	-0.012
7	Naubahini R. M	2.698	4.590	-0.005
8	Jhimruk R. M	2.253	3.753	-0.010
9	Airawati R. M	2.074	4.309	-0.009

District: 3. Gulmi (12)

SN	Name	tfrCens	tfr.EBB	r
1	Kali Gandaki RM	1.680	2.779	-0.019
2	Satyawoti RM	1.081	2.432	-0.021
3	Chandrakot RM	1.378	2.669	-0.018
4	Musikot M.	1.521	3.113	-0.014
5	Isma RM	2.181	3.716	-0.010
6	Malika RM	2.155	3.698	-0.010
7	Madane RM	2.215	3.932	-0.008
8	Dhurkot RM	1.977	3.259	-0.012
9	Resunga M.	1.563	2.575	-0.019
10	Gulmi Durbar RM	1.195	2.761	-0.018
11	Chhatrakot RM	1.624	2.638	-0.020
12	Ruru RM	1.100	2.660	-0.020

District: 4. Arghakhanchi (6)

SN	Name	tfrCens	tfr.EBB	r
1	Chhatradev RM	1.723	2.926	-0.015
3	Bhumikasthan M.	1.614	3.276	2
3	Bhumikasthan M.	1.614	3.276	-0.013
4	Sandhikharka M.	1.192	2.256	-0.023
5	Shitaganga M.	1.802	3.683	5
6	Shitaganga M.	1.802	3.683	-0.010

District: 5. Palpa (10)

SN	Name	tfrCens	tfr.EBB	r
1	Rampur M.	1.390	2.721	-0.021
2	Purbakhola RM	1.689	2.631	-0.024
3	Baganaskali RM	1.540	2.253	3
4	Baganaskali RM	1.540	2.253	-0.024
5	Tansen M.	0.892	1.879	-0.021
6	Ribdikot RM	1.545	2.464	-0.022
7	RainadeChhahara	1.673	2.521	-0.028
8	Mathagadhi RM	1.955	2.476	8
9	Mathagadhi RM	1.955	2.476	-0.024
10	Nisdi RM	2.028	2.521	-0.028

District: 6. Parasi (7)

SN	Name	tfrCens	tfr.EBB	r

1	Bardaghat M.	1.094	2.306	-0.023
2	Sunawal M.	0.775	2.091	-0.025
3	Ramgram M.	0.962	2.424	-0.017
4	Palhinandan RM	1.113	2.922	-0.015
5	Sarawal RM	1.001	2.552	-0.018
6	Pratapapur RM.	1.647	2.917	-0.016
7	Susta RM	1.485	3.036	-0.013

District: 7. Rupandehi (16)

SN	Name	tfrCens	tfr.EBB	r
1	Devdaha M.	1.203	2.081	-0.026
2	Butwal S.M. C.	0.825	1.947	-0.022
3	Sainamaina M.	1.167	1.926	-0.028
4	Kanchan RM	1.075	2.382	-0.020
5	Gaidahawa RM.	1.131	4.013	-0.004
6	Suddhodhan RM	1.169	2.557	-0.019
7	Siyari RM	0.990	2.825	-0.015
8	Tilottama M.	1.011	1.947	-0.025
9	Om Satiya RM	1.217	2.649	-0.016
10	Rohini RM	1.337	3.263	-0.010
11	Siddharthanagar M.	0.951	2.253	-0.016
12	Mayadevi RM	1.649	4.236	-0.002
13	Lumbini SanskriM.	1.618	4.661	0.004
14	Kotahimai RM	1.586	3.002	-0.014
15	Sammarimai RM	2.082	4.298	0.000
16	Marchawari RM	0.782	2.962	-0.013

District: 8. Kapilvastu (10)

SN	Name	tfrCens	tfr.EBB	r
1	Banganga M.	0.869	2.405	-0.019
2	Buddhabhumi M.	1.492	3.712	-0.005
3	Shivaraj M.	1.792	4.202	-0.003
4	Bijayanagar RM	1.545	3.441	-0.002
5	Krishnanagar M.	1.658	4.723	0.009
6	Maharajganj M.	2.477	4.839	0.004
7	Kapilbastu M.	1.324	3.534	-0.004
8	Yasodhara RM	1.882	4.719	0.007
9	Mayadevi RM	1.700	4.211	0.000
10	Shuddhodhan RM	2.394	5.039	0.007

District: 9. Dang (10)

SN	Name	tfrCens	tfr.EBB	r
1	Bangalachuli RM	3.111	4.416	-0.007
2	Ghorahi S.M. C.	1.218	2.622	-0.017
3	Tulsipur S.M. C.	0.958	2.350	-0.016
4	Shantinagar RM	1.030	2.661	-0.025
5	Babai RM	0.996	2.948	-0.016
6	Dangisharan RM	1.207	2.654	-0.018
7	Lamahi M.	1.112	2.708	-0.016
8	Rapti RM	0.922	2.907	-0.015
9	Gadhawa RM	1.283	3.421	-0.011
10	Rajpur RM	1.404	3.721	-0.012

District: 10. Banke (8)

SN	Name	tfrCens	tfr.EBB	r
1	Rapti Sonari RM	1.406	3.088	-0.022
2	Kohalpur M.	1.296	2.867	-0.010
3	Baijanath RM	1.253	2.348	-0.024
4	Khajura RM	1.457	2.754	-0.020
5	Janaki RM	1.227	3.215	-0.008
6	Nepalganj S.M. C.	1.131	2.640	-0.012
7	Duduwa RM	1.686	3.943	-0.007
8	Narainapur RM.	2.427	4.915	0.006

District: 11. Bardiya (8)

SN	Name	tfrCens	tfr.EBB	r
1	Bansgadhi M.	1.325	2.676	-0.023
2	Barbardiya M.	1.258	2.769	-0.021
3	Thakurbaba M.	1.141	2.517	-0.024
4	Geruwa RM	1.174	2.678	-0.023
5	Rajapur M.	1.035	2.211	-0.027
6	Madhuwan M.	1.058	2.423	-0.024
7	Gulariya M.	1.375	3.428	-0.011
8	Badhaiyatal. RM	1.264	2.821	-0.018

District: 12. Eastern Rukum (3)

SN	Name	tfrCens	tfr.EBB	r
1	Bhume RM	1.444	3.831	-0.003
2	Putha Uttarganga	1.495	2.680	-0.019
3	Sisne RM	2.239	3.770	-0.001

Karnali Province: 10-79

District: 1. Dolpa (8)

SN	Name	tfrCens	tfr.EBB	r
1	Dolpo Buddha RM	0.495	3.241	-0.017
2	Shey Phoksundo RM	0.635	2.224	-0.030
3	Jagadulla RM	2.202	4.397	-0.012
4	Mudkechula RM	3.360	5.100	0.013
5	Tripurasundari M.	3.123	4.437	-0.005
6	Thulibheri M.	2.539	3.803	-0.010
7	Kaike RM	2.560	3.608	-0.014
8	Chharka Tangsong	1.535	2.591	-0.024

District: 2. Mugu (4)

SN	Name	tfrCens	tfr.EBB	r
1	Mugumakarmarog RM	2.435	4.652	-0.001
2	Chhayanath Rara M.	3.657	5.363	0.004
3	Soru RM	3.526	5.990	0.019

