Projecting Internal Migration and Population Change from Scenarios of Economic Growth: a Case Study for the Alto Paraopeba Valley, Brazil

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Abstract. This paper discusses the impacts and consequences on demographic dynamics of big development projects on demographic dynamics in small regions. We use as case study the Alto Paraopeba Valley in Brazil, a region which will face structural changes in the following decades due to investments in mining, metallurgic and steel industry. Projected high employment generation will deeply affect the demographic dynamics in the region, particularly through high in-migration rates, and will change urban and regional development patterns by imposing further pressures on the already fragile infrastructure (e.g., water supply, sanitation, transportation system and housing) and social services (health, education). We propose a methodology to forecast population growth at the region al and municipal levels which is sensible to incorporate employment scenarios. We then discuss how these results will imply a restructuring of the territory and challenges for regional planning. Furthermore, given the proximity of the study region to the Metropolitan Area of Belo Horizonte (MA), we will show how the expansion of the last in direction to the study region, and the expansion of study region in direction to the MA, will increase mobility of people, goods and services and may create a process of conurbation between the two regions. Finally and based on our study region, we will address the need of better addressing the temporal and spatial scales involved in the relationship between population and planning and development in developing countries: the scale and speed of economic investments has usually bypassed the scale and speed of these social investments. In this sense, adequate regional planning and policymaking, informed by adequate technical knowledge may help bridge the gap, although this is not usually the case in many developing countries or regions.

Keywords: demographic dynamics; migration; economic growth; Brazil

Introduction

This paper discusses the impacts and consequences on demographic dynamics of big development projects on demographic dynamics in small regions. We use as case study the Alto Paraopeba Valley in Brazil, a region which will face structural changes in the following decades due to investments in mining, metallurgic and steel industry. Projected high employment generation will deeply affect the demographic dynamics in the region, particularly through high in-migration rates, and will change urban and regional development patterns by imposing further pressures on the already fragile

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infrastructure (e.g., water supply, sanitation, transportation system and housing) and social services (health, education).

As for other developing countries, Brazil is facing sustained growth rates given high investments in several economic sectors. However, planning capacity to anticipate the social, demographic and environmental impacts of these investments is still an important constrain. The fact that these investments and impacts tend to be concentrated in some areas have required different policy approaches. In particular, migration and mobility patterns induced by economic stimulus impose several challenges to urban and regional planning, given the usually slower speed in adapting infrastructure, services and institutions. The lack of an integrated planning perspective in policymaking as well as inadequate methodologies in demographic analysis is an important limitation in the assessment of regional and local impacts and consequently informing regional policies.

We propose a methodology which belongs to a set of projection techniques known as "ratio methods" to forecast pressures from population growth, at the regional and municipal levels, and which is sensible to incorporate employment scenarios. The results will be interpreted at light of the literature on the linkages between demographic dynamics, economic growth and development. In particular, we discuss the need to improve methodologies in demographic analysis for small areas or regions which incorporate economic scenarios and their impacts on mobility, the population component most sensible to varying regional economic scenarios.

Demographic Dynamics, Development and Regional Planning

The main objective of the Symposium on Population and Development Planning in Riga, in 1993 (United Nations, 1993) was to better understand the role of population dynamics in development planning. Maybe the most important recommendation from the symposium was the need to include population variables in planning capital and labor force scenarios.

In this regard, migration is a critical variable in development processes since the selectivity of migration fluxes is usually linked to higher levels of human capital, benefiting destination areas rather than origin areas. Population growth due to in-migration below the employment level can lead to wage reduction, thus increasing bargaining power to attract new economic investments. On the other hand, increasing unemployment lead to higher poverty and negative externalities which hinders economic growth (Skeldon, 1990).

Concerns of regional planners regarding the spatial distribution of population can be traced to the assumption that, in market rationality, demographic growth can bring negative consequences to the development. Thus the role of planning is to anticipate and propose courses of actions regarding future demands in the social and environmental dimensions as well as in terms of infrastructure and services (FRIEDMAN, 1987; BILSBORROW, 1976).

Given these considerations, the remaining of this section we will discuss the following issues:

- the relationship between population mobility (particularly migration) and development, highlighting its endogenous nature. We will use as references, among others, Bilsborrow et al (1984), Skeldon (2008), and Rees (1993).

- the importance of adequate methodologies and policy assessments in development planning considering the endogeneity between demographic dynamics and development.

- how to build upon Friedman (1987) concepts of *market rationality* and *social rationality*, policy and planning strategies taking into account the interaction of economic development and demographic dynamics in sub-national regions.

This article discusses planning rationalities and policymaking in a context of rapid demographic transformation (particularly due to migration) and proposes a methodology to assess scenarios of population growth in these contexts. The following sections discuss a case study on the Alto Paraopeba Valley, in the state of Minas Gerais, Brazil, which is going to face important challenges in its regional structure given high investments in mining and steel industry in the next fifteen years.

Study Area[3]

The study area encompasses seven municipalities in the state of Minas Gerais, Brazil, in a region contiguous (at south) to the Metropolitan Area of Belo Horizonte (Figure 1). The municipalities are: Belo Vale, Congonhas, Conselheiro Lafaiete, Entre Rios de Minas, Jeceaba, Ouro Branco e São Brás do Suaçuí. These municipalities are part of a regional entity, called CODAP, which was created to coordinate the development process in the region[4].

