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Projecting Nepal's Demographic Future- How to deal with spatial and demographic heterogeneity

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Working Paper **WP-16-021**

Projecting Nepal's Demographic Future – How to deal with spatial and demographic heterogeneity?

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Contents

1 Introduction 1
2 Data and Methodology 4
2.1 Age and Sex Structure 4
2.2 Fertility 6
2.2.1 Fertility Scenario 7
2.3 Mortality 8
2.3.1 Mortality Scenario 12
2.4 International Migration 12
2.4.1 Emigration Base Year Estimations 13
2.4.2 Emigration Scenario 14
2.4.3 Immigration Base Year Estimates 15
2.4.4 Immigration Scenario 16
2.5 Internal Migration 16
2.5.1 Internal Migration Base Year Estimates 16
2.5.2 Internal Migration Scenario 17
2.6 Population Projections for Village Development Committees and Municipalities 17
3 Results 18
3.1 National Level 18
3.1.1 Fertility and Mortality: Age and Sex Structure 19
3.1.2 International Migration 22
3.2 District-Level 24
3.2.1 Age and Sex Details: Three Typical Districts of Nepal 27
3.2.2 Births: Relative Change to Earlier Period 28
3.2.3 Deaths: Relative Change to Earlier Period 29
3.2.4 Internal and International Migration 29
3.3 VDC/Municipalities Level 32
4 Conclusion 35
5 References 36

Abstract

This Working Paper outlines the efforts of the cooperation between researchers at IIASA's World Population Program and the Ministry of Health and Population, Nepal to conduct small-area population projections on Village Development Committee and Municipality levels for Nepal from 2011 to 2031.

In order to fulfil this aim it was necessary to compile, harmonize and estimate small-area population data based on the latest census and survey data. Due to the lack of comprehensive fine-grained data on the demographic determinants fertility, mortality, and migration we estimate those with different methodological approaches like the Child-Women-Ratio or mortality corrections. In recent time, internal and international migration has become the most common of the three demographic components; therefore, most efforts went into estimating the rates of migration flows to and from several directions.

The creation of this small-area fertility, mortality and migration data by age and sex enables us to apply the well-known cohort component method in a multi-state framework (each district as a state) and to create reasonable scenarios on the prospective population development for Nepal on regional and local level. This will help national, regional and local actors and policymakers to set appropriate measures to steer and adapt to the future characteristics of the Nepalese society on all administrative levels.

Acknowledgments

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Projecting Nepal's Demographic Future – How to deal with spatial and demographic heterogeneity?

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1 Introduction

In 2013, the *Population Division of the Ministry of Health and Population (MoHP)*, Nepal proposed to Samir K.C., Research Scholar at the *World Population Program (POP)*, *International Institute for Applied Systems Analysis (IIASA),* to conduct population projections by age and sex at the *Village Development Committee* (VDC, constituting the number of villages as one administrative unit) and *Municipality* levels of Nepal for the period 2011 to 2031. While VDCs refer to villages and therefore rural areas, municipalities represent cities and urban areas in Nepal. The definition of urban in Nepal has been defined and redefined multiple times, what creates problems of consistency in the definition. Additionally quantitative criteria like population size (e.g. not less than 10.000 inhabitants) has not been followed consistently and got biased due to political interests. Since 1971 areas with municipal status have been ipso facto considered as urban. The approval of this status is connected to population size, density, urban environment (e.g. high school, college, bazaar, judicial and administrative offices, etc.), occupational structure and political interests. (CBS Nepal 2003a)

These local administrative levels are the planning units in the Nepalese bottom-up planning policy strategy. This spatial granularity is of great interest for governmental organizations, policymakers, planners and program implementers in order to identify the potential prospective of socio-demographic development as foundation for local action plans. As these interest groups need to gauge the future demand for *Services of General Interest (SGI)* in fields such as health, education, food, water, energy, infrastructure, and labor market on a yearly basis, it is essential to create regional and local population projections.

The initiated project lasted from 2013 to 2015 and resulted in the presentation of the subnational population projections at district and VDC/municipality level to the MoHP so that they could be used for the planning, monitoring, coordination, supervision and evaluation of health and population related policy programs. Up to that point, the MoHP had been downscaling the population at the VDC/Municipality levels using the district level population projections provided by the *Central Bureau of Statistics* (CBS, 2003b) that uses data from the census and surveys prior to 2001. On behalf of the *National Planning and Commission Secretariat (NCPS)* the CBS provides population projections by 5-year age groups and sex on district level in 5-year steps for the period 2002-2021. Since the CBS does not have a mandate to produce population projections lower than at

the district level, the *Department of Health Services (DoHS)* under the MoHP developed its own way to annually interpolate the 5-yearly district level projections offered by the CBS, and then downscaled them to smaller administrative units (VDC/Municipality)[1]. The results serve as annual demographic benchmark (expected pregnancies, births, immunization, several age specific populations, etc.) and define the targets for public health administrators and workers in their respective areas. The achievements of the health administrators and workers are evaluated against these targets and are therefore perceived as very important.

Unfortunately, these projections showed unreasonable deviations, larger in recent years, from the de facto population development since 2001. The main reason for these discrepancies is the use of outdated population projections at the district level that were never successfully updated since 2003. Also, the CBS's method of downscaling the projected population at the district level resulted in unrealistic results[2]. This circumstance and its relevance to local planning activities caused and initiated the collaboration between the MOHP and IIASA with the aim to create more accurate projections based on newer data.

Initially, the idea was to use newer district level projections from the CBS based on the census results from 2011, and then develop demographic-based methods to project the population at the VDC/Municipalities levels in order to replace the earlier used approach developed at the DoHS. However, the projections by the CBS were not yet available[3], hence, we developed the district population projections independently.

In this report, we present the methods and results of the population projections for Nepal and its 75 districts in 5-year steps for the period 2011-2031. In addition, we projected the population for 4,051 VDCs and Municipalities of Nepal in 5-year steps and for the period 2011-2031. The results for the VDCs/Municipalities were further interpolated annually. The projections for VDC/Municipality levels were conducted for a shorter period from 2011 to 2021 due to small population sizes of the low level administrative units and the with time increasing uncertainty of the projection model. As detailed demographic data are less available for smaller administrative levels, we used data estimated for higher levels to estimate the values for immediate lower levels. The classification is based on ecological and administrative areas. Nepal is divided in 3 ecological zones (from Southern plain Terai Region bordering India, to the mid Hill Region, and to the Northern Mountain Region bordering Tibet) and 5 development regions from east to west (Eastern, Central, Western, Mid-Western, and Far-Western Development Region)[4] that are subdivided into 14 administrative zones[5], and then into 75 districts. Districts are further subdivided into 4,051 VDCs/Municipalities that consist of numerous Wards which is the lowest administrative unit in Nepal (see Figure 1).

[1] The software was contracted to http://www.pcs.com.np/ by the DoHS

[2] For e.g. the national age-sex distribution was applied to the districts without taking any consideration of the empirical distribution in the year 2001.

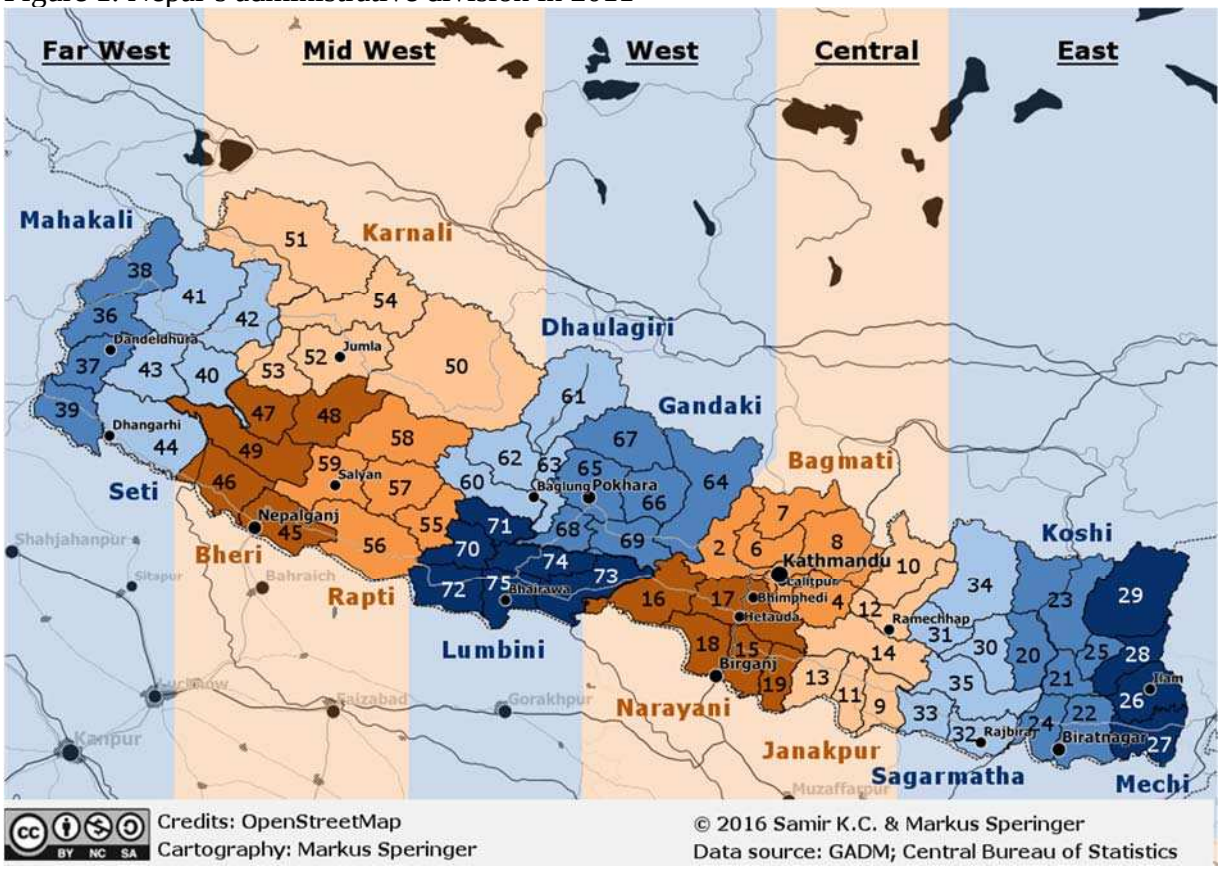
[3] The CBS released the district wise projections in Oct 2014 but withdrew them immediately after some serious flaws were pointed out by the main author of this report.

[4] In September 2015, the new constitution of Nepal redefined this geographical division into 7 provinces by regrouping the existing 75 districts.

[5] From West to East: Mahakali, Seti (*Far-West Development Region*), Bheri, Karnali, Rapti (*Mid-West DR*), Lumbini, Dhaulagiri, Gandaki (*West DR*), Narayani, Bagmati, Janakpur (*Central DR*), Sagarmatha, Koshi, Mechi (*East DR*).

Alternatively to the administrative zones, data are often reported for15 eco-development regions[6] that are basically a crossover of the 3 ecological zones and 5 development regions. The following sections first present the methods leading to the projections, followed by an outline of our results and some discussions and conclusions at the end of this report.

Figure 1. Nepal's administrative division in 2011



Districts: (1) Bhaktapur, (2) Dhading, (3) Kathmandu, (4) Kavrepalanchok, (5) Lalitpur, (6) Nuwakot, (7) Rasuwa, (8) Sindhupalchok, (9) Dhanusa, (10) Dolakha, (11) Mahottari, (12) Ramechhap, (13) Sarlahi, (14) Sindhuli, (15) Bara, (16) Chitawan, (17) Makwanpur, (18) Parsa, (19) Rautahat, (20) Bhojpur, (21) Dhankuta, (22) Morang, (23) Sankhuwasabha, (24) Sunsari, (25) Terhathum, (26) Ilam, (27) Jhapa, (28) Panchthar, (29) Taplejung, (30) Khotang, (31) Okhaldhunga, (32) Saptari, (33) Siraha, (34) Solukhumbu, (35) Udayapur, (36) Baitadi, (37) Dadeldhura, (38) Darchula, (39) Kanchanpur, (40) Achham, (41) Bajhang, (42) Bajura, (43) Doti, (44) Kailali, (45) Banke, (46) Bardiya, (47) Dailekh, (48) Jajarkot, (49) Surkhet, (50) Dolpa, (51) Humla, (52) Jumla, (53) Kalikot, (54) Mugu, (55) Pyuthan, (56) Dang, (57) Rolpa, (58) Rukum, (59) Salyan, (60) Baglung, (61) Mustang, (62) Myagdi, (63) Parbat, (64) Gorkha, (65) Kaski, (66) Lamjung, (67) Manang, (68) Syangja, (69) Tanahu, (70) Arghakhanchi, (71) Gulmi, (72) Kapilbastu, (73) Nawalparasi, (74) Palpa, (75) Rupandehi;

[6] From West to East: Far-Western Mountain, Far-Western Hill, Far-Western Terai, Mid-Western Mountain, Mid-Western Hill, Mid-Western Terai, Western Mountain, Western Hill, Western Terai, Central Mountain, Central Hill, Central Terai, Eastern Mountain, Eastern Hill and Eastern Terai.

2 Data and Methodology

The basis for the presented population projections is data retrieved from the 2011 Population and Household Census and survey data, mainly the Demographic and Health Survey (DHS) 2006 and 2011 (Measure DHS 2012; Measure DHS 2007). We used the base year distribution of the population by age and sex directly from the 2011 census reports and estimated various parameters of the core demographic components, namely, fertility, mortality, and (internal and international) migration. Once the baseline structure and estimates were prepared, we defined a medium scenario that reflects the continuation of recent demographic trends into the future.

We first defined a narrative for the medium scenario that would represent Nepal on a *business-as-usual* pathway. This pathway is based on the expectation of continuous progress in several socioeconomic and health related areas, including women's education, employment opportunities and labor force participation, successful family planning policies and programs, the expansion of health facilities and healthcare workers, as well as the continuity of other factors such as persistent international migration of young men and women, increasing urbanization, and a shift from a quantity to a quality (e.g. good health and education) perception of children and reproduction.

These trends and existing knowledge of other influencing socioeconomic, cultural, and political factors were used to calculate assumptions for the demographic components fertility, mortality and migration in the medium scenario. Those demographic components are getting projected from the base year 2011 in four 5-yearly-projection-steps to 2031. In further sections, we will explain in details the underlying assumptions for each demographic component. It is a tradition in population projections to present alternative what-if scenarios to gauge the uncertainty span into the future as well as to test sensitivity of certain assumed values. UN population projections, for e.g. have their 'high' and 'low' scenario (the UN calls it variants) where the level of fertility is half a child more or less respectively than in their medium variant; any other what-if scenarios can be defined and calculated as needed.

Finally, these assumptions were implemented into the standard cohort component model to project the population at various administrative levels of Nepal. All calculations were done using Excel – Visual Basics for Application (Excel – VBA) and the statistical software R.

2.1 Age and Sex Structure

Information on the age-sex distribution of the Nepalese population from national to VDC/Municipality levels in 2011 was retrieved from the National Population and Household Census 2011 and related publications provided by the CBS[7]. (CBS Nepal 2012; CBS Nepal 2014a; CBS Nepal 2014b; CBS Nepal 2014c; CBS Nepal 2014d; CBS Nepal 2014f; CBS Nepal 2014g; CBS Nepal 2014h; CBS Nepal 2014i; CBS Nepal 2014e; CBS Nepal 2014j; CBS Nepal 2014l; CBS Nepal 2014k) The age and sex structure as shown in Figure 2. (Panel A) holds information about demographic developments in Nepal in the past 100 years. Two major recent trends are visible in the population pyramid (KC 2014): A major decline in fertility resulting in the shrinking of younger aged

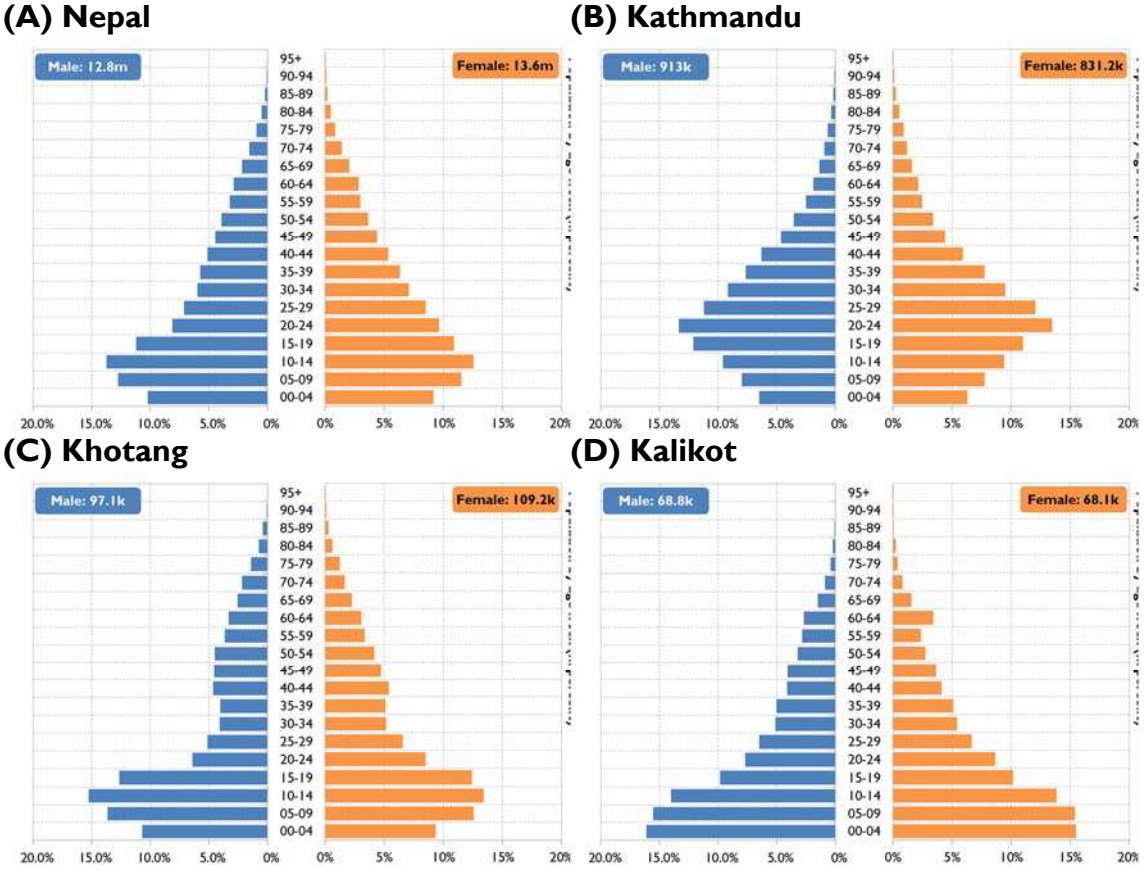
[7] Source: CBS – Central Bureau of Statistics, Nepal (http://cbs.gov.np/)

population; and a very high rate of male emigration resulting in an imbalanced age structure of young adults.