4	Khatyad RM	4.160	5.284	0.012

District: 3. Humla (7)

SN	Name	tfrCens	tfr.EBB	r
1	Chankheli RM	3.961	6.366	0.014
2	Kharpunath RM	3.788	5.506	0.007
3	Simkot RM	2.804	4.245	-0.006
4	Namkha RM	1.842	2.814	-0.010
5	Sarkegad RM	3.310	5.795	0.008
6	Adanchuli RM	3.761	6.709	0.010
7	Tanjakot RM	2.863	6.232	0.003

District: 4. Jumla (8)

SN	Name	tfrCens	tfr.EBB	r
1	Patarasi RM	2.349	4.069	-0.002
2	Kanaka Sundari RM	2.149	4.612	-0.010
3	Sinja RM	3.699	5.343	0.006
4	Chandannath M.	1.952	3.466	-0.004
5	Guthichaur RM	2.026	4.396	-0.003
6	Tatopani RM	3.204	5.565	0.010
7	Tila RM	4.253	5.767	0.001
8	Hima RM	3.234	5.909	0.002

District: 5. Kalikot (9)

SN	Name	tfrCens	tfr.EBB	r
1	Palata RM	4.680	5.892	0.007
2	Pachal Jharana RM	4.779	6.213	0.007
3	Raskot M.	3.795	5.792	0.005
4	Sanni Tribeni RM	3.940	6.392	0.018
5	Naraharinath RM	3.221	5.629	0.002
6	Khandachakra M.	3.081	6.180	0.011
7	Tilagupha M.	3.981	6.212	0.009
8	Mahawai RM	3.024	5.276	-0.001

9	Kalika RM	4.836	5.713	0.012

District: 6. Wesren Rukum (6)

SN	Name	tfrCens	tfr.EBB	r
1	Aathbiskot	2.161	4.405	-0.001
2	Banfikot	1.784	4.353	-0.004
3	Chaurjahari	1.959	4.017	-0.004
4	Musikot	1.165	3.642	-0.009
5	Sani Bheri	2.505	4.556	-0.004
6	Tribeni	1.724	3.862	-0.015

District: 7. Dailekh (11)

SN	Name	tfrCens	tfr.EBB	r
1	Naumule RM	2.572	5.041	0.002
2	Mahabu RM	2.258	4.362	-0.005
3	Bhairabi RM	2.622	5.218	0.004
4	Thantikandh RM	3.678	6.555	0.009
5	Aathbis M.	3.347	6.078	0.006
6	Chamunda B.M.	4.282	5.936	0.007
7	Dullu M.	2.428	4.449	-0.004
8	Narayan M.	1.305	2.934	-0.017
9	Bhagawatimai RM	2.121	6.427	0.006
10	Dungeshwor RM	1.961	4.198	-0.003
11	Gurans RM	1.926	3.710	-0.011

District: 8. Jajarkot (7)

SN	Name	tfrCens	tfr.EBB	r
1	Barekot RM	2.850	5.422	0.008
2	Kuse RM	3.718	5.971	0.010
3	Junichande RM	4.689	8.278	0.026
4	Chhedagad M.	2.995	7.128	0.014
5	Shivalaya RM	2.681	5.044	-0.009
6	Bheri Malika M.	3.412	5.169	0.013

7	Tribeni Nalagad	2.904	5.128	0.001

District: 9. Surkhet (9)

SN	Name	tfrCens	tfr.EBB	r
1	Barahatal RM	1.917	3.448	-0.012
2	Bheriganga M.	1.394	2.821	-0.020
3	Birendranagar M.	1.157	2.349	-0.019
4	Chaukune RM	2.324	5.198	0.002
5	Panchapuri M.	1.930	3.935	-0.008
6	Gurbhakot M.	1.213	2.957	-0.014
7	Lekabeshi M.	1.637	2.949	-0.016
8	Chingad RM	1.787	4.151	-0.004
9	Simta RM	1.320	3.052	-0.023

District: 10. Salyan (10)

SN	Name	tfrCens	tfr.EBB	r
1	Bagachour M.	1.477	3.817	-0.010
2	BanagadKupindeM	1.870	3.931	-0.006
3	Chhatreshwori RM	1.073	3.022	-0.016
4	Darma RM	2.857	5.308	0.002
5	Siddha Kumakha	2.904	5.128	0.001
6	Kalimati RM	1.665	4.000	-0.015
7	Kapurkot RM	1.581	3.484	-0.012
8	KumakhaRM	1.427	3.517	-0.015
9	Sharada M.	1.363	3.020	-0.002
10	Tribeni RM	1.373	3.105	-0.015

Sudurpashchim Province: 9-88

District: 1. Kailali (13)

SN	Name	tfrCens	tfr.EBB	r
1	Mohanyal RM	2.211	4.644	-0.007
2	Chure RM	1.878	4.115	-0.008
3	Godawari M.	1.417	3.119	-0.014

SN	Name	tfrCens	tfr.EBB	r
4	Gauriganga M.	1.184	2.996	-0.021
5	Ghodaghodi M.	1.288	3.105	-0.018
6	Bardagoriya RM	1.102	2.939	-0.019
7	Lamki Chuha M.	1.536	3.210	-0.014
8	Janaki RM	1.132	2.418	-0.023
9	Joshipur RM	0.928	2.444	-0.023
10	Tikapur M.	1.040	2.493	-0.022
11	Bhajani M.	1.133	2.711	-0.022
12	Kailari RM	0.701	2.413	-0.020
13	Dhangadhi S. M. C.	1.022	2.652	-0.019

District: 2. Kanchanpur (9)

SN	Name	tfrCens	tfr.EBB	r
1	Krishnapur M.	1.386	3.216	-0.015
2	Shuklaphanta M.	1.692	3.366	-0.010
3	Bhimdatta M.	0.872	2.712	-0.011
4	Mahakali M.	1.324	3.353	-0.008
5	Laljhadi RM	1.377	2.795	-0.020
6	Punarbas M.	1.549	3.191	-0.016
7	Belouri M.	1.329	2.806	-0.020
8	Beldandi RM	0.974	3.181	-0.016
9	Bedkot RM	1.47	3.012	-0.013

District: 3. Bajura (9)

SN	Name	tfrCens	tfr.EBB	r
1	Himali RM	3.901	5.705	0.007
2	Gaumul RM	3.548	5.581	0.002
3	Budhinanda M.	3.694	6.346	0.012
4	Swami Kartik RM	3.335	6.250	0.003
5	Pandab Gufa RM	2.790	5.947	0.005
6	Badimalika M.	2.454	5.582	0.002
7	Chhededaha RM	2.403	5.296	-0.001
8	Budhiganga M.	3.644	5.624	0.006
9	Tribeni M.	3.979	5.940	0.006

District: 4. Bajhang (12)

SN	Name	tfrCens	tfr.EBB	r
1	Kanda RM	3.650	3.380	0.010
2	Bungal M.	2.508	4.887	0.002
3	Surma RM	2.891	5.434	0.008
4	Talkot RM	4.350	5.796	0.006
6	Masta RM	2.779	4.671	0.005
7	Jayaprithbi M.	2.356	4.638	0.000
8	Durgathali RM	3.043	4.691	-0.001
9	Kedarsyun RM	2.402	4.653	0.001
10	Bitthadchir RM	3.935	5.414	0.005
11	Thalara RM	2.790	4.896	0.003
12	Khaptad Chhanna RM	1.642	4.238	-0.002