The shape of the age pyramid represents an aggregation with a great deal of heterogeneity across districts and VDC/Municipalities. Looking at the age structure of the 75 districts, there are three distinct shapes characterizing the different demographic faces of Nepal (see Figure 2):

- ***Diamond*** shaped population distribution in districts with major urban centers and a high proportion of young adult population, as shown for Kathmandu in Panel B.
- ***Pagoda*** shaped population distribution in districts with a high proportion of young men absent due to migration, mostly in hill districts surrounding major urban centers and easily accessible by roads, as shown for Khotang in Panel C.
- ***Pyramid*** shaped districts with a broad base, characterized by a larger proportion of children, especially in rural less economically developed hill and mountain regions as shown for Kalikot in Panel D.

Figure 2. Age and sex pyramids of (A) Nepal, (B) Kathmandu, (C) Khotang, and (D) Kalikot, 2011

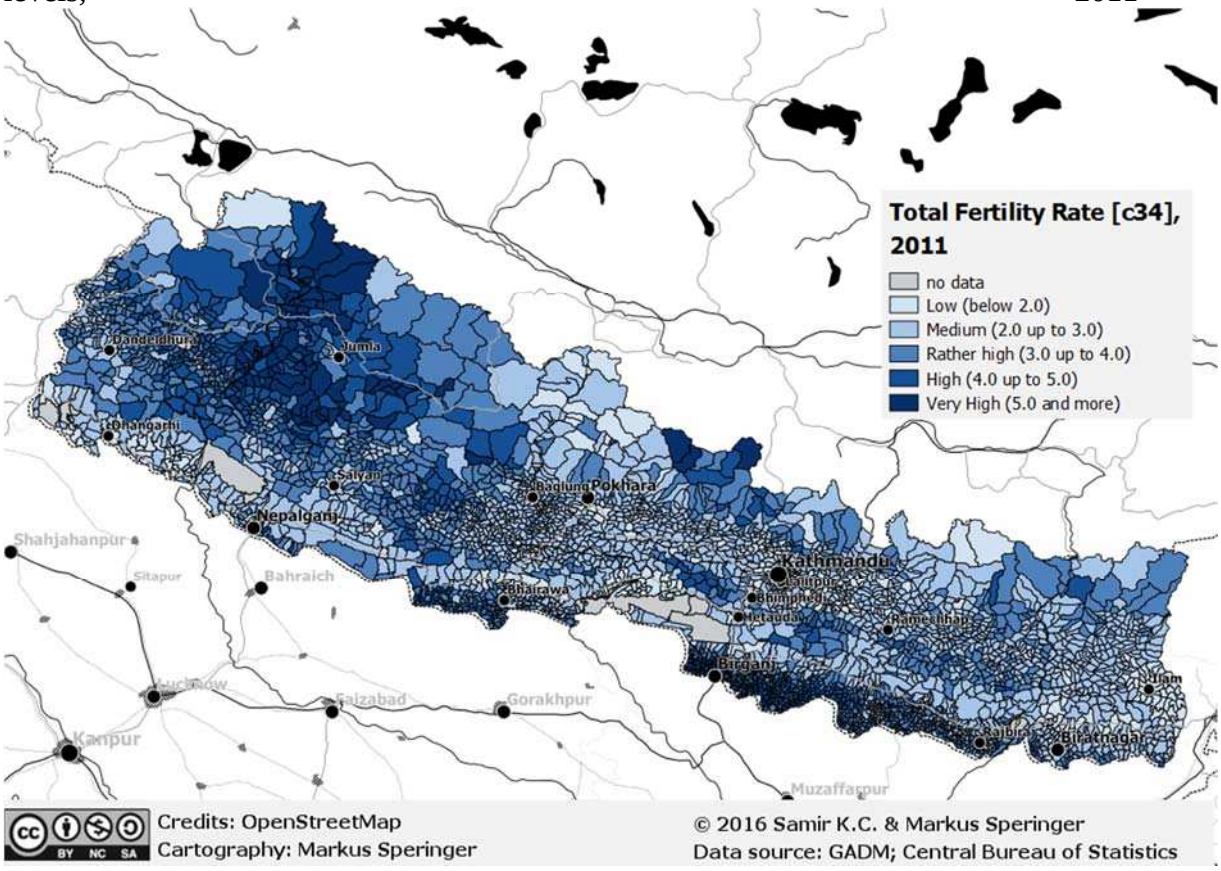


2.2 Fertility

The different shapes in Figure 2 infer different levels of fertility in the districts. However, the fertility rates are not readily available from the 2011 census. A problem of heavy under-counting of births during the last 12 months was found when the data was compared with the corresponding population size of the less than 1-year old. In the country, the level of underreporting is 1 in 3 births, but the level of under-reporting of births is different by region. The level is worst in the Terai region with 2 in 5 births, and least severe in mountain regions with 1 in 5 births. In hill districts, the level is better than the average, roughly 1 in 4 births is not reported. Due to this bias and almost no direct knowledge of census under-count, we did not use birth data from the census and instead used the Total Fertility Rate (TFR) as reported by the DHS 2011 (Measure DHS 2012), for the period 2008-2011, available for the national level and the 5 development regions of Nepal.

In order to estimate the TFR at the district and the VDC/Municipality levels, we used an indirect estimation technique to calculate a Child-Women-Ratio (CWR) by dividing the population of 0-4 years old by the population of woman aged 15-34. This served as a proxy for the relative level of fertility in each district or VDC/Municipality. The CWR and the encompassing development region was used to derive the TFR for each area relative to the TFR of the development region. At the VDC/Municipality levels, the ceiling value for the TFR was set to be at 6 children per woman. This process resulted in a spatially highly heterogeneous picture of the local TFR across all VDC/Municipalities with highest fertility rates in the northwestern mountainous regions (see Figure 3).

Figure 3. Total fertility rate derived from the Child-Women-Ratio on VDC/Municipality levels, 2011



2.2.1 Fertility Scenario

Taking these indirectly estimated fertility rates for the period 2008-2011, we developed a medium fertility scenario for 2011-2031 expecting some level of progressive economic and societal development and political stabilization. The general trend in the overall fertility level has been declining. We observed a TFR level of 4.10 children per woman during 1998-2001 (Measure DHS 2002, p.2). In the next ten years, the TFR estimated for 2003-2006 declined by one child to 3.1 children per woman (Measure DHS 2007) and then by half a child to 2.6 for 2008-2011 (Measure DHS 2012). The current National Population Policy reports a TFR estimate of 2.30 children per woman in 2014 (see Table 1 in MoHP 2015). Will the fertility decline further?

At the national level, we expect that the TFR will continue to decline and in the medium scenario we assume that it will reach the replacement level fertility of 2.1 for the period 2016-2021. This expectation is based on the narrative of the medium scenario, specifically, progress in women's education, increasing rate of female's labor force participation and rapid urbanization, that are all negatively associated with fertility.

In Nepal, the education differential in fertility is large, almost 2 children. Using the data from DHS in 2011 (Measure DHS 2012), we estimated the TFR by six levels of education: no education (3.64 children per women), some primary education (3.08) children, primary (2.46), lower secondary (1.76), upper secondary (1.77), and post-secondary education (1.70). As the level of educational attainment will increase in the future as projected by the Wittgenstein Centre for Demography and Global Human Capital (IIASA, VID/ÖAW, WU) (Lutz et al. 2014) from 39% with at least lower secondary education among 20-39 years old in 2010 to 56% in 2020 and 68% in 2030, the change in the education distribution will result in further decline in overall fertility level. There are large rural-urban disparities in fertility between. DHS (Measure DHS 2012) estimated a TFR of 2.80 children per woman among the rural residents compared to a very low 1.60 in urban areas.

These evidence along with the continuity of the government's fertility policy to achieve replacement level fertility (TFR of 2.1 children per woman) in the future lead us to the assumption that a further fertility decline of 0.2 children per women in the next 4-5 years, by 2016-2021, is feasible. Following the same arguments, we expect that in the medium scenario the fertility will further decline with a slower rate of 0.15 children per women per 5 years reaching a TFR of 1.95 and 1.80 for the period 2021-2026 and 2026-2031 respectively. We assume that the fertility trend at the subnational level will follow the pathway expected for the next higher administrative level, for e.g. the districts will follow the national pathway and the VDC/Municipalities will follow the district trend. However, the current fertility differentials by districts and VDC/Municipalities are expected to remain partially converge as explained in the next paragraph. The expected partial convergence is based on the diffusion of development and technological forces that influences fertility.

For districts, the current TFR level will follow the path of the national fertility with a partial convergence by closing the gap by 50% by 2026-2031. For districts with a TFR below the national TFR in 2011, we let the TFR decline to 1.50, after which the TFR increases slowly by 0.05 children per quinquennium to a maximum value of 1.80. This means that once any region has a fertility level of 1.50, the maximum value it could ever reach is 1.80. At the VDC/Municipality levels, we repeat a similar procedure by going

from country-level to districts again and closing the gap with the district level TFR by 50% by 2026-2031.

In terms of Age-Specific Fertility Rates (ASFR) patterns, we assume that the fertility pattern of the urban (TFR = 1.60 children per woman) and the rural (2.78) areas, as reported in 2011 (Measure DHS 2012), will serve as boundaries. For a given level of TFR, the ASFR patterns are interpolated between the rural and urban pattern. For the TFR below and above this range (i.e. 1.6 and 2.78), the patterns are kept to be the same as in the boundaries of the range.

2.3 Mortality

In their *Population Monograph of Nepal*, CBS calculated a period life expectancy at birth (*le0*) (see Appendix 6.3, CBS Nepal 2015) of 66.6, 65.5 and 67.9 years respectively for males and females based on a series of steps using DHS-2006, DHS-2011 and Census-2011 data. They first estimated *le0* for both sexes (66.6 years) using the DHS data and then applied differentials estimated from Census-2011 data to calculate *le0*s by sex and spatial disaggregation (rural/urban, 5 development regions, 15 eco-development regions and 75 districts). They applied the Children Ever Born And Children Surviving (CEB-CS) method to estimate the child mortality rate and extracted the life table using the Coale-Demeny West Model Life Tables (CBS Nepal 2015, p.132).

The initial idea was to use these estimates for the projections in this project. However, after carefully reviewing the data and methods, we decided to estimate the life tables independently. Our major concerns were a lack of clarity regarding the methods used, incorrect ways of calculating certain values, and disregarding the age-patterns of death observed in the Census-2011.

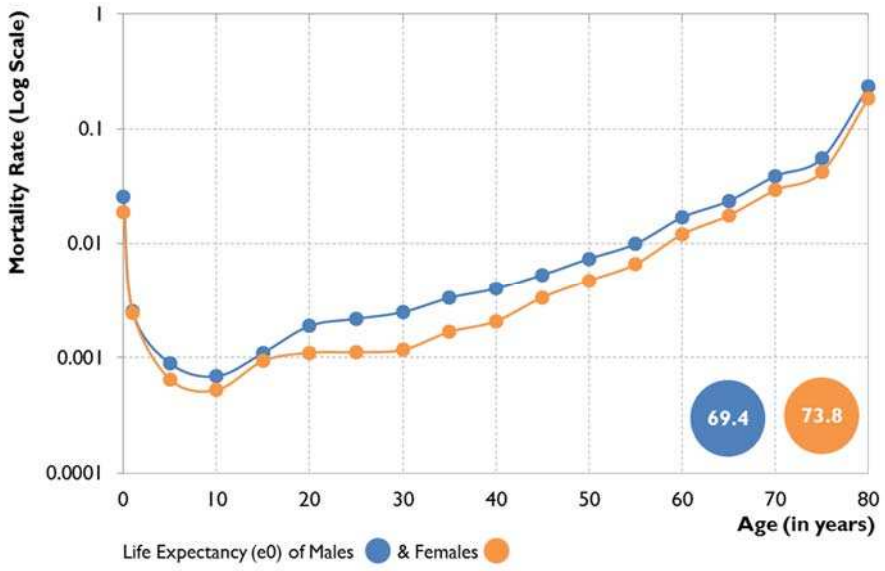
At national level, sex-specific *le0*s were calculated applying the sex differential and sex-ratio at birth on the overall life expectancy of 66.6 years. This method is fine, however, the problem arises with the calculation of *le0* at the sub-national levels. As demonstrated by CBS (CBS Nepal 2015, p.133), at the national level *le0* of 71.27 years was estimated for both sexes using only data from the Census-2011, which was considered an overestimate of 4.67 years compared to the *le0* of 66.6 years reported above. Next, for urban regions of Nepal (Municipalities), the *le0* of 73.06 years estimated for both sexes was adjusted (subtracted) for the over-estimation in a wrong way by splitting the over-estimation at the national level (4.67 years) proportionally to the rural/urban population distribution (*73.06 - 4.67 * 4,523,820/26,494,504 = 72.26).*

We also found that the value reported in the Appendix table in the same report (Appendix 6.3, CBS Nepal 2015) is 70.5 years for urban Nepal while it is 66.6 years for the overall population. It is odd to find that the *le0* in rural Nepal is reported to be 66.6 years, the same as for the national level, while it is 70.5 years in urban Nepal (Appendix 6.3, CBS Nepal 2015). This is not possible considering the simple rule of average, when 17% of the population live in urban-Nepal.

While examining the census based age specific mortality rates for males and females, a large gap emerged at ages between 20-40 years (Figure 4), favoring females, which is not reflected in the assumed CBS model life tables. It is noticable that while the gender gap of 2.6 favoring men is estimated, CBS reported (in Appendix 6.3) higher life expectancy for males. The existence of such a gender gap in Nepal is substantiated in the

literature (Lutz et al. 2014). The increasing focus on reproductive health, family planning, and maternal and health workers could have resulted in a better situation for women, whereas for men the situation has worsened, mainly due to a higher number of road accidents and occupational hazards, making the gap seem plausible. Therefore, we used the reported death data from the census with a correction for underreporting to estimate the life tables.

Figure 4. Age-specific mortality rate (log scale) and life expectancy (*e0*) for Nepal, 2011



Source: Author's calculation from the 2011 Population and Household Census, Nepal

The estimation of the age specific mortality rate was conducted by dividing the reported number of deaths (during 12 months prior to the census interview) by the midyear population (calculated by subtracting half of the deaths from the population at the time of the interview). We then constructed the life tables using the age specific mortality rate. First estimates resulted in a life expectancy of 69.4 years for males and 73.8 years for females. The difference of 4.4 years between the sexes is much higher than the reported 2.6 years by the CBS, and is based on the difference in mortality among children. The remaining difference of 1.8 years could be contributed by the difference in adult mortality. A similar level of sex differential (4.6 years) was reported in the Nepal Human Development Report 2014 (NHDR, UNDP 2014). Correcting (without providing any details of the correction) for the underreporting, the NHDR estimated the *le0* for 2011 to be 66.8 years for males and 71.4 years for females. By acknowledging the underreporting of deaths in the census, we applied the following corrections.

The main concern with the census data was the underreporting of deaths during the interviews. Normally, a census is followed by a post enumeration sample survey where the interview is repeated to estimate the accuracy of the census and one of the outcome of interest is the estimates of underreporting and misreporting of events. Unfortunately, due to unknown reasons, the post enumeration survey was never conducted after the most recent census in 2011. In the absence of reliable data, we made the following correction. We expect the rate of underreporting to vary by age, sex, and location (residence and/or districts), with a higher rate of death underreporting among the youngest, for females, and in less developed locations. However, since the post

enumeration survey was not conducted, we were unable to estimate the correction factors for variables other than age.

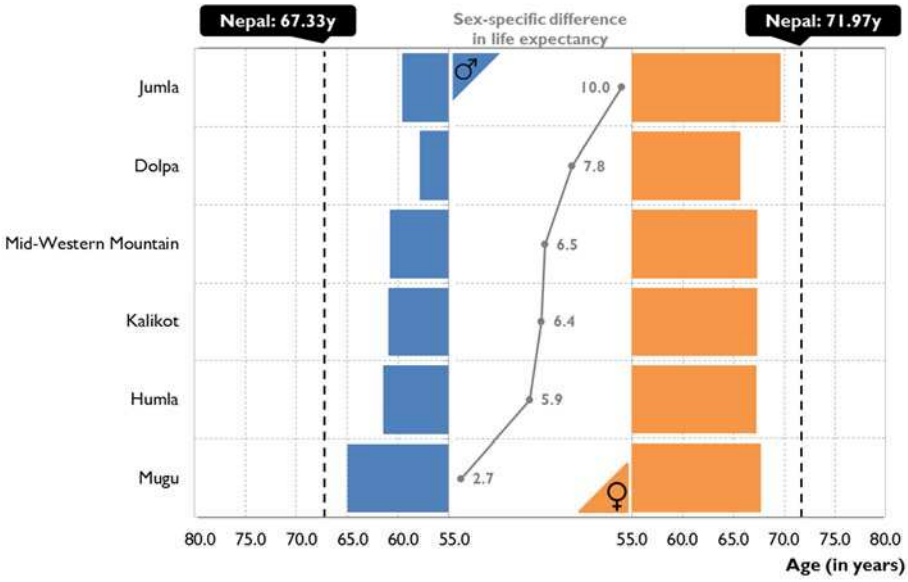
In this process an age specific adjustment factor was calculated for the youngest age groups by comparing the *Infant Mortality Rate* (IMR, deaths within the first year) or *Under-Five Mortality Rate* (U5MR, deaths in the first 5 years) between the estimates from the DHS for 2006-2011 and the census for 2010-2011 (Measure DHS 2012). According to the DHS, the IMR and U5MR for the period 2006-2011 are 46 and 54 deaths for 1000 live births respectively (these are symbolized by *1q0* and *5q0* in the life table). The *1q0* (and *5q0*) obtained from the census for the period 2010-2011 are 25 (34) for males and 18 (28) for females. The *4q1* (probability of deaths within second to fifth year of life) is the same in the census and the DHS. The census values for *1q0* are roughly half of what the DHS reports.

Comparing the number of births in the last 12 months with the population of less than 1 year olds reported in the census 2011, and adjusted with the IMR, 1 in 3 births seems to be underreported. Assuming a similar level of underreporting for deaths in the first year, the IMR for the period 2010-2011 would be 37.5 and 27 deaths per 1000 live births for males and females respectively, which seems more likely than the DHS numbers. The *Child Mortality Rate* (CMR, deaths between ages 2 to 5 years), *4q1* seems to be the same as reported in the DHS. Respondents might not report deaths of very young children, but the chances of underreporting seem to be lower for ages above 1. Therefore, we inflate the reported number of deaths for ages <1 years by a multiplicative adjustment factor of 1.50 (1 in 3 deaths) and slightly correct the number of deaths for other ages by 1.11 (1 in 10 deaths). This results in a *le0* of 67.33 years for males and 71.97 years for females with a gap of 4.64 years. We acknowledge that these are approximations.

In the DHS, 10-yearly rates (2000-2010) show a very small gap between male and female IMR and CMR. The difference can be checked by looking at single regions for e.g., the IMR among male children was 9.5 deaths per 1000 live births compared to 7.3 for females in Kathmandu district, 13 vs 11 in Central Hill, and 22 vs 17 for Central DR. The large sex difference in the Census-2011 data raises the question if female deaths were underreported. But on the other hand, it is likely that in recent years the situation has improved more for females than males.

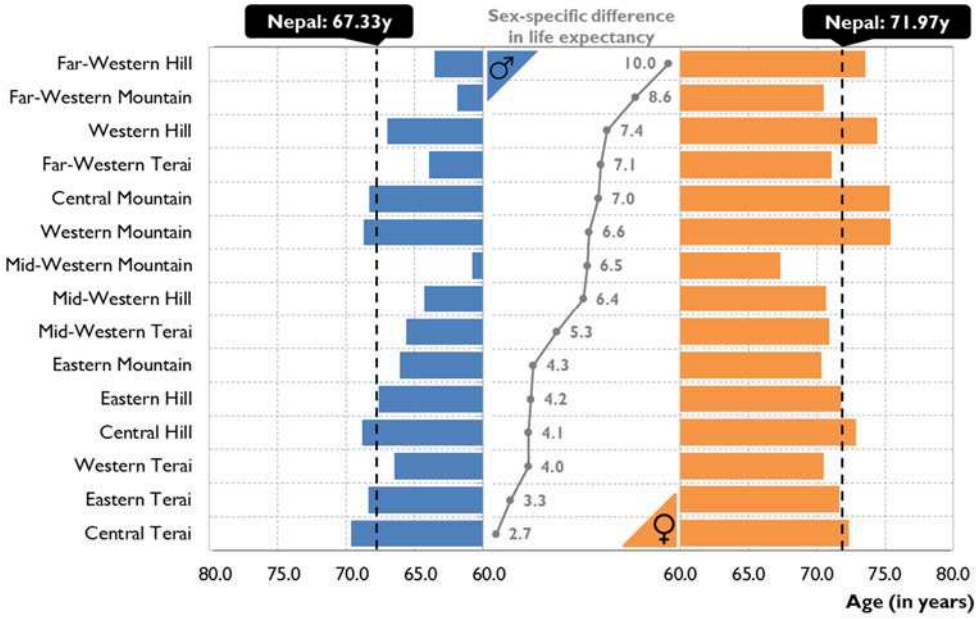
In this project, initially census based *le0* was used, with 69.4 years for males and 73.8 years and females. Since the deaths reported could also include the deaths occurring to people abroad (labor migrants), the absentee population was included in the denominator. However, there was almost no effect in terms of mortality for men (69.5 years) and for women (73.8 years), but the difference was reduced to 4.3 years. We then included the correction for the underreporting of 1 in 3 deaths for infants (<1 year) as was explained earlier in this section, which resulted in a decline in life expectancy at birth by 0.9 years for men and 0.6 years for women, and the overall difference between sexes increased to 4.6 years (same as reported in the NHDR 2014). A last set of adjustments for remaining ages for 1 in 10 deaths being underreported resulted in further declines in the life expectancy of 67.3 years for men and 72.0 years for females, with an overall difference of 4.7 years. Some examples of the sex specific life tables for several subnational levels are shown in Figure 5 and Figure 6).

Figure 5. Life expectancy at birth by sex in districts of the Mid-Western Mountain region, 2011



Examinations on district level revealed extreme values and large sex differences. For example, in the Mid-Western Mountain region the sex difference ranged between 2.7 years in Mugu and 10 years in Jumla, in districts with similar attributes. It is reasonable to assume that this variability in the sex ratio is due to a lower number of deaths within a period of 12 months occurring in districts with a smaller population size. In order to get a reliable estimate for mortality at the district levels, particularly those districts with a smaller population size, further detailed analysis was needed. For example, rules can be applied for certain districts to be merged with similar neighboring districts such that the population size of the combined area becomes significantly larger. However, for this project we decided to use the earlier mentioned 15 eco-development region specific life tables for districts for the year 2011 as shown in Figure 6). These estimates were used as the base for the future scenario.

Figure 6. Life expectancy at birth by sex in eco-development region of Nepal, 2011



2.3.1 Mortality Scenario

In the medium of the road scenario we expect a continuous improvement in health and mortality. Life expectancy at birth is assumed to increase by 6 years for females and 4.8 years for males during 2011-2031. This value is similar to what the UN assumes in their medium scenario (United Nations 2013), 5.8 years and 4.9 years for females and males respectively.

At the district levels, similar to what we assumed for the future TFR, the current level of life expectancy will continue to increase such that the gap between the national and the district level diminishes by half during the period 2026-2031. Our scenario assumes expanding health care, infrastructure, education, etc. and some level of development in all corners of the country.

Due to the lack of reliable data and small population sizes of VDCs/Municipalities, we applied corresponding district specific life tables for VDCs/Municipalities. We did not use model life tables, mainly because the empirical mortality age patterns, as explained earlier, do not match with the patterns in existing model life tables. Instead, we used the sex specific empirical age pattern as a standard and applied the Brass-Gompertz Relational Model to calculate the life tables for a given life expectancy at birth.

2.4 International Migration

Both, internal and international migration are included in the projections. Migration in different forms is one of the most occurring demographic events in Nepal. The most common internal migration flows are from rural to urban areas (e.g. to district headquarters), and from all areas to the big urban centers in Kathmandu Valley, Biratnagar, Chitawan, Pokhara, etc. While large numbers of young women aged 15-24 migrate internally after getting married to men living in different places (e.g. different villages or districts), men migrate mostly for employment reasons.

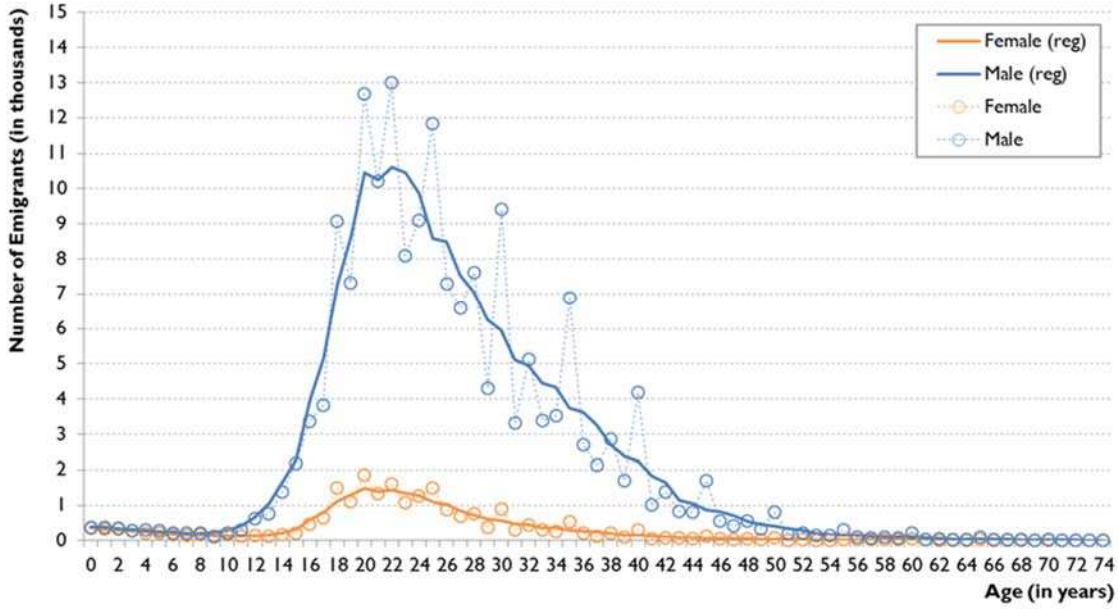
Traditionally, the most common international destination for migration from Nepal was India, mainly due to proximity and open border, economic reasons, historic ties, and a common culture and language as most Nepalese understand and speak Hindi. While India is still a frequent destination, in recent times, labor migrants have dispersed around the world with a large number of young Nepali men migrating to countries in the Middle East, and Southeast and East Asia (a significant proportion are migrating to Malaysia, and more recently to South Korea). In 2011, almost two million people were reported to be living abroad, so called absentee population, with about 1.5 million leaving the country during the past 5 years. Most destination countries have strict laws to ensure the return of the migrants after their labor contract is over. In the past, laws in Nepal prohibited or made it difficult for women to go abroad for labor purposes. In recent times, laws are less stringent and many young women choose to go abroad mostly to countries in the Middle East to work as nannies or housemaids. In recent times, a growing diversity of jobs are being offered abroad in the service sector (for e.g. drivers, clerks, salesperson, etc.) and a significant number of young people who move to countries for educational purposes, most commonly the United States, Australia, the United Kingdom, and some other countries in Europe. Therefore, the trend of a high emigration rate is likely to continue into the future.

With the ever growing importance of migration, the census 2011 has seriously focused on collecting the data on in this regard. We used the census data to estimate various migration rates, namely the absentee rate, emigration, immigration, and internal migration flows. Based on these rates, data sources from the Department of Foreign Employment (DOFE)[8] and arguments regarding the determinants of migration future migration scenarios were developed.

2.4.1 Emigration Base Year Estimations

Starting with emigration, we collected the information on absentee population with information on the age at departure and the duration of absence to estimate the current age of the absentee population. We used the micro data released by the CBS, containing individual level raw data for more than 10% of the population enumerated in the census 2011. Figure 7 shows the current age (in 2011) and sex distribution of the absentee population in the micro data. The small circles represent the empirical values and the lines are fitted using 5-yearly moving averages. The picture clearly reveals that a large number of young males left the country.

Figure 7. Empirical (dotted line and ring markers) and fitted (line) number of emigrants that left less than 5 years ago by age and sex based on 10% sample from Census 2011



As a next step, these fitted number of emigrants were converted into migration rates by dividing them by resident population 5 years ago (in 2006, a rough estimate by back-projecting the population from 2011). The single age specific emigration rates (small circles in Figure 8) were estimated and finally a cubic splines was fitted to these rates. Since our projection is done at 5-yearly steps, we repeated the above steps by aggregating the age in 5-yearly groups and estimated sex specific 5-yearly emigration rates (Figure 9). The rates were also estimated for subnational regions and districts. The district level estimates were not used because in many districts smaller population sizes resulted in a high level of erratic variation. We decided to apply the estimates from higher spatial levels (data available for eco-development regions) to the districts, similar to what

[8] Source: DOFE – Department of Foreign Employment (http://www.dofe.gov.np/new/)

we did for earlier for mortality rates (see end of Section 2.3). These age and sex specific rates were used to produce emigration scenarios for Nepal in the future.

Figure 8. Estimated emigration rate by single age and sex in Nepal, 2006-2011

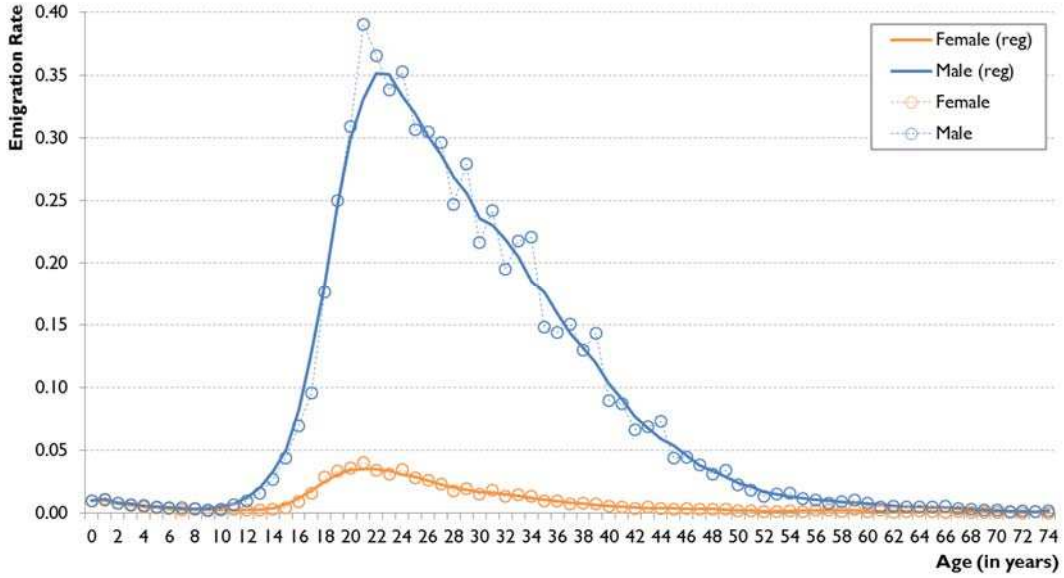
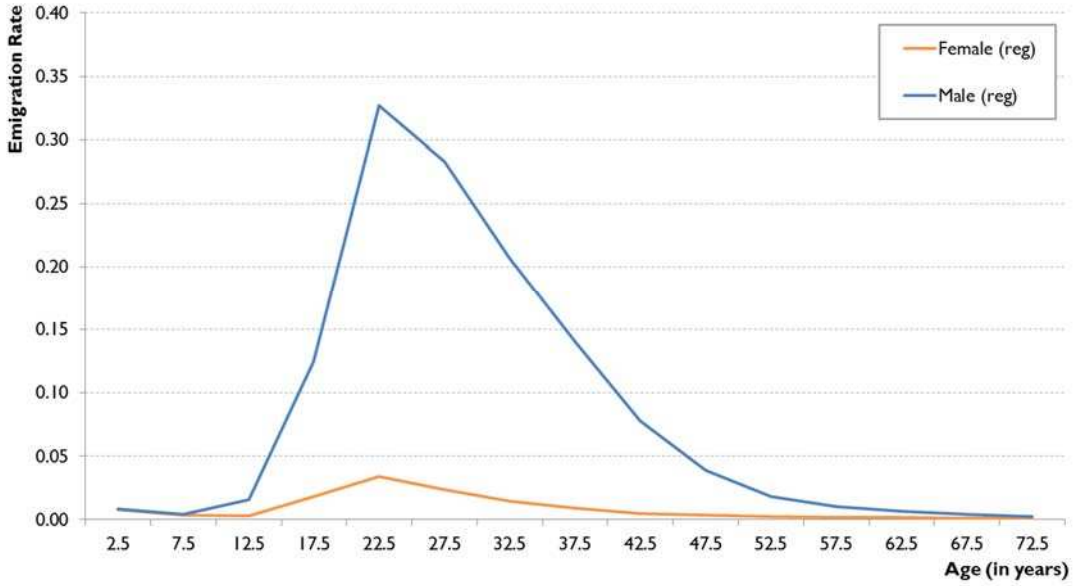


Figure 9. Estimated emigration rate by 5-year age groups and sex in Nepal, 2006-2011



2.4.2 Emigration Scenario

At each 5-yearly time-step of population projections at the district level, the encompassing eco-development region specific emigration rates were applied to the district. We assumed that the age specific emigration rate by sex remains constant throughout the 20 year projection period. We defined a medium scenario, assuming that the emigration rates will further increase in the near future and peak during 2011-2016. Our assumption is based on the data from the DOFE which corresponds roughly to a 20% increase in the rate for the period 2011-2016. The demand is increasing due to a large

wage difference and the need of cheap laborer in many Asian economies, particularly in the Middle East and some countries in Southeast and East Asia.