District: 5. Darchula (9)

SN	Name	tfrCens	tfr.EBB	r
1	Byas G.	1.122	3.099	-0.015
2	Duhun G.	1.609	3.864	-0.009
3	Mahakali M.	1.650	3.071	-0.011
4	Naugad G.	2.740	5.325	0.000
5	Apihimal G.	1.416	3.863	-0.005
6	Marma G.	3.218	5.199	0.008
7	Shailyashikhar M.	2.587	4.120	0.002
8	Malikarjun G.	2.025	3.402	-0.005
9	Lekam G.	2.247	4.167	0.000

District: 6. Baitadi (10)

SN	Name	tfrCens	tfr.EBB	r
1	Dilasaini RM	2.905	4.126	-0.002
2	Dogada Kedar RM	2.869	4.332	0.002
3	Puchaundi M.	2.852	5.009	0.005
4	Surnaya RM	2.993	4.502	0.007
5	Dasharathchand M.	1.525	3.130	-0.01
6	Pancheshwor RM	2.645	4.238	-0.004
7	Shivanath RM	3.151	5.397	0.000
8	Melauli M.	2.072	3.847	-0.011
9	Patam M.	1.914	3.718	-0.006
10	Sigas RM	2.545	4.520	0.002

District: 7. Dadeldhura (7)

SN	Name	tfrCens	tfr.EBB	r
1	Nawadurga RM	1.465	3.827	-0.006
2	Amargadhi M.	1.340	2.823	-0.014
3	Ajayameru RM	2.066	3.941	-0.003
4	Bhageshwor RM	1.493	3.843	-0.011
5	Parashuram M.	2.299	4.257	-0.011
6	Aalital RM	1.854	4.471	-0.009
7	Ganyapdhura RM	2.096	4.003	-0.002

District: 8. Doti (9)

SN	Name	tfrCens	tfr.EBB	r
1	Purbichouki RM	4.288	5.092	0.007
2	Sayal RM	4.045	5.669	0.008
3	Aadarsha RM	2.397	4.829	0.003
4	Shikhar M.	2.677	4.169	0.002
5	Dipayal Silgadhi M.	1.952	3.920	0.000
6	K.I. Singh RM	2.094	4.427	-0.001
7	Bogatan RM	4.268	5.589	0.004
8	Badi Kedar RM	3.632	5.364	-0.001
9	Jorayal RM	2.375	4.638	0.000

District: 9. Achham (10)

SN	Name	tfrCens	tfr.EBB	r
1	Panchdebal B. M.	2.948	5.473	0.005
2	Ramaroshan RM	4.261	6.195	0.012
3	Mellekh RM	3.152	5.342	0.004
4	Sanphebagar M.	2.593	4.713	0.006

SN	Name	tfrCens	tfr.EBB	r
5	Chaurpati RM	3.376	5.578	0.006
6	Mangalsen M.	2.743	4.829	0.004
7	Bannigadhi J. RM	1.808	4.298	-0.004
8	Kamal bazar M.	2.518	4.803	0.005
9	Dhakari RM	3.469	5.428	0.012
10	Turmakhand RM	3.709	5.523	0.015

APPENDIX III

Ratio and index

Dependency ratio of 2001

Dependency ratio	Nepal	**Province 1**	**Madhesh**	**Bagmati**	**Gandaki**	**Lumbini**	**Karnali**	**Sudurpashchim**
Child dependency ratio	73	69	76	62	74	79	79	82
Working ages ratio	54	55	53	58	53	52	53	52
Ageing dependency ratio	12	12	11	12	16	12	8	11
Child + aged ratio	85	81	87	74	90	91	87	93
Child- women ratio	0.492	0.444	0.573	0.402	0.249	0.527	0.579	0.577
Aging index	16.51	17.34	14.98	19.16	21.82	15.27	10.42	13.57

Dependency ratio 2011

Dependency ratio	Nepal	**Province 1**	**Madhesh**	**Bagmati**	**Gandaki**	**Lumbini**	**Karnali**	**Sudurpashchim**
Child dependency ratio	61	56	71	46	57	65	80	75
Working ages ratio	57	58	54	63	57	56	52	53
Ageing dependency ratio	14	15	14	13	19	14	12	14
Child + aged ratio	76	71	85	59	76	79	91	89
Child- women ratio	0.361	0.321	0.455	0.260	0.299	0.365	0.526	0.450
Aging index	23.25	26.36	19.47	28.56	32.84	21.61	14.69	19.11

APPENDIX IV

Sex Ratio

$$Sex\ ratio = \frac{Male}{female} * 100$$

Child dependency ratio

$$Child\ depency\ ratio = \frac{P(0-14)}{P(15-59)} * 100$$

Aging dependency ratio

$$\text{Aging dependency ratio} = \frac{P(60+)}{P(15-59)} * 100$$

Child-aging dependency ratio

$$\text{Child} - \text{aging dependency ratio} = \frac{P(15-14)+P(60+)}{P(15-59)} * 100$$

Ageing index

$$\text{Ageing index} = \frac{P(60+)}{P(0-14)} * 100$$

Child Women Ratio

$$\text{Child Women Ratio} = \frac{P(0-4)}{Pf(15-49)} * 100$$

APPENDIX V
HILL JANAJATI

Arriaga Method Census 2001

Age	ASFR from CEB	Cum. ASFR	ASFR Pattern	Cumulative ASFR pattern	Adj factors	Adj. Fertility f*
15-19	0.073	0.073	0.034	0.034	2.121	0.075
20-24	0.185	0.258	0.117	0.151	2.201	0.258
25-29	0.157	0.415	0.101	0.252	1.850	0.222
30-34	0.100	0.515	0.080	0.332	1.752	0.176
35-39	0.045	0.560	0.051	0.383	1.462	0.112
40-44	0.015	0.575	0.029	0.412	1.496	0.064
45-49	0.002	0.577	0.009	0.420	1.472	0.020
MAC=28.9			(K)= 2.201		TFR=4.633	
Arriaga Method Census 2011						
15-19	0.054	0.054	0.025	0.025	2.148	0.049
20-24	0.150	0.204	0.087	0.113	1.973	0.172
25-29	0.129	0.333	0.076	0.189	1.864	0.150
30-34	0.078	0.411	0.048	0.237	1.738	0.095
35-39	0.043	0.455	0.028	0.264	1.719	0.055
40-44	0.022	0.476	0.013	0.278	1.715	0.026
45-49	0.005	0.481	0.004	0.282	1.706	0.008
MAC= 27.91			(K)= 1.973		TFR=2.772	