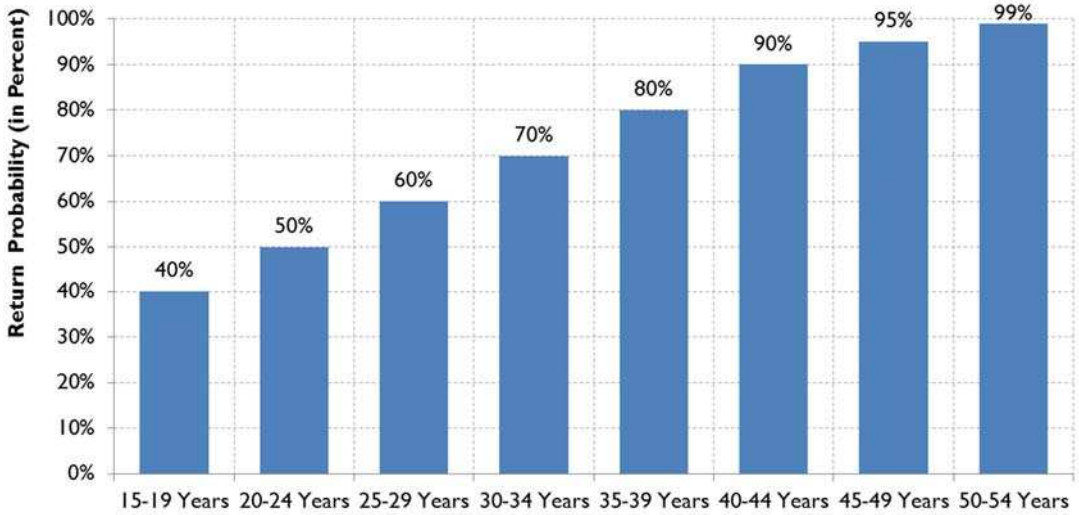
However, in the period 2016-2031 we expect a moderate level of decline in the demand of foreign laborer in the current destination countries. Also, we expect that a better economic situation in Nepal will bring a decline in the emigration rates. We assume that the emigration rate in 2016-2021 will decline to the level of 2006-2011, followed by a slower decline of 10% per quinquennium during the periods 2021-2026 and 2026-2031. The emigration numbers for Nepal were obtained by aggregating district level numbers which were again obtained from the district level calculations. Certain proportions of emigrants (calculated from the micro data) were assumed to be temporarily absent and were added for estimating the return migrants in the future (see Section 2.4.4).

2.4.3 Immigration Base Year Estimates

The high rate of emigration for labor purposes in Nepal is a recent phenomenon attenuated by the Maoist movement in Nepal and the timing of the census in 2011 was a bit too early to capture the rate of return migrants. In the census about 110 thousand people, who were in Nepal during the census, reported to be living abroad 5 years ago, out of which the majority were women mostly because of cross-border marriages. Hence, from this data, it was not possible to get any estimates of the immigration rate that could somehow capture the future return migrants. While it is alright to expect that the returning absentee population will increase in the coming years, the question about the timing of return is largely unknown.

We assume that the absentee population will spent an average of 5 years abroad before returning to Nepal. At the same time, we assume that the younger emigrants are likely to continue to work abroad much longer than the older ones. There could be several reasons including family reunion (as families are mostly not allowed in the destination countries), enough money saved, ageing issues, labor market restrictions, etc. With no clear data, we are assuming that 40% of those who are absent now and are of age 15-19 will be in Nepal in 5 years' time and the older a person gets the higher are the chances of returning in 5 years such that the probability is 99% of those aged 50-54 (see Figure 10).

Figure 10. Age specific probability of temporary absentee population in Nepal in 5 years



2.4.4 Immigration Scenario

Future immigration to Nepal largely depends on the size and structure of the population who temporarily migrated for labor to countries where the rules are clear about the *"temporary"* nature of visa and work permits. For this purpose, we maintained a separate temporary absentee population. From the micro data on destinations of the absentee population, we calculated the proportion of those who would eventually return as the proportion going mainly to countries in the Gulf and Southeast Asia. At each step of the projections, the temporary absentee population was projected further by applying the Nepal specific mortality rates, adding new emigrants from Nepal, increasing the size of absentee population, and subtracting the return migrants. We applied the age specific probability of return as shown in Figure 10 to the temporary absentee population.

In addition to the returning absentee population, the number of immigrants recorded in the 2011 census of which the majority is women migrating to Nepal due to marriage or other family reasons, is assumed to be the same as recorded in the Census-2011.

2.5 Internal Migration

2.5.1 Internal Migration Base Year Estimates

An origin-destination matrix (75x75) between districts of total internal migrant population from Census-2011 was obtained from the CBS. However, district wise age and sex distribution of internal migrants by was not available. We could have used microdata from the Census-2011 to estimate the age and sex specific details of internal migration but due to different levels of coverage (sampling in some districts) in the micro data, it was not possible to estimate age and sex specific internal migration rates[9].

Instead, we used the bi-regional approach developed by Rees et al. (2015) to estimate 75 sets of the destination specific age and sex distribution of internal migrants in all districts from the census reports. Dividing these numbers by corresponding population in the rest of the districts, we estimated age and sex specific internal in-migration rates for each district from rest of Nepal. The bi-regional approach assumes that the age and sex pattern of the rate of internal out-migration to a district from rest of the districts is same.

By adding these age and sex specific internal migrants in all districts, we obtained the age and sex distribution of internal migrants between districts in the whole country. The age and sex specific total number of internal migrants between districts reported in the census was distributed to 75 districts using the district specific distribution of proportion of internal out-migrants (who went to other districts). As a result, we have a rough estimate of age and sex specific internal out-migrants from each district.

[9] If the details of a person's migration status at the destination district are known, one could estimate the origin specific number of migrants by using proper population weights, but the weights were not available. These population weighted numbers of migrants could be then used as the numerators and population of the origin districts as denominator.

2.5.2 Internal Migration Scenario

Under the medium scenario we expect that the age and sex specific rate of internal migration will remain constant over time. This means that the Nepalese population remains highly mobile and the origin-destination links between districts will remain intact. We operationalize this assumption by keeping the baseline age and sex specific internal in-migration rates from the rest of Nepal to each district constant and calculated age and sex specific internal in-migrants in each district.

As a final step of the projections, the aggregated total in-migrants by age and sex in all districts that is equal to the total out-migrants were distributed (allocated) to all the districts according to baseline proportional distribution of internal migrants.

2.6 Population Projections for Village Development Committees and Municipalities

To project the population structure and rates of the VDCs/Municipalities within each district that have a larger population size, we applied the cohort component method using the same set of assumptions for migration and mortality rates, and the indirect estimation technique for calculating the CWR to get the VDC/Municipalities specific fertility rates (see Section 2.2). We assumed that the future demographic trajectory (fertility, mortality, and migration) will follow the rate of change of the district that they belong to.

The cohort component method is not recommended for VDCs/Municipalities with a smaller population size because the demographic structure and rates could have been and were in the past affected by random events, such as natural disasters, local conflicts, etc. Such an event, as unlikely as it might be, happened on 25th April 2015 when an earthquake (also known as Gorkha earthquake) with its epicenter east of the Gorkha district at Barpak hit the regional population with a magnitude of 8.1 M_S[10] and a maximum Mercalli intensity of IX, killing more than 8,000 and injuring more than 21,000 people. In the period after the earthquake areas within the devastation zone, including Kathmandu, registered a high outflux of resident population due to fear of potential aftershocks, (partial) damage of houses and infrastructure, and a lack of sufficient supply with water, food, etc. However, a study from Bengtsson et.al. (2015) showed that many people permanently left the affected areas to other areas in the Southeastern Terai region, but many new people arrived and produced a notable population increase. (Bengtsson et al. 2015)

Beside the occurring random events, the quality of reported data related to mortality, migration, fertility, and age gives reason for concern. Particularly the former two generally have a higher likelihood of mis- or underreporting. Therefore, we decided to apply the mortality and migration rates of the district level to the small population VDC/Municipalities, but kept the age-sex structure and fertility levels (see Section 2.2) of the VDC/Municipalities.

As a final step, the resulting population projections for the VDC/Municipalities were adjusted to add up to the district level population projections.

[10] M_S – Surface Wave Magnitude

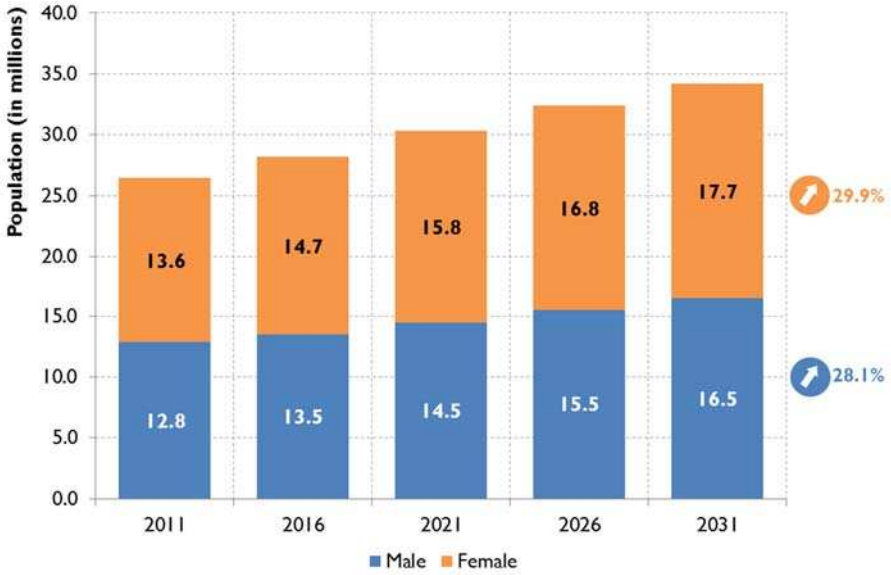
3 Results

The total population of Nepal has been increasing in the past and will keep increasing in the future. In the last decade the total population has increased by 3.4 million, from 23.2 million in 2001 to 26.5 million in 2011. In terms of natural increase, there were more births than deaths which would have resulted in a rapid population rise. However, due to the recent high rate of emigration, the total population increased less rapidly than expected. In this paper we present the medium scenario for the demographic components fertility, mortality, international and internal migration, as detailed in Section 2. It portrays a continuation of current trends with a slightly positive expectation for future development.

3.1 National Level

Under the medium of the road scenario and as shown in Figure 11, the population will continue to increase to 30.3 million by 2021 and to 34.2 million by 2031. The decadal increase will be 3.8 million between 2011 and 2021 and 3.9 million between 2021 and 2031, which is a bit higher than what was observed during 2001-2011. In total the population in Nepal will increase by 29.0% between 2011 and 2031, 28.1% males and 29.9% females. In terms of sex differentials, the female population in 2011 was already higher by 0.80 million, whereby in this scenario it is expected to increase by 1.26 million in 2031, mainly due to labor migration of men.

Figure 11. Population projection and change by sex for Nepal, 2011-2031

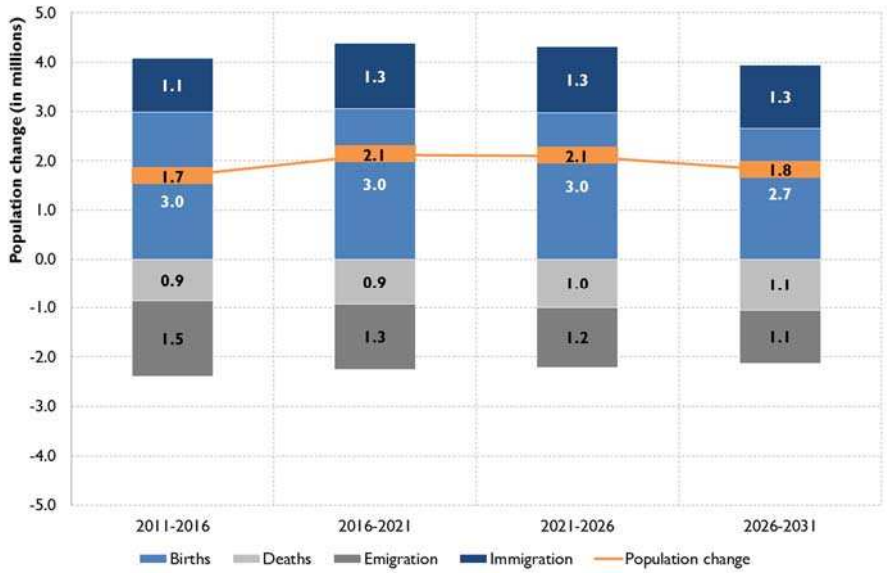


Source: Author's calculation from Nepalese 2011 Population and Household Census

Figure 12 shows the total changes in the population structure decomposed into demographic components. There will be 11.7 million births during 2011-2031. The number of births will be 3 million during each of the first three 5-yearly periods, but will decline to 2.7 million in the last 5-yearly period. Despite this assumption of a fertility rate decline, there will be no decline in the number of births due to the increasing number of women entering the reproductive age, which will outweigh the fertility rate decline. The number of deaths will start increasing in the future from 0.9 million during 2011-2016 to

1.1 million during 2026-2031. This can be attributed to larger cohorts getting older, again, outweighing the declining rates of mortality assumed for this scenario. Together, the 5-yearly natural population growth (births minus deaths) will slowly decline in the future, starting with 2.1 million at the beginning to 1.6 million by the end of the projection period.

Figure 12. Total population change by demographic determinants for Nepal, 2011-2031



Source: Author's calculation from Nepalese 2011 Population and Household Census

At the national level, international migration will play an important role in the demographic composition of Nepal and is the second most common occurring demographic event, after about 3.0 million birth events, with more than 2.6 million people changing their migration status during the period 2011-2016. Both, the numbers of migrants entering and leaving the country, are higher than the number of deaths in all projection periods. The past decade (2001-2011) could be well characterized as a decade of emigration when the stream of people leaving the country increased rapidly. This trend will continue in the current decade (1.5 million in 2011-2016), but we expect a decline in the total number of emigrants in the future.

The period 2016-2026 will be characterized by *"return-migration"* from the Middle East, Malaysia and few other countries. This is well embedded in our assumptions for immigration, as the number of return migrants will be 1.1 million in the period 2011-2016 and will increase to 1.3 million during the period 2011-2031.