Estimate ASFR based on P/F Hypothetical Inter-Survey Cohort

Age	2001P(i)	2011P(i)	∆ P(i)	P(i,s)	2001 f(i)	2011 f(i)
15-19	0.1078	0.0753	0.0753	0.0753	0.0342	0.0251
20-24	0.8860	0.6790	0.6790	0.6790	0.1167	0.0874
25-29	1.9355	1.5554	1.4475	1.5228	0.1007	0.0762
30-34	2.8272	2.2987	1.4126	2.0916	0.0802	0.0480
35-39	3.4540	2.8599	0.9244	2.4471	0.0512	0.0277
40-44	3.9380	3.3648	0.5376	2.6292	0.0286	0.0133
45-49	4.2249	3.6950	0.2410	2.6881	0.0087	0.0043
Age	**f(i)**	**ϕ (i)**	**F(i)**	**K**	**f+**	**f*(i)**
15-19	0.0297	0.1483	0.0448	1.682	0.0375	0.068
20-24	0.1021	0.6588	0.3995	1.825	0.1044	0.191
25-29	0.0884	1.1008	0.8881	1.715	0.0860	0.157
30-34	0.0641	1.4213	1.2719	1.644	0.0614	0.112
35-39	0.0395	1.6186	1.5246	1.605	0.0378	0.069
40-44	0.0209	1.7232	1.6705	1.574	0.0191	0.035
45-49	0.0065	1.7559	1.7458	1.540	0.0050	0.009
					K=1.825	TFR=3.205

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Age	ASFR from CEB	Cum. ASFR	ASFR Pattern	Cumulative ASFR pattern	Adj factors	Adj. Fertility f*
Arriaga Method Census 2001						
15-19	0.039	0.039	0.015	0.015	2.662	0.036
20-24	0.140	0.179	0.070	0.084	2.429	0.170
25-29	0.128	0.307	0.063	0.148	2.281	0.153
30-34	0.073	0.381	0.036	0.184	2.167	0.087
35-39	0.024	0.404	0.018	0.202	2.005	0.044
40-44	0.005	0.410	0.007	0.208	1.968	0.017
45-49	0.002	0.412	0.002	0.210	1.960	0.005
MAC=27.49				(K)= 2.429		TFR=2.563
Arriaga Method Census 2011						
15-19	0.024	0.024	0.010	0.010	2.461	0.019
20-24	0.097	0.122	0.056	0.066	1.932	0.108
25-29	0.095	0.217	0.054	0.120	1.842	0.104
30-34	0.051	0.268	0.037	0.157	1.705	0.072
35-39	0.009	0.277	0.013	0.171	1.624	0.025
40-44	0.006	0.271	0.004	0.175	1.551	0.008
45-49	0.002	0.270	0.001	0.176	1.533	0.002
MAC=27.62				(K)= 1.932		TFR=1.691

Estimate ASFR based on P/F Hypothetical Inter-Survey Cohort

Age	2001P(i)	2011P(i)	∆ P(i)	P(i,s)	2001 f(i)	2011 f(i)
15-19	0.0484	0.0308	0.0308	0.0308	0.0147	0.0099
20-24	0.5764	0.3720	0.3720	0.3720	0.0696	0.0565
25-29	1.4728	1.0530	1.0046	1.0353	0.0634	0.0540
30-34	2.2375	1.6652	1.0888	1.4608	0.0364	0.0370
35-39	2.7877	2.1242	0.6514	1.6867	0.0175	0.0134
40-44	3.1667	2.4113	0.1738	1.6346	0.0065	0.0043
45-49	3.4263	2.7418	-0.0458	1.6409	0.0019	0.0010
Age	**f(i)**	**ϕ (i)**	**F(i)**	**K**	**f+**	**f*(i)**
15-19	0.0123	0.0615	0.0143	2.149	0.0166	0.032
20-24	0.0630	0.3766	0.2115	1.954	0.0658	0.129
25-29	0.0587	0.6703	0.5298	1.892	0.0565	0.111
30-34	0.0367	0.8537	0.7721	1.881	0.0340	0.067
35-39	0.0155	0.9311	0.8967	1.759	0.0142	0.028
40-44	0.0054	0.9581	0.9453	1.729	0.0048	0.010
45-49	0.0014	0.9651	0.9628	1.704	0.0010	0.002
					K=1.954	TFR=1.886

TARAI JANAJITI

Arriaga Method Census 2001

Age	ASFR from CEB	Cum. ASFR	ASFR Pattern	Cumulative ASFR pattern	Adj factors	Adj. Fertility f*
15-19	0.102	0.102	0.040	0.040	2.527	0.093
20-24	0.195	0.296	0.107	0.147	2.317	0.248
25-29	0.127	0.423	0.082	0.229	1.995	0.190
30-34	0.068	0.491	0.052	0.281	1.749	0.120
35-39	0.005	0.496	0.026	0.306	1.619	0.060
40-44	0.004	0.492	0.013	0.319	1.543	0.030
45-49	0.000	0.492	0.007	0.326	1.510	0.016
MAC=27.20				(K)= 2.317	TFR=3.788	

Arriaga Method Census 2011

Age	ASFR from CEB	Cum. ASFR	ASFR Pattern	Cumulative ASFR pattern	Adj factors	Adj. Fertility f*
15-19	0.049	0.049	0.018	0.018	2.698	0.043
20-24	0.154	0.203	0.078	0.096	2.408	0.188
25-29	0.112	0.316	0.059	0.155	2.237	0.142
30-34	0.048	0.363	0.033	0.188	1.936	0.079
35-39	0.016	0.379	0.012	0.200	1.898	0.029
40-44	0.010	0.389	0.006	0.206	1.889	0.014
45-49	0.003	0.392	0.003	0.208	1.881	0.007
MAC=26.79				(K)= 2.408	TFR=2.516	

Estimate ASFR based on P/F Hypothetical Inter-Survey Cohort

Age	2001P(i)	2011P(i)	Δ P(i)	P (i, s)	2001 f(i)	2011 f(i)
15-19	0.1825	0.0696	0.0696	0.0696	0.0402	0.0183
20-24	1.1921	0.7519	0.7519	0.7519	0.1066	0.0782
25-29	2.2718	1.7193	1.5367	1.6063	0.0819	0.0585
30-34	3.0601	2.4020	1.2099	1.9618	0.0519	0.0327
35-39	3.5889	2.8803	0.6085	2.2148	0.0259	0.0119
40-44	3.8542	3.2795	0.2194	2.1813	0.0125	0.0061
45-49	4.1132	3.5135	-0.0754	2.1394	0.0066	0.0026

Age	f(i)	ϕ (i)	F(i)	K	f+	f*(i)
15-19	0.0293	0.1463	0.0448	1.552	0.0375	0.085
20-24	0.0924	0.6083	0.3769	2.395	0.0929	0.210
25-29	0.0702	0.9593	0.7947	2.121	0.0668	0.151
30-34	0.0423	1.1708	1.0767	1.922	0.0395	0.089
35-39	0.0189	1.2653	1.2212	1.814	0.0179	0.040
40-44	0.0093	1.3118	1.2833	1.700	0.0088	0.020
45-49	0.0046	1.3348	1.3277	1.611	0.0036	0.008
	P_2/F_2=2.395			P_3/F_3=2.121	K=2.258	TFR=3.014

BRAHMAN/CHHETRI

Arriaga Method Census 2001

Age	ASFR from CEB	Cum. ASFR	ASFR Pattern	Cumulative ASFR pattern	Adj factors	Adj. Fertility f*
15-19	0.063	0.063	0.025	0.025	2.538	0.058
20-24	0.210	0.272	0.120	0.145	2.304	0.276
25-29	0.160	0.432	0.093	0.238	2.194	0.214
30-34	0.089	0.521	0.054	0.292	1.994	0.124
35-39	0.050	0.571	0.030	0.322	1.784	0.069
40-44	0.018	0.589	0.015	0.337	1.773	0.035
45-49	0.005	0.593	0.005	0.342	1.745	0.012
	MAC=27.64		(K)= 2.304		TFR=3.940	

Arriaga Method Census 2011

Age	ASFR from CEB	Cum. ASFR	ASFR Pattern	Cumulative ASFR pattern	Adj factors	Adj. Fertility f*
15-19	0.047	0.047	0.019	0.019	2.423	0.036
20-24	0.173	0.220	0.100	0.119	1.909	0.191
25-29	0.144	0.364	0.091	0.211	1.727	0.174
30-34	0.074	0.438	0.045	0.256	1.715	0.086
35-39	0.040	0.478	0.023	0.278	1.718	0.044
40-44	0.016	0.494	0.009	0.288	1.717	0.017
45-49						0.010
	MAC=27.43		(K)= 1.909		TFR=2.610	

Estimate ASFR based on P/F Hypothetical Inter-Survey Cohort

Age	2001P(i)	2011P(i)	∆ P(i)	P (i, s)	2001 f(i)	2011 f(i)
15-19	0.0801	0.0565	0.0565	0.0565	0.0247	0.0193
20-24	0.8740	0.6743	0.6743	0.6743	0.1202	0.1000
25-29	2.0294	1.6815	1.6015	1.6580	0.0932	0.0912
30-34	2.8111	2.3972	1.5232	2.1974	0.0540	0.0449
35-39	3.3964	2.8922	0.8627	2.5207	0.0300	0.0228
40-44	3.7784	3.2852	0.4741	2.6715	0.0153	0.0095
45-49	4.0711	3.5626	0.1662	2.6869	0.0049	0.0039

Age	f(i)	ϕ (i)	F(i)	K	f+	f*(i)
15-19	0.0220	0.1102	0.0258	2.187	0.0298	0.057
20-24	0.1101	0.6606	0.3784	1.968	0.1137	0.216
25-29	0.0922	1.1217	0.9068	1.828	0.0874	0.166
30-34	0.0495	1.3691	1.2566	1.749	0.0463	0.088
35-39	0.0264	1.5012	1.4399	1.751	0.0250	0.047
40-44	0.0124	1.5631	1.5304	1.746	0.0114	0.022
45-49	0.0044	1.5849	1.5781	1.703	0.0033	0.006
	P_2/F_2=1.968		P_3/F_3=1.828		K=1.898	TFR=3.007

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Arriaga Method Census 2001

Age	ASFR from CEB	Cum. ASFR	ASFR Pattern	Cumulative ASFR pattern	Adj factors	Adj. Fertility f*
15-19	0.066	0.066	0.024	0.024	2.690	0.056
20-24	0.174	0.240	0.093	0.117	2.342	0.218
25-29	0.128	0.367	0.062	0.179	2.148	0.145
30-34	0.067	0.435	0.042	0.221	1.968	0.098
35-39	0.008	0.427	0.013	0.234	1.826	0.030
40-44	0.017	0.410	0.005	0.239	1.716	0.012
45-49	0.000	0.411	0.001	0.240	1.708	0.002
	MAC=26.38		(K)= 2.342		TFR=2.810	

Arriaga Method Census 2011

Age	ASFR from CEB	Cum. ASFR	ASFR Pattern	Cumulative ASFR pattern	Adj factors	Adj. Fertility f*
15-19	0.031	0.031	0.008	0.008	3.951	0.019
20-24	0.133	0.164	0.061	0.068	2.396	0.146
25-29	0.110	0.274	0.056	0.124	2.202	0.134
30-34	0.039	0.313	0.028	0.152	2.059	0.067
35-39	0.011	0.324	0.012	0.164	1.970	0.029
40-44	0.010	0.314	0.002	0.167	1.883	0.005
45-49	0.001	0.313	0.001	0.168	1.866	0.002
	MAC=27.11		(K)=		TFR=2.13	

Estimate ASFR based on P/F Hypothetical Inter-Survey Cohort

Age	2001P(i)	2011P(i)	∆ P(i)	P(i,s)	2001 f(i)	2011 f(i)
15-19	0.0821	0.0390	0.0390	0.0390	0.0244	0.0079
20-24	0.8894	0.5259	0.5259	0.5259	0.0929	0.0606
25-29	1.8697	1.4283	1.3463	1.3853	0.0621	0.0560
30-34	2.6501	2.0217	1.1323	1.6581	0.0416	0.0275
35-39	3.1113	2.4832	0.6135	1.9987	0.0129	0.0125
40-44	3.2922	2.6424	-0.0077	1.6504	0.0051	0.0024
45-49	3.4127	2.6643	-0.4470	1.5517	0.0012	0.0009

Age	f(i)	ϕ (i)	F(i)	K	f+	f*(i)
15-19	0.0162	0.0808	0.0194	2.009	0.0220	0.050
20-24	0.0767	0.4645	0.2703	2.345	0.0786	0.180
25-29	0.0591	0.7598	0.6205	2.232	0.0559	0.128
30-34	0.0346	0.9327	0.8571	1.935	0.0318	0.073
35-39	0.0127	0.9961	0.9686	2.064	0.0116	0.027
40-44	0.0038	1.0149	1.0057	1.641	0.0034	0.008
45-49	0.0011	1.0202	1.0185	1.524	0.0008	0.002
	P_2/F_2=2.345			P_3/F_3=2.232	K=2.286	TFR=2.333

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			Arriaga Method Census 2001			
Age	**ASFR from CEB**	**Cum. ASFR**	**ASFR Pattern**	**Cumulative ASFR pattern**	**Adj factors**	**Adj. Fertility f***
15-19	0.111	0.111	0.041	0.041	2.667	0.101
20-24	0.210	0.321	0.107	0.149	2.459	0.263
25-29	0.142	0.463	0.084	0.232	2.193	0.207
30-34	0.075	0.538	0.056	0.288	1.993	0.138
35-39	0.007	0.545	0.034	0.322	1.867	0.084
40-44	0.012	0.533	0.016	0.338	1.690	0.039
45-49	0.004	0.529	0.007	0.345	1.578	0.017
	MAC=27.64		(K)= 2.459		TFR=4.242	
			Arriaga Method Census 2011			
15-19	0.069	0.069	0.020	0.020	3.409	0.046
20-24	0.190	0.259	0.092	0.112	2.305	0.212
25-29	0.133	0.392	0.076	0.188	2.088	0.175
30-34	0.063	0.455	0.039	0.227	2.009	0.090
35-39	0.000	0.455	0.020	0.247	1.845	0.046
40-44	0.008	0.448	0.010	0.256	1.746	0.023
45-49	0.002	0.446	0.004	0.261	1.709	0.009
	MAC=27.37		(K)= 2.305		TFR=3.01	
			Estimate ASFR based on P/F Hypothetical Inter-Survey Cohort			
Age	**2001P(i)**	**2011P(i)**	**Δ P(i)**	**P(i,s)**	**2001 f(i)**	**2011 f(i)**
15-19	0.2016	0.0956	0.0956	0.0956	0.0415	0.0202
20-24	1.2372	0.9330	0.9330	0.9330	0.1071	0.0920
25-29	2.3166	1.9451	1.7435	1.8391	0.0838	0.0756
30-34	3.0568	2.6344	1.3972	2.3301	0.0558	0.0388
35-39	3.4875	2.9927	0.6761	2.5152	0.0341	0.0201
40-44	3.6522	3.2068	0.1500	2.4801	0.0156	0.0097
45-49	3.5649	3.2064	0.2811	2.2341	0.0073	0.0044
Age	**f(i)**	**ϕ (i)**	**F(i)**	**K**	**f+**	**f*(i)**
15-19	0.0309	0.1543	0.0471	2.029	0.0393	0.091
20-24	0.0995	0.6520	0.4009	2.327	0.1007	0.234
25-29	0.0797	1.0504	0.8639	2.129	0.0760	0.177
30-34	0.0473	1.2869	1.1783	1.977	0.0447	0.104
35-39	0.0271	1.4222	1.3594	1.850	0.0257	0.060
40-44	0.0126	1.4853	1.4480	1.713	0.0118	0.027
45-49	0.0058	1.5144	1.5055	1.484	0.0046	0.011
					K=2.327	TFR=3.523