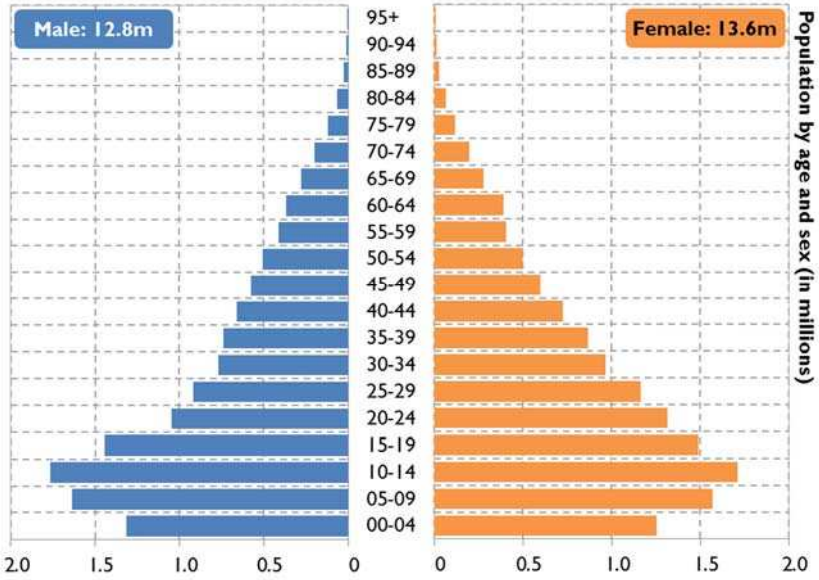
In summary, the total population gain will peak during the next decade (2016-2026) and will then start declining. By extending the projection horizon, we were able to foresee whether the population will continue to decline in the future, the most likely answer is *"yes"*.

3.1.1 Fertility and Mortality: Age and Sex Structure

The shape of the age structure of population of Nepal, as shown in Figure 13 is no longer a pyramid due to the declining number of births during 2001-2011. The rapid decline in the number of births (4.1 million in 1998-2001 to 2.6 million in 2008-2011) outweighed the increasing number of women entering reproductive age. At the same time, this was the period when, in the framework of the Millennium Development Goals, governmental

and international efforts increased to reduce early childhood mortality and morbidity, improve overall health and achieve improvements in primary level education.

Figure 13. Total population by age and sex for Nepal, 2011



However, our projections show that the number of women entering the reproductive age will increase from 2011 and 2016 outweighing the decline in the TFR resulting in higher number of births during 2011-2016 compared to 2006-2016 (see Figure 14). The TFR level declines from 2.6 children per woman in 2008-2011 to 2.30 in 2011-2016but a much higher number of women will enter the reproductive ages 15-19, 20-24 and 25-29 and this will continue for the next 5-yearly period 2016-2021(see Figure 14 and Figure 15), and later will start to decline slowly (Figure 16 and Figure 17).

Figure 14. Total population projection by age and sex for Nepal, 2016

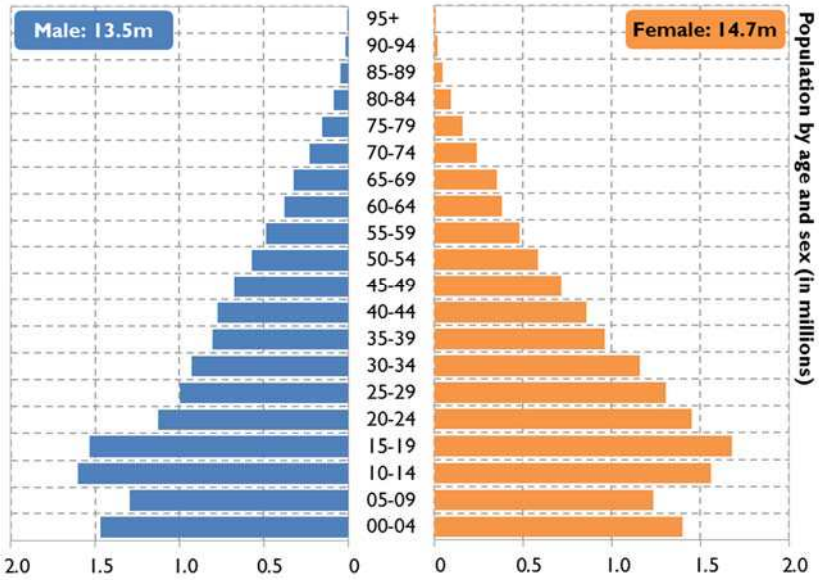
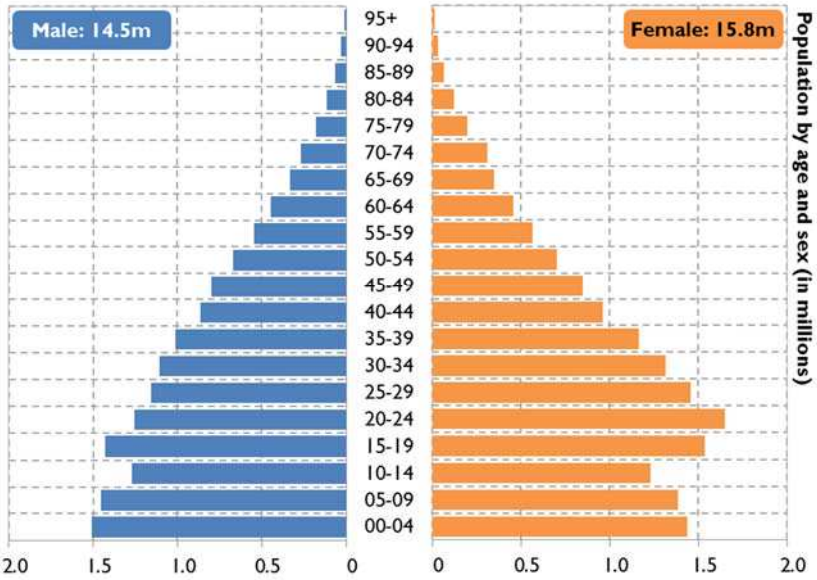


Figure 15. Total population projection by age and sex for Nepal, 2021



While the shape of the bottom of the pyramid is directly linked with the age-structure of females in their reproductive age, the age structure at the middle of the pyramid is impacted by migration assumptions (Figure 13 to Figure 17) that show a continuation of the migration trend in the past decade i.e., a very high rate of male-migration for reasons of employment. A significant proportion of males aged 20 to 49 was not in the country at the time of the census 2011. Figures 16 and 17 show that in the medium scenario the scraping of the males from the pyramid for emigration reasons will continue in the future. However, due to return migration the number of older adults will start to rebound and by the age group 50-54 the sex ratio will be again balanced. In case the wage differences between Nepal and the destination countries will remain high and the political situation does not improve, it is likely that the rate of return migration could be smaller resulting in a large number of absentee males in the country also at older ages, but this would be introduced as factor for another scenario for international migration.

Figure 16. Total population projection by age and sex for Nepal, 2026

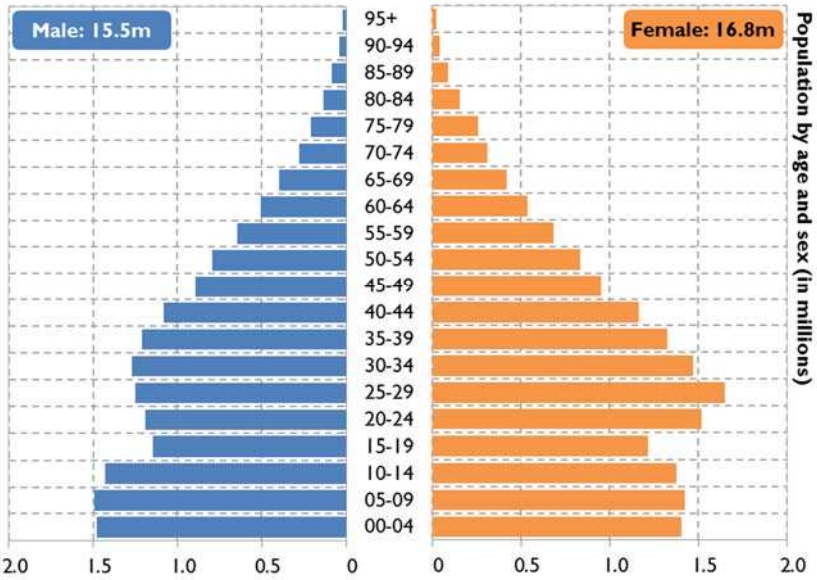
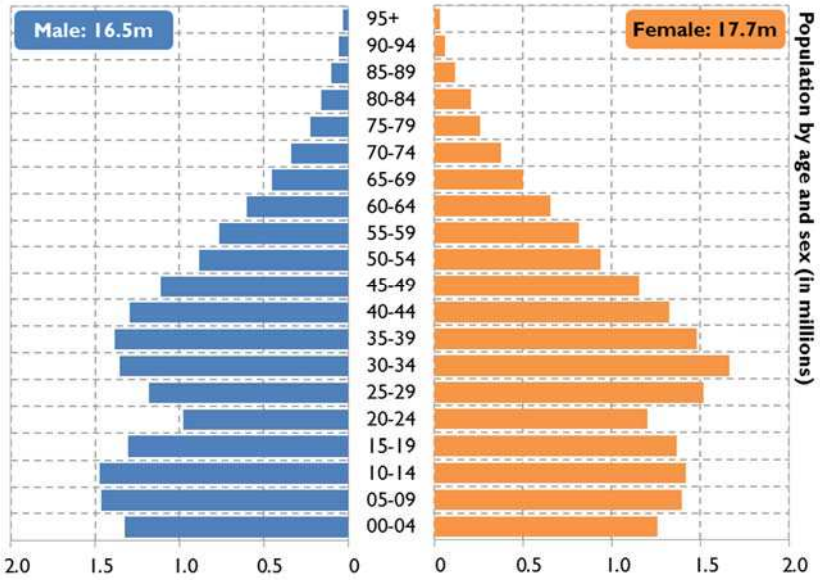


Figure 17. Total population projection by age and sex for Nepal, 2031



3.1.2 International Migration

Under the medium scenario, Figure 18 and Figure 19 show the aggregated age and sex distribution of emigrants from Nepal during the period 2011-2016 and 2026-2031 respectively.

Figure 18. Projected emigrants by age and sex for Nepal, 2011-2016

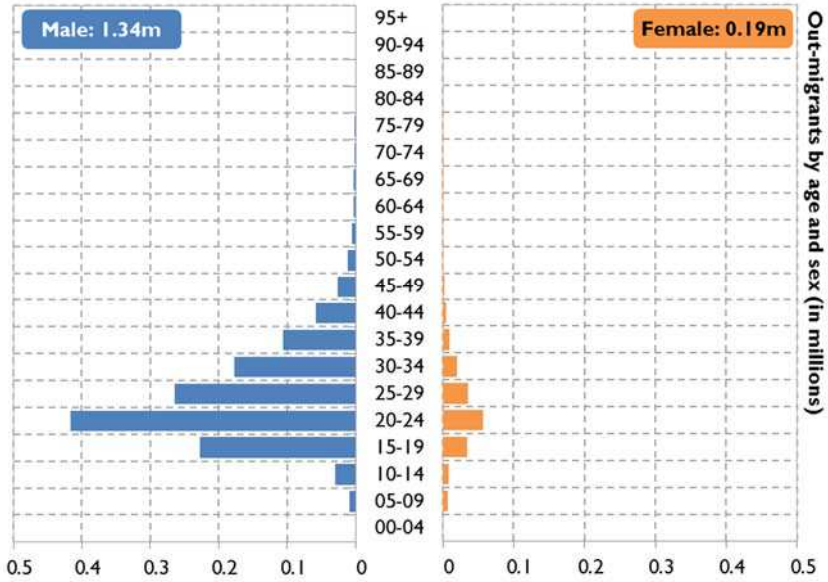
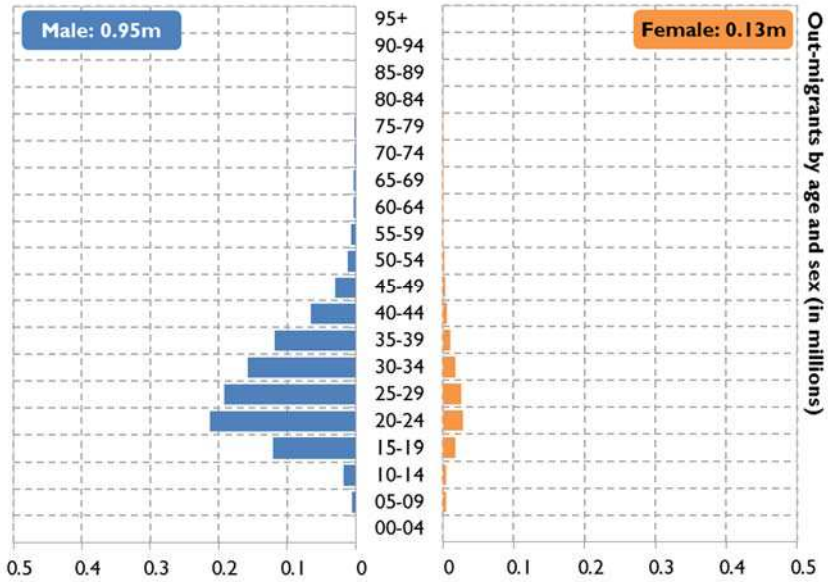


Figure 19. Projected emigrants by age and sex for Nepal, 2026-2031



Our assumptions regarding the immigration rates for the future as well as the method applied are unique. We expect questions about the likelihood of our projected scenario that we want to anticipate. As mentioned earlier in Section 2.4.4, due to the lack of data regarding return migrants and since the process of return migration is a new phenomenon that is currently unfolding, we assumed a plausible but ad-hoc immigration scenario. For each district we maintained the population age and sex structure of the absentee population who are likely to return. A hypothetical set of age specific probabilities of return were assumed, starting with a value of 0.4 for those absentees who are aged 15-19 at the beginning of a 5-yearly projection interval to 0.99 for aged 50-54 (see Figure 10 in Section 2.4.3). Using the district specific absentee population distribution and the age specific probabilities of return, we calculated the age and sex specific distribution of immigrants for each district and aggregated those numbers for the whole country (see Figure 20 and Figure 21).

Figure 20. Projected immigrants by age and sex for Nepal, 2011-2016

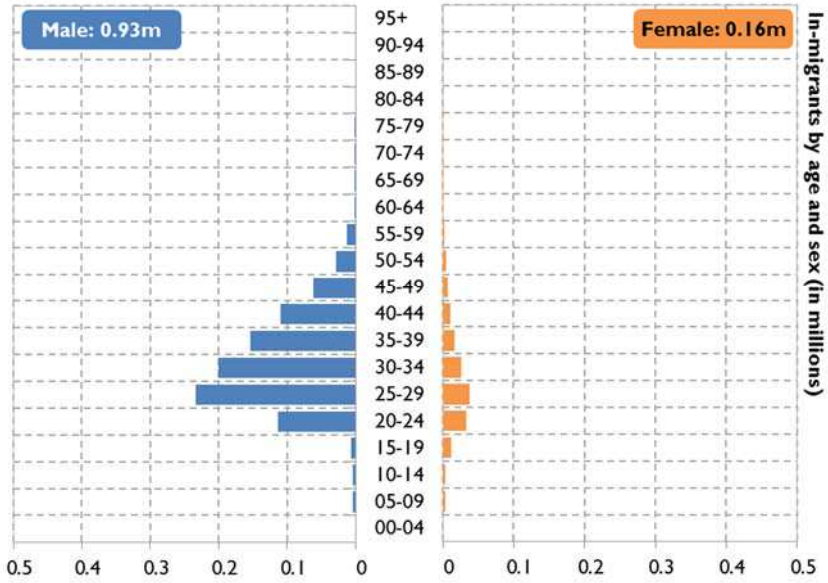
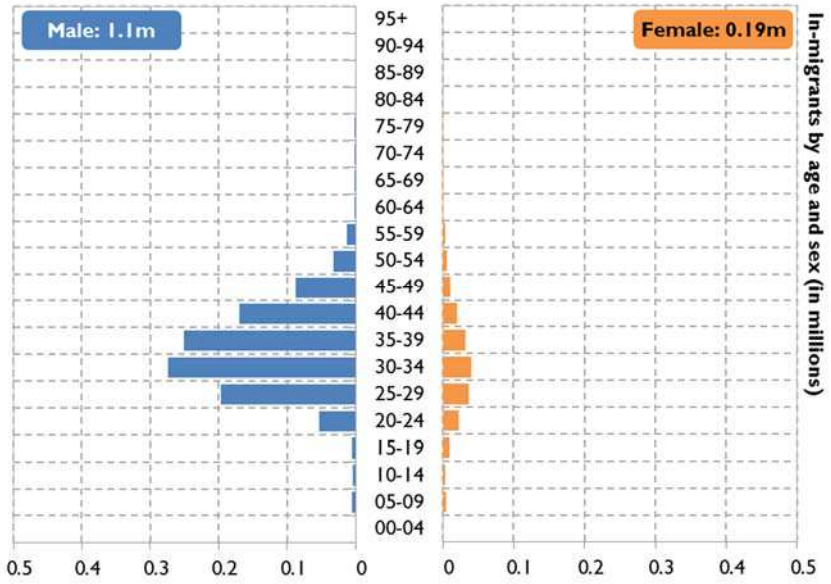


Figure 21. Projected immigrants by age and sex for Nepal, 2026-2031



3.2 District-Level

Under the medium scenario, in the next 20 years, between 2011 and 2031, population growth at the district level will range from depopulation by -26% in Khotang to an increase by 86% in Kathmandu (see Figure 22). These estimates do not consider random event that might occur, such as the already noted earthquake in 2015 (see Section 2.5), as this would go beyond the scope of this paper, but we remark, that this would be an interesting analysis for the future. Altogether, this scenario expects the population to decrease in 21 districts and to increase in all other 54 districts.