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Arriaga Method Census 2001

Age	ASFR from CEB	Cum. ASFR	ASFR Pattern	Cumulative ASFR pattern	Adj factors	Adj. Fertility f*
15-19	0.112	0.112	0.050	0.050	2.232	0.095
20-24	0.237	0.348	0.137	0.188	1.898	0.260
25-29	0.182	0.530	0.121	0.308	1.719	0.230
30-34	0.120	0.650	0.078	0.386	1.683	0.148
35-39	0.058	0.709	0.051	0.438	1.619	0.097
40-44	0.030	0.739	0.026	0.464	1.594	0.049
45-49	0.009	0.749	0.012	0.476	1.573	0.023
	MAC=28.24		(K)= 1.898		TFR=4.508	

Arriaga Method Census 2011

Age	ASFR from CEB	Cum. ASFR	ASFR Pattern	Cumulative ASFR pattern	Adj factors	Adj. Fertility f*
15-19	0.090	0.090	0.042	0.042	2.159	0.079
20-24	0.219	0.310	0.124	0.165	1.873	0.232
25-29	0.169	0.479	0.094	0.260	1.845	0.176
30-34	0.107	0.586	0.058	0.317	1.847	0.109
35-39	0.064	0.650	0.038	0.356	1.829	0.071
40-44	0.033	0.683	0.020	0.376	1.820	0.037
45-49	0.008	0.691	0.010	0.385	1.795	0.019
MAC=27.83				(K)= 1.873	TFR=3.615	

Estimate ASFR based on P/F Hypothetical Inter-Survey Cohort

Age	2001P(i)	2011P(i)	∆ P(i)	P(i,s)	2001 f(i)	2011 f(i)
15-19	0.1808	0.1335	0.1335	0.1335	0.0501	0.0418
20-24	1.2363	1.0552	1.0552	1.0552	0.1374	0.1235
25-29	2.4158	2.1716	1.9908	2.1243	0.1207	0.0944
30-34	3.3221	2.9947	1.7584	2.8136	0.0781	0.0576
35-39	3.9272	3.5717	1.1559	3.2802	0.0513	0.0383
40-44	4.3363	4.0433	0.7212	3.5348	0.0261	0.0199
45-49	4.6097	4.2720	0.3448	3.6250	0.0122	0.0097
Age	**f(i)**	**ϕ (i)**	**F(i)**	**K**	**f+**	**f*(i)**
15-19	0.0460	0.2298	0.0742	1.800	0.0573	0.109
20-24	0.1305	0.8821	0.5534	1.907	0.1317	0.251
25-29	0.1076	1.4199	1.1673	1.820	0.1034	0.197
30-34	0.0679	1.7593	1.6001	1.758	0.0650	0.124
35-39	0.0448	1.9833	1.8773	1.747	0.0429	0.082
40-44	0.0230	2.0983	2.0293	1.742	0.0215	0.041
45-49	0.0109	2.1529	2.1363	1.697	0.0088	0.017
					K=1.907	TFR=4.106

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Age	ASFR from CEB	Cum. ASFR	ASFR Pattern	Cumulative ASFR pattern	Adj factors	Adj. Fertility f*
Arriaga Method Census 2001						
15-19	0.120	0.120	0.045	0.045	2.647	0.104
20-24	0.206	0.326	0.109	0.154	2.311	0.252
25-29	0.144	0.470	0.094	0.249	2.190	0.217
30-34	0.076	0.546	0.062	0.311	1.855	0.143
35-39	0.031	0.577	0.038	0.349	1.755	0.088
40-44	0.004	0.573	0.025	0.373	1.636	0.058
45-49	0.001	0.572	0.011	0.385	1.588	0.025
MAC=28.25				(K)= 2.311	TFR=4.437	
Arriaga Method Census 2011						
15-19	0.090	0.090	0.027	0.027	3.404	0.063
20-24	0.197	0.288	0.098	0.124	2.315	0.227
25-29	0.133	0.421	0.076	0.200	2.101	0.176
30-34	0.080	0.501	0.048	0.249	2.014	0.111
35-39	0.019	0.520	0.031	0.279	1.860	0.072
40-44	0.001	0.519	0.015	0.294	1.763	0.035
45-49	0.000	0.519	0.005	0.299	1.733	0.012
MAC=27.89				(K)= 2.315	TFR=3.473	

Estimate ASFR based on P/F Hypothetical Inter-Survey Cohort

Age	2001P(i)	2011P(i)	∆ P(i)	P(i,s)	2001 f(i)	2011 f(i)
15-19	0.2497	0.1486	0.1486	0.1486	0.0453	0.0266
20-24	1.2088	1.0453	1.0453	1.0453	0.1091	0.0978
25-29	2.2647	1.9980	1.7483	1.8969	0.0943	0.0761
30-34	2.8993	2.6561	1.4473	2.4926	0.0622	0.0484
35-39	3.3302	3.0307	0.7660	2.6629	0.0378	0.0305
40-44	3.3932	3.1887	0.2894	2.7819	0.0246	0.0151
45-49	3.2958	3.1860	-0.1442	2.5187	0.0114	0.0050
Age	**f(i)**	**ϕ (i)**	**F(i)**	**K**	**f+**	**f*(i)**
15-19	0.0359	0.1795	0.0577	2.577	0.0448	0.107
20-24	0.1034	0.6967	0.4362	2.396	0.1045	0.250
25-29	0.0852	1.1226	0.9217	2.058	0.0820	0.196
30-34	0.0553	1.3990	1.2706	1.962	0.0528	0.127
35-39	0.0341	1.5697	1.4872	1.791	0.0329	0.079
40-44	0.0198	1.6690	1.6132	1.725	0.0185	0.044
45-49	0.0082	1.7098	1.6974	1.484	0.0065	0.016
					K=2.396	TFR=4.097

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Arriaga Method Census 2001

Age	ASFR from CEB	Cum. ASFR	ASFR Pattern	Cumulative ASFR pattern	Adj factors	Adj. Fertility f*
15-19	0.109	0.109	0.030	0.030	3.629	0.0749
20-24	0.217	0.325	0.100	0.130	2.497	0.2497
25-29	0.191	0.516	0.105	0.235	2.197	0.2622
30-34	0.117	0.634	0.091	0.326	1.942	0.2272
35-39	0.044	0.677	0.056	0.383	1.770	0.1398
40-44	0.023	0.701	0.037	0.420	1.670	0.0924
45-49	0.009	0.709	0.019	0.439	1.616	0.0474
MAC=30.15			(K)= 2.497		TFR=5.4684	

Arriaga Method Census 2011

15-19	0.077	0.077	0.024	0.024	3.267	0.0611
20-24	0.202	0.279	0.086	0.109	2.544	0.2188
25-29	0.159	0.438	0.081	0.191	2.295	0.2061
30-34	0.122	0.560	0.060	0.251	2.235	0.1526
35-39	0.091	0.651	0.036	0.287	2.271	0.0916
40-44	0.023	0.674	0.019	0.306	2.202	0.0483
45-49	0.004	0.677	0.010	0.316	2.144	0.0254
MAC=29.04				(K)= 2.544	TFR=4.0195	

Estimate ASFR based on P/F Hypothetical Inter-Survey Cohort

Age	2001P(i)	2011P(i)	∆ P(i)	P(i,s)	2001 f(i)	2011 f(i)
15-19	0.1933	0.1206	0.1206	0.1206	0.0299	0.0235
20-24	1.1830	0.9519	0.9519	0.9519	0.1004	0.0859
25-29	2.3747	2.0427	1.8495	1.9701	0.1046	0.0814
30-34	3.3929	2.9091	1.7261	2.6780	0.0912	0.0597
35-39	3.9479	3.6986	1.3239	3.2940	0.0565	0.0359
40-44	4.1712	3.9701	0.5772	3.2552	0.0370	0.0194
45-49	4.0454	4.0674	0.1195	3.4135	0.0194	0.0101
Age	**f(i)**	**ϕ (i)**	**F(i)**	**K**	**f+**	**f*(i)**
15-19	0.0267	0.1337	0.0411	2.934	0.0332	0.0882
20-24	0.0932	0.5996	0.3583	2.657	0.0966	0.2567
25-29	0.0930	1.0646	0.8365	2.355	0.0918	0.2439
30-34	0.0755	1.4421	1.2658	2.116	0.0727	0.1932
35-39	0.0462	1.6730	1.5599	2.112	0.0445	0.1182
40-44	0.0282	1.8141	1.7256	1.886	0.0262	0.0696
45-49	0.0147	1.8876	1.8655	1.830	0.0125	0.0332
					K=2.657	TFR=5.0151

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Age	ASFR from CEB	Cum. ASFR	ASFR Pattern	Cumulative ASFR pattern	Adj factors	Adj. Fertility f*
Arriaga Method Census 2001						
15-19	0.095	0.095	0.039	0.039	2.452	0.090
20-24	0.212	0.307	0.099	0.138	2.318	0.229
25-29	0.158	0.465	0.085	0.224	2.179	0.197
30-34	0.092	0.557	0.060	0.284	1.992	0.139
35-39	0.069	0.626	0.044	0.327	1.911	0.102
40-44	0.047	0.673	0.024	0.351	1.915	0.056
45-49	0.018	0.690	0.007	0.358	1.926	0.016
	MAC=28.47		(K)= 2.318		TFR=4.149	
Arriaga Method Census 2011						
15-19	0.073	0.073	0.025	0.025	2.885	0.054
20-24	0.208	0.281	0.104	0.130	2.162	0.225
25-29	0.141	0.421	0.099	0.228	1.844	0.214
30-34	0.080	0.502	0.044	0.272	1.844	0.095
35-39	0.076	0.577	0.027	0.299	1.929	0.058
40-44	0.031	0.608	0.016	0.315	1.930	0.035
45-49	0.011	0.620	0.005	0.320	1.933	0.011
	MAC=28.69		(K)= 2.162		TFR=3.459	

Estimate ASFR based on P/F Hypothetical Inter-Survey Cohort

Age	2001P(i)	2011P(i)	Δ P(i)	P(i,s)	2001 f(i)	2011 f(i)
15-19	0.1583	0.1109	0.1109	0.1109	0.0389	0.0253
20-24	1.0729	0.9174	0.9174	0.9174	0.0994	0.1044
25-29	2.1259	1.9570	1.7987	1.9096	0.0852	0.0986
30-34	2.8532	2.5429	1.4699	2.3873	0.0603	0.0436
35-39	3.3873	3.1303	1.0044	2.9139	0.0436	0.0273
40-44	3.7933	3.3651	0.5119	2.8992	0.0237	0.0160
45-49	3.8081	3.3585	0.0288	2.8851	0.0071	0.0053
Age	**f(i)**	**ϕ (i)**	**F(i)**	**K**	**f+**	**f*(i)**
15-19	0.0321	0.1605	0.0498	2.226	0.0404	0.091
20-24	0.1019	0.6702	0.4076	2.250	0.1043	0.235
25-29	0.0919	1.1298	0.9157	2.085	0.0881	0.198
30-34	0.0519	1.3894	1.2671	1.884	0.0495	0.111
35-39	0.0354	1.5666	1.4814	1.967	0.0342	0.077
40-44	0.0199	1.6659	1.6160	1.794	0.0182	0.041
45-49	0.0062	1.6968	1.6873	1.710	0.0047	0.011
					K=2.250	TFR=3.818

APPENDIX VI

Estimation of total fertility rate at Kanda Rural Municipality, 2001

Ages	**15–19**	**20–24**	**25–29**	**30–34**	**35–39**	**40–44**	**45–49**
Index (i)	**1**	**2**	**3**	**4**	**5**	**6**	**7**
Empirical Bayes Estimates							
P_{EB}	0.059	0.607	1.932	3.051	3.970	4.217	4.553
f_{EB}	0.029	0.131	0.129	0.083	0.058	0.044	0.016
Interpolated moments							
Fi	0.035	0.436	1.158	1.673	2.023	2.288	2.393
μi	16.136	20.285	23.208	25.238	26.909	28.403	29.101
Regression Inputs							
(Pi/Fi)	1.673	1.391	1.668	1.823	1.962	1.843	1.903
(Yi=Fω Pi/Fi)	4.089	3.399	4.076	4.455	4.794	4.504	4.650
Avg $(\mu_x\text{-}x)_i$	-1.364	-2.215	-4.292	-7.262	-10.591	-14.097	-18.399
Weight	0.022	0.283	1.029	1.938	2.968	3.773	4.380