The simple increase of spatial granularity from national to district-level empowers us to identify differential population growth in regions. Mapping the projection results on district level shows remarkable spatial differences between growing districts in the Southern Terai region, Western Hill and Mountain regions, and the districts Kathmandu and Kaski with flourishing central cities. On the other hand the Northern and Eastern Mountain and Hill regions will lose population, mainly due to international, and rural to urban migration within Nepal.

Figure 24 shows the top 10 districts where the population will increase significantly by more than 40%. All shown districts are destination districts with the highest level of current internal migration and contain major urban areas such as Kathmandu, Bhaktapur, Lalitpur, Rupandehi (with Bhairahawa/Butawal), Banke (Nepalgunj), Kaski (Pokhara), Chitawan (Narayanghat/Bharatpur), Kailai (Dhangadi), Kapilbastu (Lumbini), and Kanchanpur (Bhimdatta). In many of these districts the fertility level is very low. Therefore, internal migration is mainly responsible for the population increase in these districts.

Figure 22. Population change in Nepal's districts under the middle of the road scenario, 2011-2031 (in %)

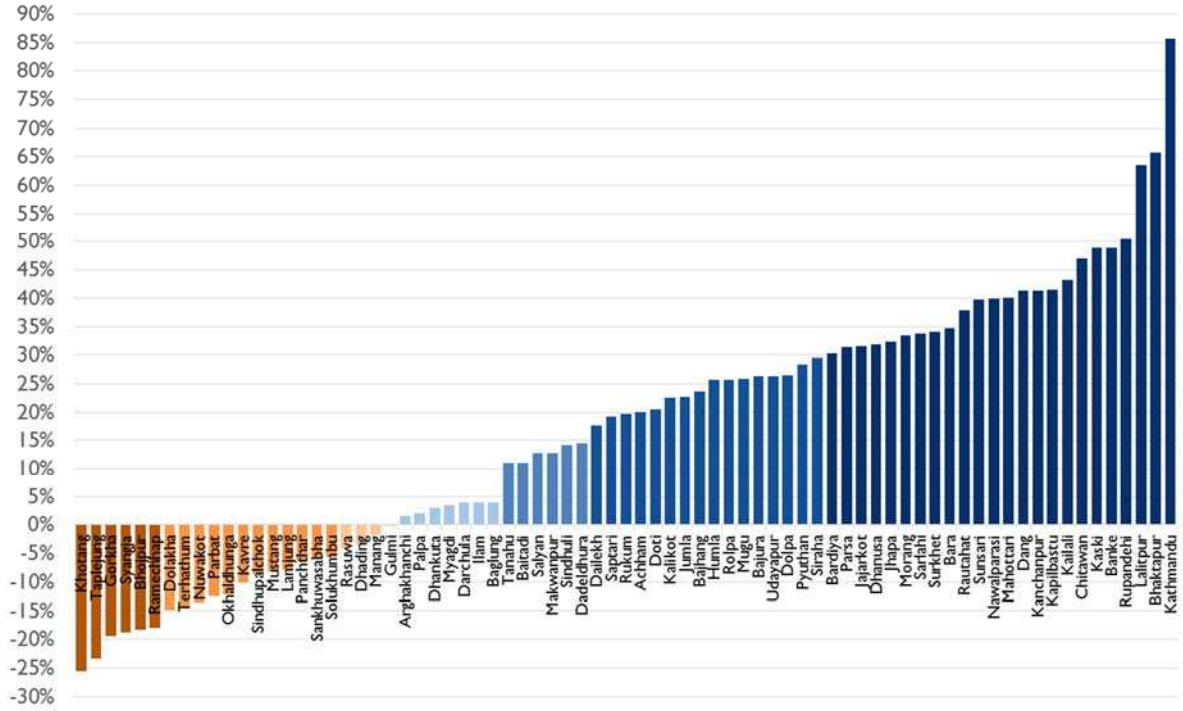


Figure 23. Relative Change of Population in Nepal’s districts from 2011 to 2031

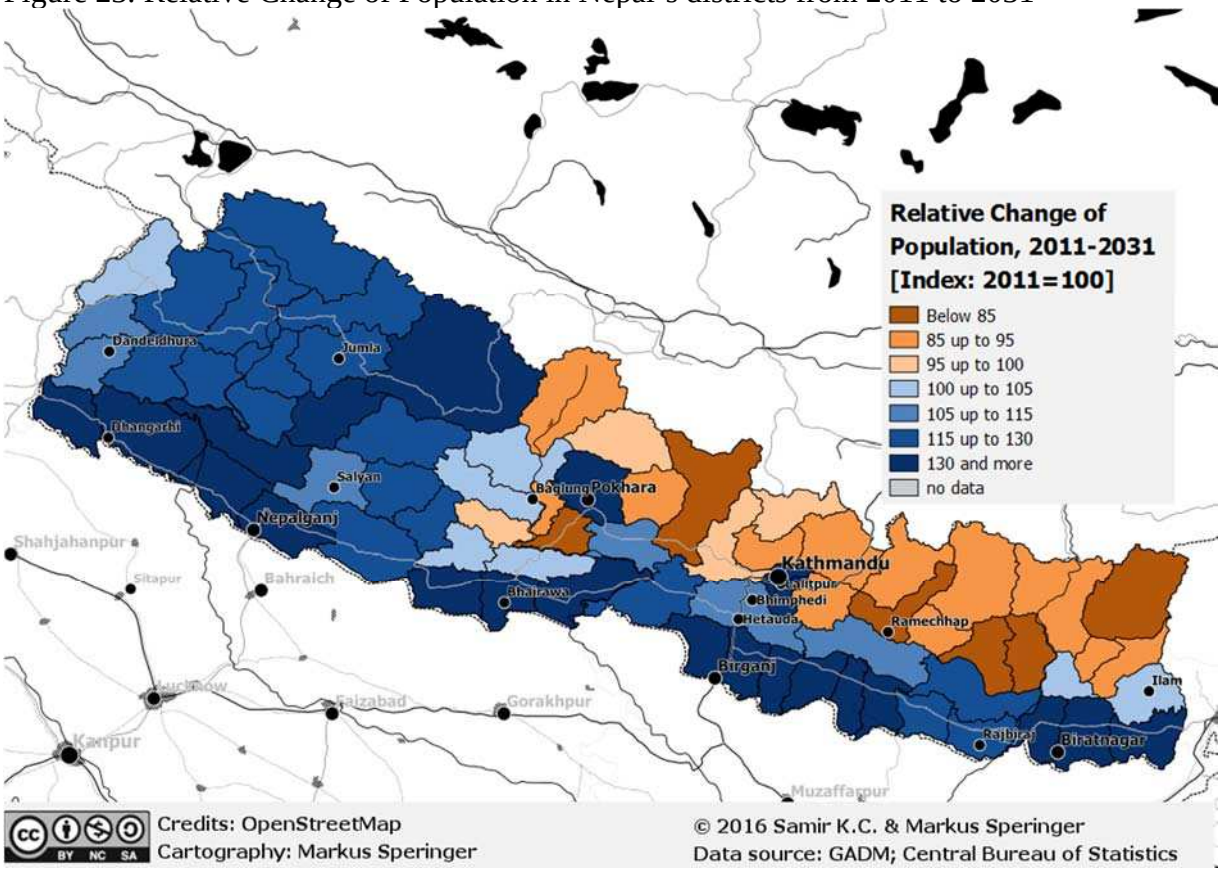


Figure 24. Top 10 populated districts in Nepal, 2011-2031 (in %)

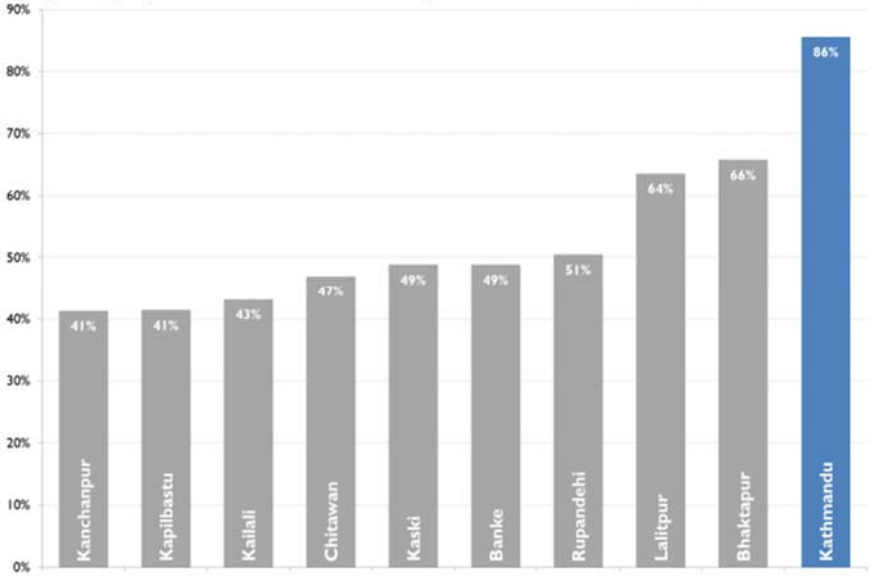
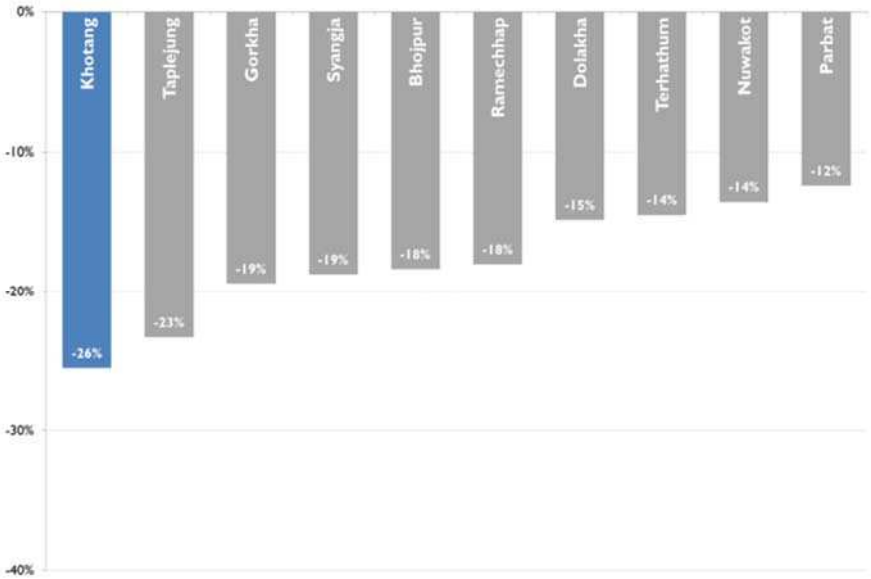


Figure 25 shows the bottom ten least populated districts, where the population will decline by more than 10% and up to 26%. All of them are hill-districts with a high level of internal and international out-migration, and a moderately high level of fertility. Under the medium scenario, we assume that the current trend of high level out-migration will cause further depopulation of these districts. Improvements in the infrastructure, such as road and track construction, are considered to be essential stimuli for the economic and demographic development of these regions in order to connect them with other parts of the country. On the contrary, improved infrastructure can have the exact opposite effect as roads and tracks can augment the outflow of the population from these areas that aim to get access to a non-agricultural job market or education.

Figure 25. Top 10 depopulating districts in Nepal, 2011-2031 (in %)



3.2.1 Age and Sex Details: Three Typical Districts of Nepal

In this section, we present three for Nepal typical districts in their age and sex structure top 10 populated districts (see Figure 24), districts with declining population (see Figure 25), and the group with average population changes. Figure 26 shows Kathmandu as one example of the top 10 populated districts. At the starting point of our calculations, in 2011, the age and sex structure of Kathmandu is diamond shaped instead of a pyramid, fertility has declined significantly in the past, and the district is one of the favorites for internal in-migration (Panel A). These districts will continue to attract younger migrants and due to a leveling (and slow reversal) of fertility at the lowest level (assumed TFR level of 1.5 children per woman), the shape of the population distribution will change (Panel B). The change in age structure has also effects on the median age that in case of Kathmandu will increase from 25.5 years in 2011 to 34.3 years in 2031.

Figure 27 shows the age and sex distribution for Khotang, representing the second group of districts with declining population Figure 27. The population structure is unique in terms of two aspects: Firstly, the fertility rates are declining, and secondly, there is a high level of out-migration. With this continuous combination, the overall population is expected to shrink and will have a non-symmetric age and sex structure (for e.g. see Figure 27, panel B) with a higher sex-ratio for women in ages between 15 and 40.

The third set of districts is represented here by Kalikot in Figure 28. The level of both international and internal out-migration is low and the level of fertility is relatively high. With the continuation of the current level of migration and the moderate decline in fertility, the population will keep increasing, and the shape of the age and sex structure resembles a pyramid with a larger base.

Figure 26. Empirical (2011, Panel A) and projected (2031, Panel B) age and sex distribution of Kathmandu

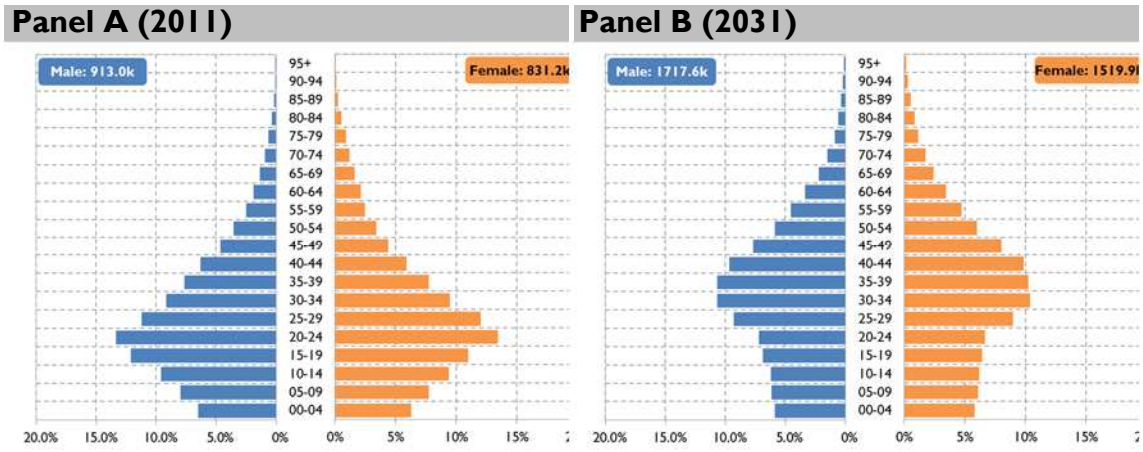


Figure 27. Empirical (2011, Panel A) and projected (2031, Panel B) age and sex distribution of Khotang

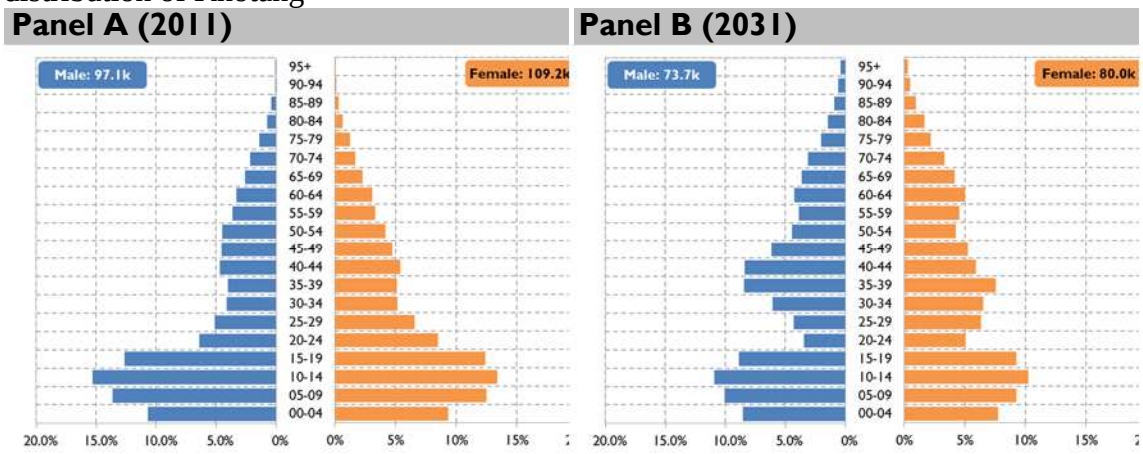
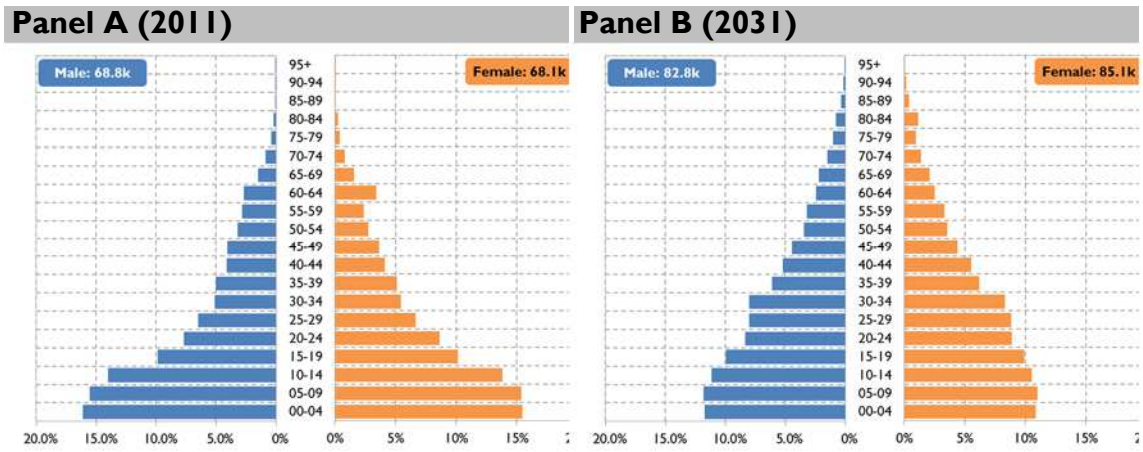