Estimation of total fertility rate at Dhanushadam Municipality, 2001

Ages	**15–19**	**20–24**	**25–29**	**30–34**	**35–39**	**40–44**	**45–49**
Index (i)	**1**	**2**	**3**	**4**	**5**	**6**	**7**
Empirical Bayes Estimates							
P_{EB}	0.230	1.175	2.338	2.942	3.609	3.557	3.623
f_{EB}	0.024	0.099	0.115	0.051	0.049	0.037	0.019
Interpolated Moments							
F_i	0.038	0.314	0.941	1.334	1.572	1.802	1.901
μ_i	16.106	20.090	23.393	25.231	26.709	28.395	29.219
Regression Inputs							
(Pi/Fi)	6.099	3.746	2.483	2.205	2.296	1.973	1.906
(Yi=Fω Pi/Fi)	11.981	7.358	4.879	4.332	4.511	3.877	3.745
Avg $(\mu_x\text{-}x)_i$	-1.394	-2.410	-4.107	-7.269	-10.791	-14.105	-18.281
Weight	0.033	0.283	1.019	1.723	2.473	3.058	3.411

Estimation of total fertility rate at Kathmandu, 2001

Ages	**15–19**	**20–24**	**25–29**	**30–34**	**35–39**	**40–44**	**45–49**
Index (i)	**1**	**2**	**3**	**4**	**5**	**6**	**7**
Empirical Bayes Estimates							
P_{EB}	0.067	0.552	1.250	1.793	2.249	2.461	2.697
f_{EB}	0.019	0.069	0.059	0.037	0.010	0.005	0.001
Interpolated Moments							
F_i	0.015	0.260	0.603	0.843	0.955	0.986	0.991
μ_i	16.545	20.315	22.934	24.885	26.022	26.443	26.539
Regression Inputs							
(Pi/Fi)	4.553	2.123	2.074	2.128	2.356	2.497	2.721
(Yi=Fω Pi/Fi)	4.530	2.113	2.064	2.118	2.345	2.484	2.708
Avg $(\mu_x\text{-}x)_i$	-0.955	-2.185	-4.566	-7.615	-11.478	-16.057	-20.961
Weight	0.012	0.215	0.688	1.353	2.053	2.405	2.668

APPENDIX VII

Classification of caste/ethnic groups of Nepal

Adivasi/Janajiti of Cast/ethinic group of enumerated in Nepal Population 2011	
1.1 Hill Janajati	Aathpariya, Bahing, Bantaba, Bhote, Bote, Brahmu, Byasi, Sauka, Chamling, Chepang/Praja, Chhantyal/Chahantel, Danuwar, Darai, Dolpo, Ghale, Gharti/Bhujej, Gurung, Hayu, Huolomo, Jirel, Khaling, Kulung, Kumal, Kusunda, Lepcha, Lopa, Limbu, Loharung, Magar, Majhi, Mewahang, Bala, Nachhiring, Pahari, Rai, raji, Raute, Samgpang, Sherpa, Sunuwar, Tamang, Thakali, Thami, Thulung, Topkegola, walung, Yakkha, Yamphu
1.2Newar	Newar
1.3 Tarai Janajiti	Dhanuka, Dhimal Gangai, Jhangad/Dhagar, Khawas, Kisan, Koche, Meche, Munda, Patharkatta/Kushwadiya, Rajbansi, Satar/Santhal, Tajpuriya, Tharu
2. Brahman/Chhetree	
2.1 Brahman/ Chhetree	Brahman -Hill, Chhetree, Thakuri, Sanyasi/ Dasnami
3. Madhesi Caste	
3.1 Madheshi Brahman	Brahman- Terai, Kayastha, Nurang, Rajput
3.2 Other Madheshi Caste	Amat, Badhaee, Baiya, Baranee, Bin, Dev, Dharikar, Dhuniya, Gaderi, Bhedihar, Hajam, Thakur, Haluwai, Kahar, Kalar, Kamar, Kanu, Kathbaniyan, Kewat, Koiri, Kushuwaha, Kori, Kumhar, Kurmi, Lodh, Mali, Mallaha, Natuwa, Nuniya, Rajbhar, raidhob, Sarbaria, Sonar, Sudhi, Teli, Yadev
4.Dalit	
4.1 Hill Dalit	Badi, Damai, Dholi, Gaine, Kami, Sarki
4.2 Madhesi Dalit	Bantar, /Surdar, Chamar/ Harijan/Ram, Chidimar, Dhobi, Dom, Dusadh/ Paswan/Pasi, Halkhor, Khatwe, Musahar, Tatma/ Tatwa
5. Musalman	Madhesi Muslim, Chraute
6 Others	Marwadi, Jain, Banboli, Punjabi/Sikh, Undefined Others groups/caste and Foreigner

Source: Central Department of Anthropology, TU, 2014

APPENDIX VIII

The population policies targets fertility trends, Nepal, 1956 to 2020

Plan/time Period	Key policies and targets during the period
First Five-Year Plan (1956-61)	FPAN was established and wants to reduce about small family size
The Second Five Year Plan (1962-65)	Nepal started setting fertility decrease targets as early as 1965. However, Nepal were never met that target.
The Third Five Year Plan (1965-70)	Third plan had estimated CBR of 39.1 in 1967 to 38.1 in 1971. However, Nepal were never met that target.
The Fourth Five Year Plan (1970-75)	Fourth planed focus supplied FP services (Target about 132,000 married couples were supplied FP services).
The Fifth Five Year Plan (1975-80)	This planned estimated CBR were reduced 40 to 38 bat the end of 1980.
The Sixth Five Year Plan (1980-85)	The planning commission to estimate CBR was 42. Planning Commission to set targets reducing by the end of the Sixth Plan.
The Seventh Five Year Plan (1985-90)	Fertility and FP Survey of 1986 showed CBR of about 39 for 1986. The Seventh Plan (1985-90) focused to achieve TFR of about four per woman by the end of seventh five-year plan.
The Eighth Five Year Plan (1992-97)	Eighth plan project TFR 5.8 per woman reducing to 4.5 by 1996/97. The Family Health Survey 1996 displayed TFR of 4.64 per woman.
The Ninth Five Year Plan (1997-2002)	The Ninth Plan will have decreased fertility to 4.2 by the conclusion of the Plan Period. Indicating that fertility was more than reached, the final NDHS in 2001 showed a TFR of 4.1 for the three-year span between 1998 and 2000. The projection for mid-2001, however, shows a reduction to 3.8 per woman, suggesting that fertility has apparently continued to decline.
The Tenth Five Year Plan (2002-2007)	The target of reducing TFR from an estimated 3.1 per woman to 3.0 from 4.1 TFR. The NDHS showed TFR of 3.10 per woman.
The Three-Year Interim Plan (2006/07 - 2009/10)	The target of reducing TFR in 2009/10. 1. TFR will be to 2.5 in 2017; 2. CPR to 67 percent by 2015
Twelve three -year plan (2010/11-2012/13)	The target of reducing TFR in 2012/13. The TFR will be to 2.5 in 2017; 2. CPR to 67 percent by 2015
Thirteen three-year plans (2013/14-2015/16)	The target of reducing TFR in 2015/16. The TFR will be to 2.5 in 2017; 2. CPR to 67 percent by 2015 but DHS obtained 2.3
Fourteen three-years plan 2073/74-2075/76 2016/17-2018/19)	The target of reducing TFR in 2018/19. The fertility reduces to replacement level
Current fifteen five years plan 2076/77-2080/81 (2019/20-2023/24)	The target of reducing TFR in 2023/24. Current goals: fertility reduce to replacement level

Sources: National Planning Commissions report (2020).

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