Figure 28. Empirical (2011, Panel A) and projected (2031, Panel B) age and sex distribution of Kalikot

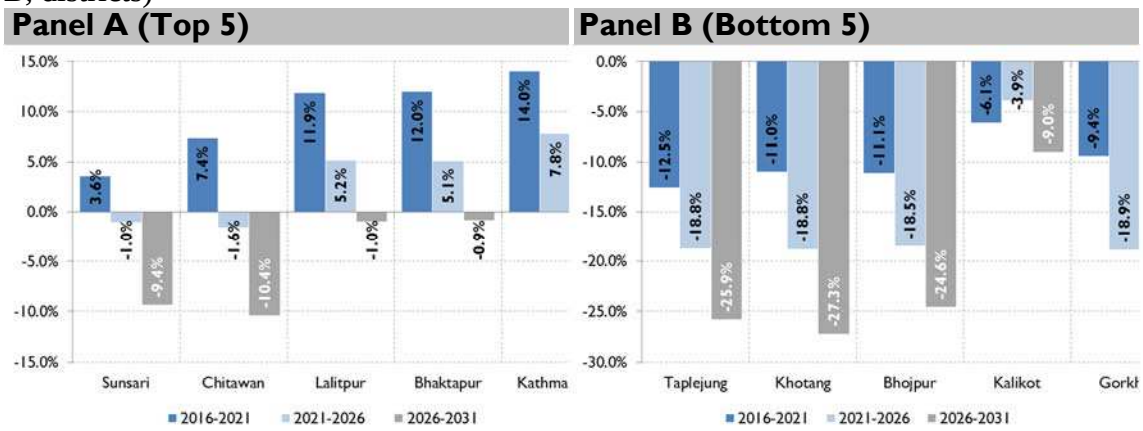


3.2.2 Births: Relative Change to Earlier Period

Figure 29 shows the top 5 (Panel A) and bottom 5 (Panel B) districts in terms of changes in the number of births relative to earlier periods. Among the top 5 districts the number of births will be higher in the second projection period (2016-2021) compared to the first period (2011-2016). Despite the inherent assumptions about diminishing fertility in the medium scenario, the number of births is higher due to migration of young women in their reproductive ages to urban center. In the third projection period (2021-2026), only three districts in Kathmandu Valley will have a higher number of births. Merely Kathmandu is expected to have a higher number of births in consecutive periods, including 2026-2031, due to a larger number of women in their reproductive ages and slightly increasing fertility.

Similar patterns can be observed among the bottom 5 districts, where due to a diminishing number of women in their reproductive ages (mainly due to migration) and a declining rate of fertility, the number of births is declining faster. In these districts, we also found high level of internal out-migration.

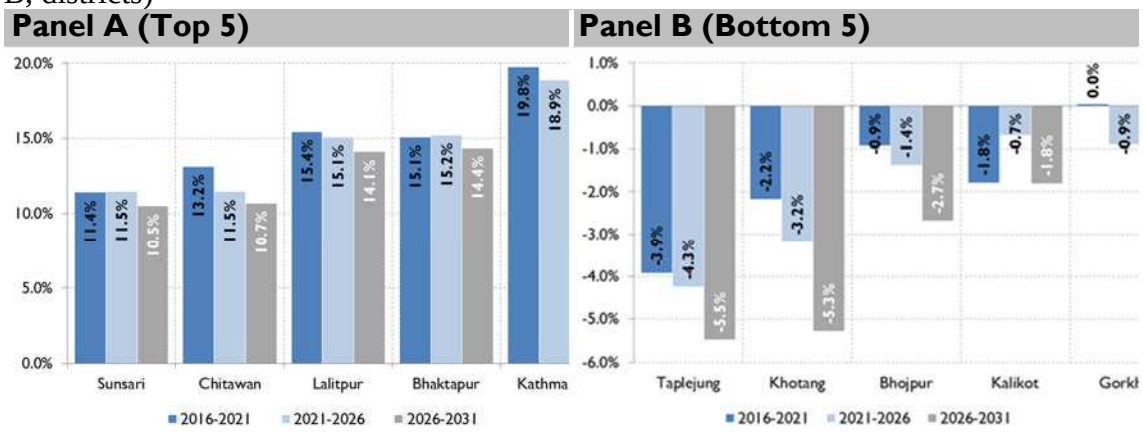
Figure 29. Relative change in the number of births (top 5, Panel A, and bottom 5, Panel B, districts)



3.2.3 Deaths: Relative Change to Earlier Period

Figure 30 shows the top 5 (Panel A) and bottom 5 (Panel B) districts in terms of changes in the number of deaths relative to earlier periods. It strikes, that the top 5 and the bottom 5 are the same districts as in the case of births. This has to do with increasing cohort sizes due to high rate of internal in-migration in districts in Panel A whereas all districts in Panel B are losing population due to emigration and internal out-migration. This is an implication for a higher need of health care in one set of districts compared to lower need in the others.

Figure 30. Relative change in the number of deaths (top 5, Panel A, and bottom 5, Panel B, districts)



3.2.4 Internal and International Migration

Figure 31 shows the total number of internal migrants between districts during the 5-yearly periods throughout the projection period. We assume that the overall rate of internal migration will remain constant. The rate is considerably higher for women and the reason is marriage. Although the rate of internal migration in our scenario will remain constant, the increasing number of people in the classic "migration-ages" (15 to 34 years) will lead to an increase of the number of migrants (see for e.g., Figure 32 and Figure 33).

Figure 31. Total number of internal migrants in Nepal, 2011-2031

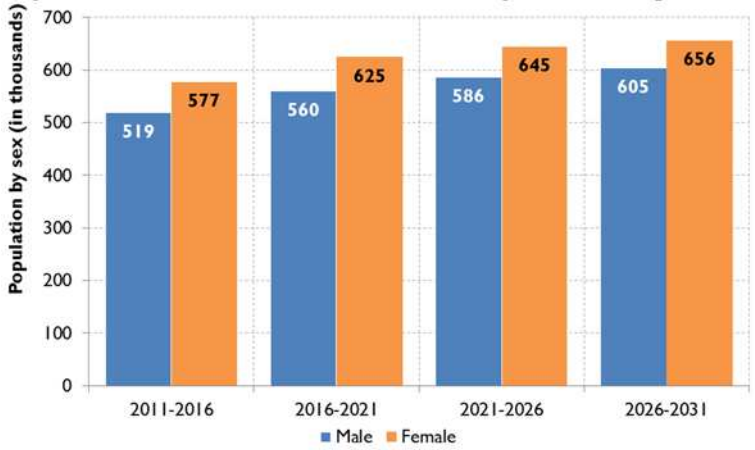


Figure 32 shows the age and sex distribution of internal migration flows for high in-migration districts for the example of Kathmandu (which has the highest number of in-migrants) in the period 2011 to 2016 (inflows in Panel A and outflows in Panel B). Kathmandu receives more males than females from other districts, together the sexes amount to 308 thousand, while a relatively small number of people actually leave for other districts. The age distribution of the inflows suggests that the main reasons are education (high school and university) and employment.

Gorkha district on the other hand represents those districts that are losing their population in the course of internal migration. The age and sex distribution, as seen in Figure 33, resembles a reversed-panel of Figure 32 for Kathmandu, which has positive net migration. Females are more actively migrating from Gorkha than males.

The set of bar charts in Figure 34 shows the top 5 (Panel A) and bottom 5 (Panel B) districts with inflows of internal migrants. If the current rate remains, Kathmandu district will continue to gain a relatively high number of migrants. The other four districts in Panel A also have one or more big urban centers that attract population and will most likely show further population increasing the future. The districts that will gain very little through inflows from other districts, as shown in Panel B, are all in the mountain regions.

The set of bar charts in Figure 35 shows the top 5 (Panel A) and bottom 5 (Panel B) districts with outflows to other districts. In Panel A, except of Pyuthan, which is located in the Mid-Western Hill Region, all other districts are located in the Eastern Development Region, whereby Siraha and Morang are located in the Southern Terai Region, Udayapur in the Hill Region, and Taplejung in the Mountain Region. The relative close distance to the economically strong Kathmandu Valley might works as a pull factor to these districts. Under the medium scenario, when assuming the current rates of internal migration are kept, the outflows will increase in all districts. The reasons are most likely the number of people in the ages with a higher rate of migration will remain high, and when the absentee population return they are likely to settle in nearby urban centers. Overall, Nepal will continue to have an increasing number of people migrating and this will have an impact on the population size and structure of the districts.

The final set of bar charts in Figure 36 shows the expected international migration, represented as absentee population, by district. With the explicit assumptions of declining

emigration rates after the period 2011-2016 (see Section 2.4.2), all districts will see a future decline of absentee population.

Figure 32. Age and sex distribution of internal migrants (inflows, Panel A, and outflows, Panel B) in Kathmandu, 2011-2016

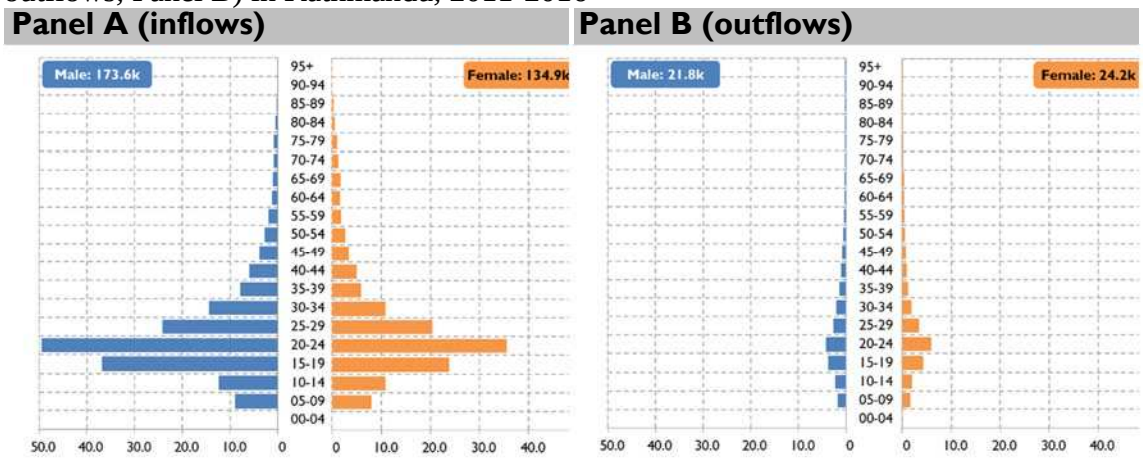


Figure 33. Age and sex distribution of internal migrants (inflows, Panel A, and outflows, Panel B) in Gorkha, 2011-2016

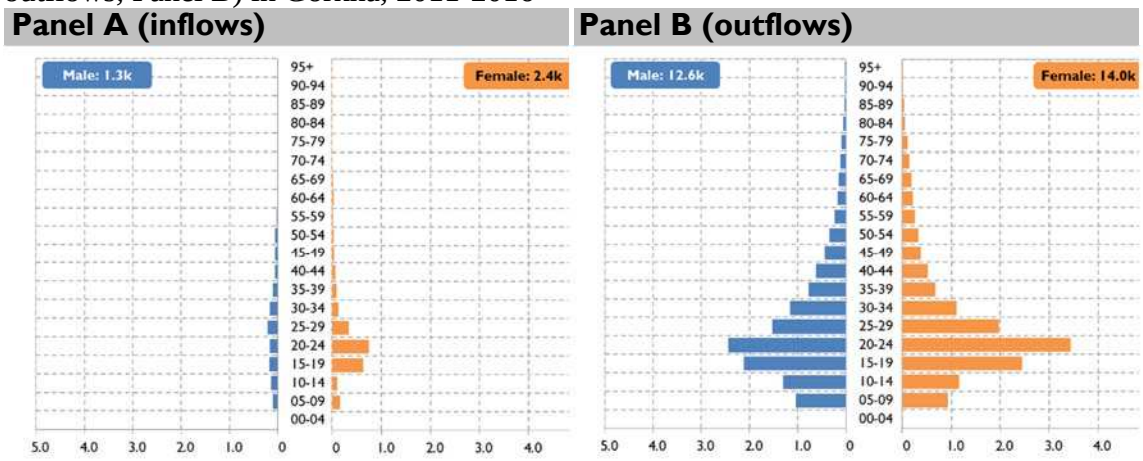


Figure 34. Inflows of internal migration (top 5, Panel A, and bottom 5, Panel B, districts)

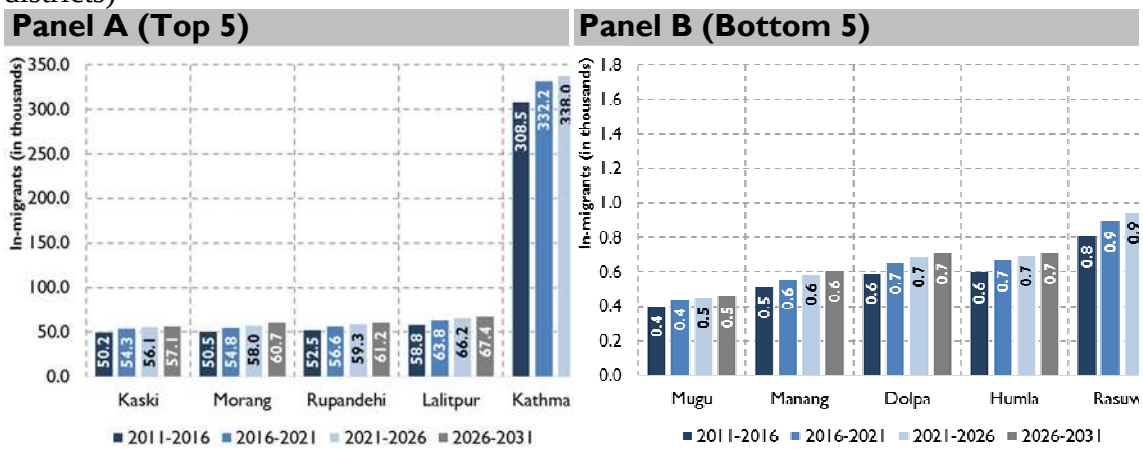


Figure 35. Outflows of internal migration (top 5, Panel A, and bottom 5, Panel B, districts)

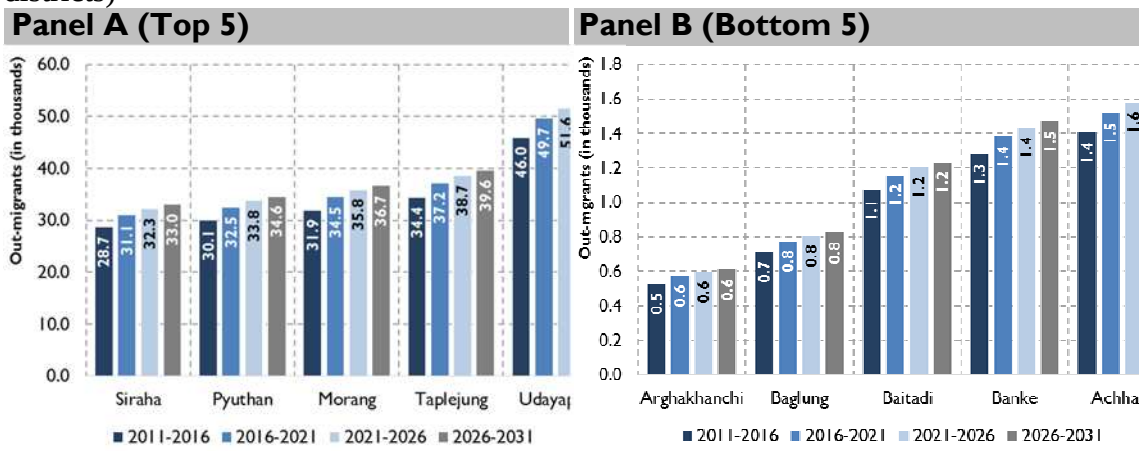
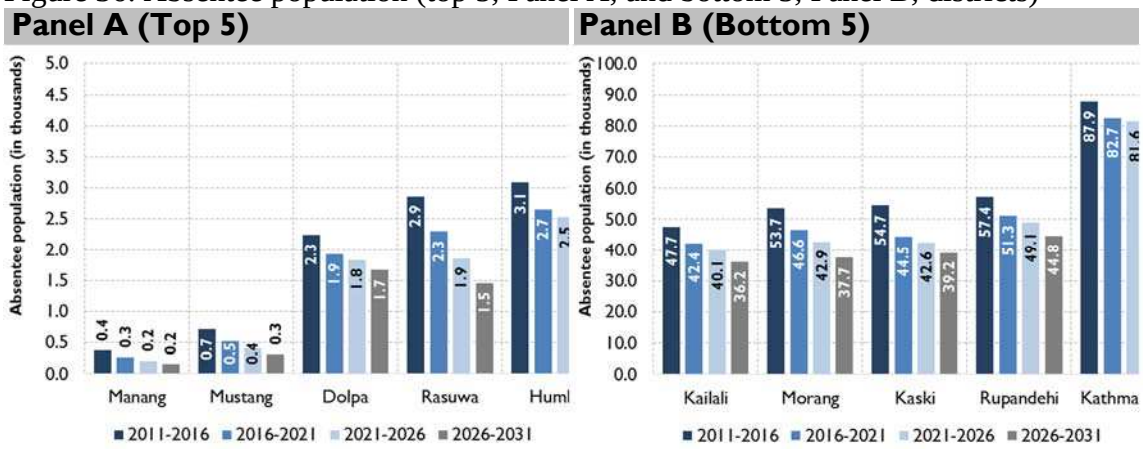


Figure 36. Absentee population (top 5, Panel A, and bottom 5, Panel B, districts)



3.3 VDC/Municipalities Level

The population projections for the VDC/Municipality levels have been conducted for the period 2011 to 2031, but due to the often small population size (especially in Manang and Mustang) and with time increasing uncertainty of the projection outcome we will show here only the projection up to 2021. The results show that, while many units closer to the urban areas, district centers and in the Terai region are gaining in population size, many other units mainly in the remote hills and mountains are losing population and these trend of depopulation will continue. Due to a very high rate of migration (internal and international) many such remote units are already losing population, mostly the young ages, and their return is less likely. However, it is unlikely that such a return migration will be significant because the population will most likely continue to migrate to established or new urban centers where the modern services (education, health, employment etc.) are readily available.

A comparison of different spatial granularities of the population projection outcome shows that a more detailed look at the subnational population projection can be important for further investigation. Figure 37 shows the relative change in population size

in the VDC/Municipalities from 2011 to 2021. Some Mountain VDC/Municipalities of Dolpa, Humla, Manang, Mugu, and Mustang and the Hill regions of Central and Eastern Nepal see population losses. Comparing this map with the district level results for the same period in Figure 38 we get a completely different picture, with Dolpa, Humla and Mugu in the Mid-Western DR experiencing a population increase on district level, while the Northeastern districts see their population declining. Hence, the differences within districts vanish on district level due to a higher weighting of VDC/municipalities with higher population size.

This phenomena is known as Modifiable Areal Unit Problem (MAUP) that can best be illustrated by the Eastern Development Region, where the area-wise large VDC/Municipalities in the Northern mountainous region with a smaller population size show a population increase, while the higher populated but smaller areas in the Hill region decrease as many people are emigrating to the urban centers within Nepal or abroad. This area-wise small areas outweigh the mountainous regions by population size and therefore have a higher impact on the population development of the superior districts.

A closer look at different spatial levels is worthwhile for more precise information, also the different period-specific trends give important insights. While Figure 37 shows an overwhelmingly increase of the population size from 2011 to 2021 of 86.9% for all VDC/Municipalities, the picture changes when looking at the time frame 2016 to 2021. In this period only 67.4%show a population increase, while the remaining 32.6%, which are mainly located in the Mountain and Hill regions of Nepal, show a population decline (see Figure 39). This decline may not be visible in the overall projection period from 2011 to 2021, but will most likely be a driving development factor in the coming years, even beyond 2021.

Figure 37. Relative Change of Population in Nepal's VDC/Municipalities, 2011- 2021

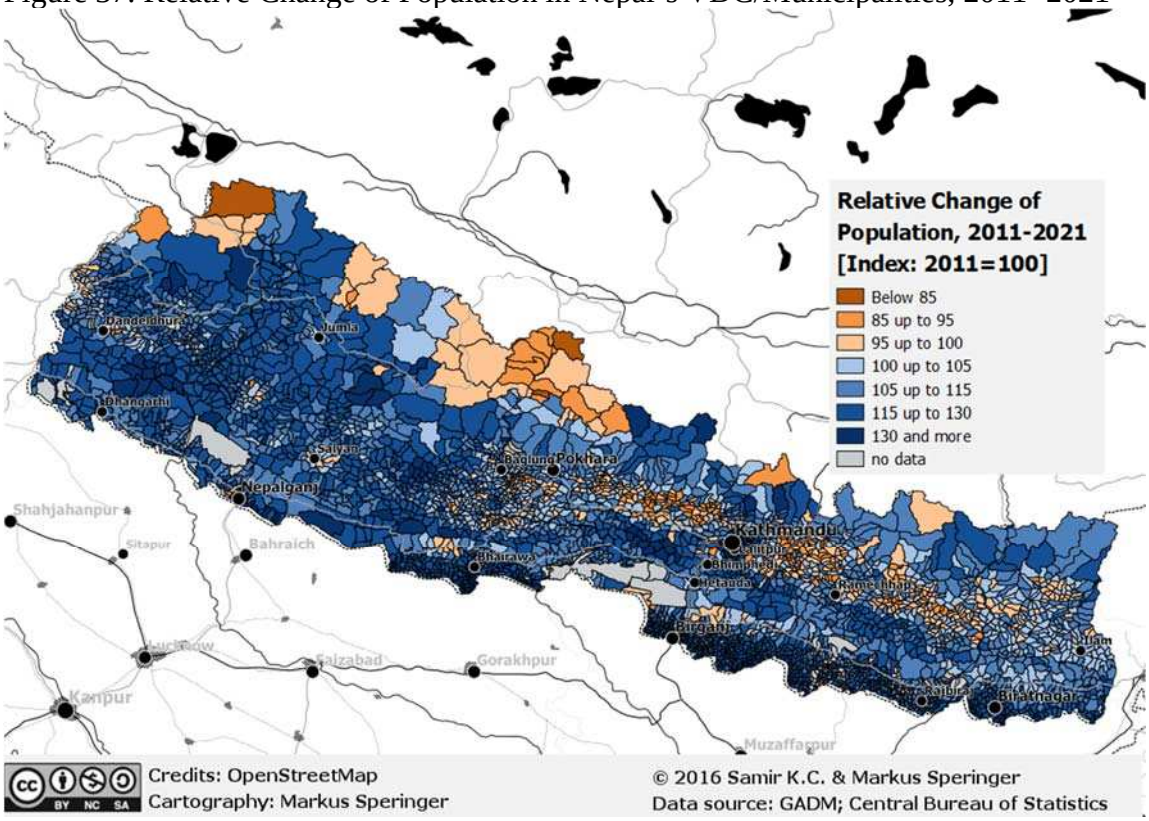


Figure 38. Relative Change of Population in Nepal's districts from 2011 to 2021

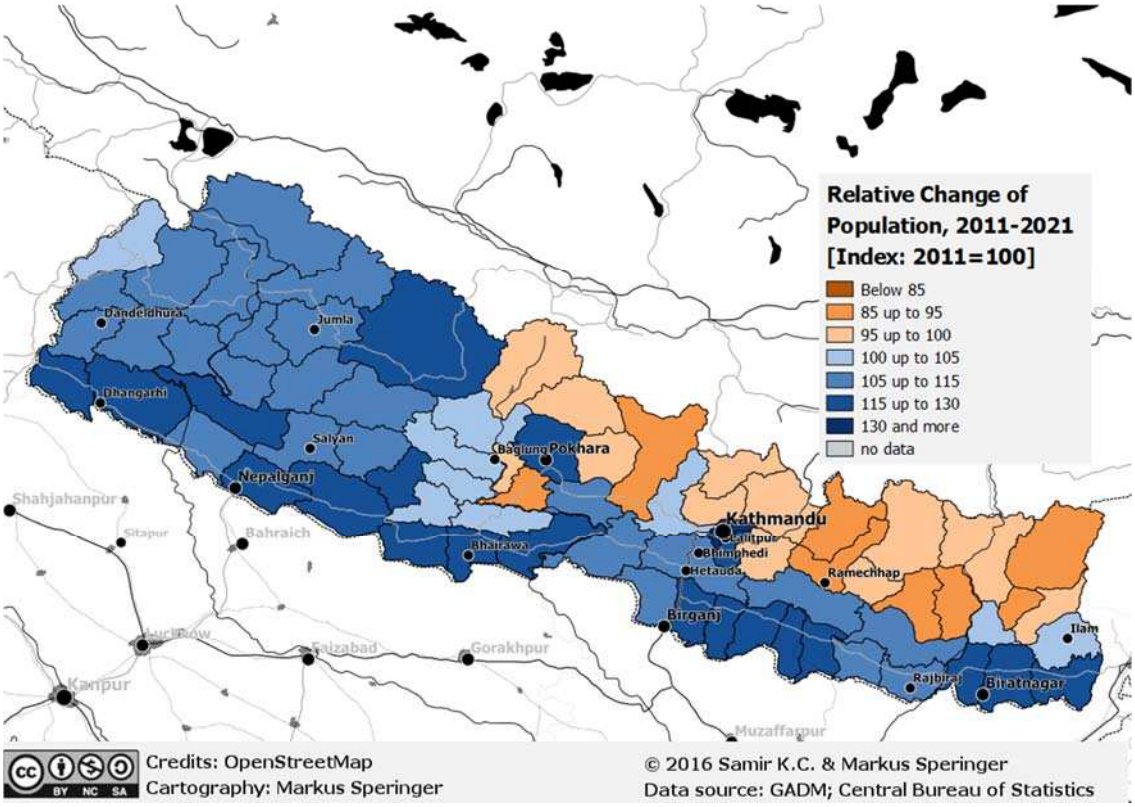
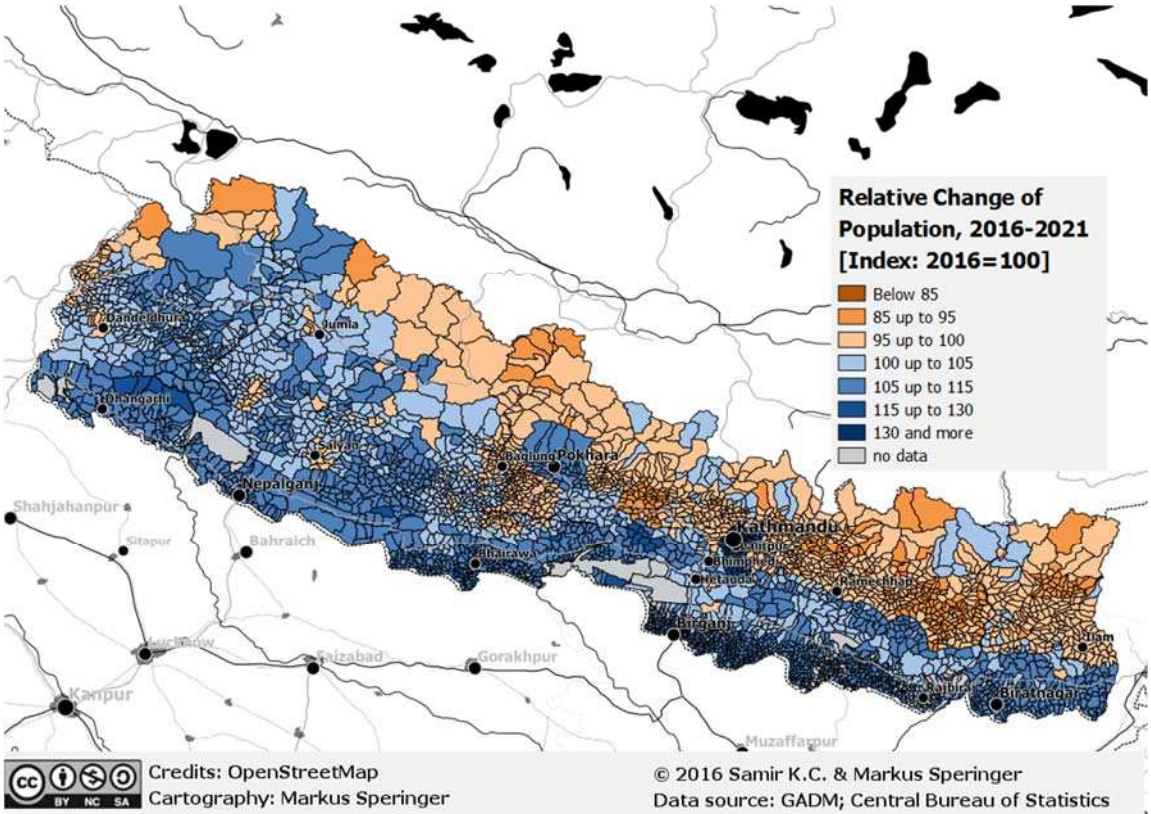


Figure 39. Relative Change of Population in Nepal's VDC/Municipalities from 2016 to 2021



4 Conclusion

In this Working Paper, we explain the data, methodology, and results of population projections for Nepal, its 75 districts and more than 4000 units of VDC/Municipalities for the time period 2011-2031. We projected the population for a single medium scenario that can serve as a baseline scenario for policy discussions. The model produces results for the age and sex structure of the population as well as the age and sex specific number of deaths, births, and flows of internal and international migration. The age and sex specific fertility, mortality (life tables), and migration rates are also a bi-product of the process and can be used to build alternative scenarios by altering specific rates of interests. The projection model is set in Excel-VBA such that more scenarios can be applied with ease.

Apart from the development of the model, the results of the medium scenario give an insight of the potential demographic future of Nepal. The likelihood of such a scenario is beyond the scope of this project; however, the results can quite well serve as a baseline future if current trends continue. Having said that, the results for the near future term 2016 or even 2021 can be treated more as a forecast because the uncertainty about the demographic events happening in the near future is small. The uncertainty around the projected values is generally smaller for the larger administrative regions compared to the smaller units, for example Nepal vs. district level and district level vs. VDC/Municipalities levels.

The demographic future of Nepal will clearly depend on the future course of migration, both internal and international, and largely on the future developments and events impacting migration rates within and outside the borders of Nepal. In the past, Nepal's demographics were mostly affected by events in Nepal and to some extent in India. Today, developments in other countries add to this external influence. Therefore, while speculating about the demographic future of Nepal, one should include a broader picture of the events and expectations at the international level. Some examples are the recent global financial problems affecting the labor demand in the construction industry, the global impact of the crisis in Syria/Iraq, or the future of the *"Make in India"* project of Modi's government on the availability of more and different types of jobs in India.

The assumptions about return migration are ad-hoc but an important feature of our projections. International migration is often either ignored (for e.g. in the official projection of CBS) or if considered the age pattern is assumed to be constant, which cannot be true in case of Nepal considering the returning absentee population in the future. Basically, Nepal will be losing young and less experienced people to foreign countries, and, with a time lag, gain older and more experienced people as return migrants. This might be a win-win situation if the gain in human capital along with the gain in financial capital (as personal savings from remittances) are invested in Nepal contributing to economic growth, increasing education and standard of living. It is however a challenge for the government and society as a whole to provide an environment where return migrants can come back and kick-start their livelihood without much difficulty in terms of legislation, public administration, infrastructure, etc. If such an environment can be developed, it might also impact the emigration rate negatively, as new jobs with better pay and prospects might already be available in Nepal.

The other demographic aspect that will clearly affect Nepal is the future prospect of declining fertility which is partly driven by migration. With more women wanting to

leave Nepal, there will simply be less births, and those women who stay are likely to not want to have more children either because their husband is not around or simply the desired family size is smaller. With the increasing level of education and the experience from other countries that have gone through this transition, the future fertility assumed in the medium scenario is quite likely.

Finally, the mortality situation will also be better in the future through better health care facilities and related efforts in awareness raising and education. With less data on this demographic determinant we relied on UN expectations. A clear message is the gender gap in mortality (see Section 2.3), which is in favor of women, suggests to revise health policies in the future.

In the future our projection model should be extended by adding other important sources of heterogeneity, such as educational attainment. There should be a serious attempt to democratize the data situation by enhancing the registration system as well as allowing quick dissemination of data by the government.

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