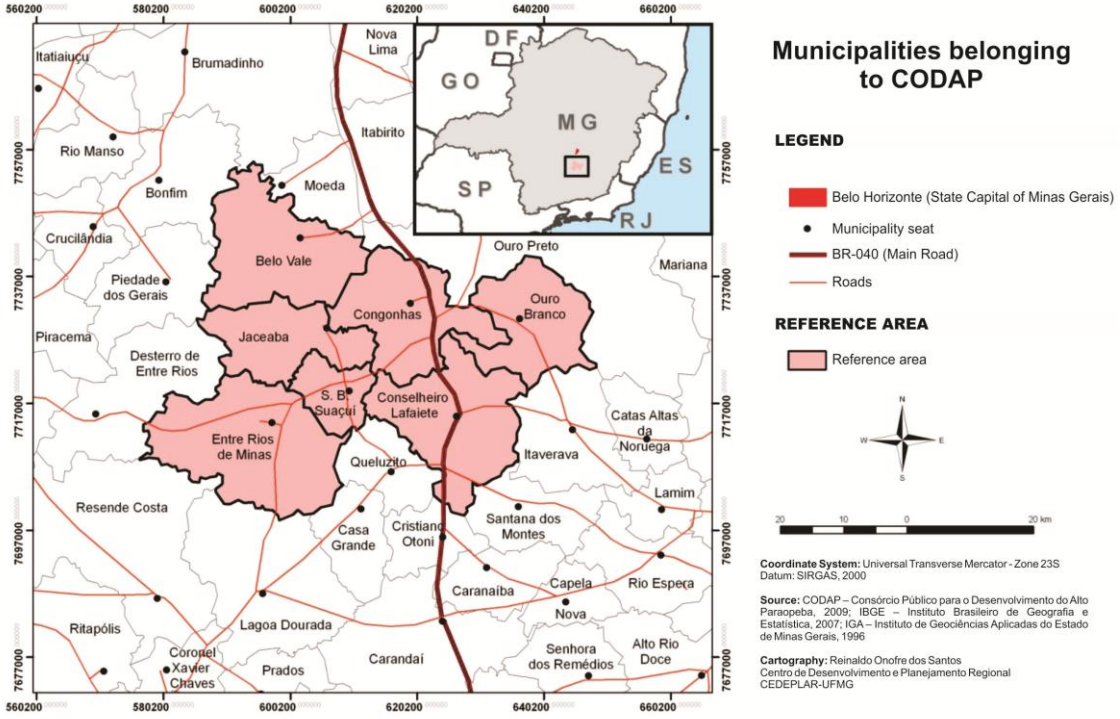
The original settlement of the CODAP region in the 18th Century is linked to the discovery and exploration of gold in the state of Minas Gerais, particularly in the (actual) municipalities of Ouro Preto and Mariana. The proximity of these municipalities to the CODAP region allowed to the last the consolidation of settlements linked to regional trade and the development of agriculture and cattle to supply the demands of the mining areas. With the decadence of gold mining after 1760, the region faced a period of stagnation with tentative episodes to develop the metallurgic industry (beginning of the 19th Century) and as a food supplier to a newer gold mining boom, with the installation of an English mining company in a neighbor municipality after 1830. At the end of the 19th Century the region became an important transportation node with the construction of two railroads.

After 1897 with the construction of the new state capital, Belo Horizonte, at less than 60 kilometers from the study area, the region faced a new dynamics as a food supplier to the new capital. While most of the region became practically stagnated in terms of its economy and urban development, Congonhas developed gold, and posteriorly iron ore mining activities, and in 1970 Ouro Branco received a big steel company (Açominas). Conselheiro Lafaiete, the biggest municipality in the study area, developed as a trade center, especially after the construction of BR040, a federal railway linking Belo Horizonte to Rio de Janeiro.

[3] The discussion in this section is based on Barbieri (et al., 2010).

[4] This is the first cooperation agreement between municipalities in the State of MInas Gerais, following the Federal Law number 11.107 from April 6th, 2005. This cooperation agreement, called *consorcio*, is a legal contract between municipalities wit the aim of joint coordinate planning and investments of mutual interest and given constitutional limits (SANTOS, 2010; BRASIL, 2005 e BRASIL, 2007).

Figure 1 – Study area in the Alto Paraopeba valley (CODAP), with regional limits and municipalities



According to the Brazilian censuses, the CODAP region had 181,294 inhabitants in 1991 and 204,631 in 2000, which correspond, respectively, to 1.15% and 1.14% of the population of the State of Minas Gerais. The annual growth rate during this period was 1.35% and the urbanization rate grew from 83.54% to 89.11%.

Nowadays the region is facing regional restructuring as a consequence of an increasing articulation with the Metropolitan Area of Belo Horizonte and the large investments in course, particularly in mining, metallurgic and steel industries, and the expansion and improvement of the available transportation infrastructure (Barbieri et al. 2010). Table 1 describes these investments predicted until 2020, considering those already confirmed and those still in the planning stage.

Metodology

Population projections for small areas

We will discuss in this section the methodology of population projections without the predicted impacts of economic investments in the CODAP region between 2010 and 2030. First, we used the *component method* to project fertility, mortality and migration functions for the CODAP region. Second, we use the *Apportionment Method (AiBi)* to disaggregate the regional projection for its municipalities. The AiBi method establishes a linear relationship between the region and its municipalities.

Table 1 – Confirmed and predicted investments for the Alto Paraopeba study area

Investment	Municipality	Year	R$ million Reais[1]
Confirmed			12222,00
Vallourec Sumitomo (metalurgy)	Jeceaba	2011	2880,00
CSN Casa de Pedra (iron mining)	Congonhas	2011	900,00
Ferrous (iron mining)	Congonhas	2013	4932,00
Ferrous (iron mining)	Brumadinho	2015	3240,00
Namisa (iron mining)	Congonhas	2011	270,00
Predicted			8280,00
CSN Siderúrgica (steel industry)	Congonhas	2015	5580,00
Gerdau-Açominas (steel industry)	Ouro Branco	2015	2700,00
TOTAL			20502,00

Source: Barbieri et al., 2010

[1] Considering a exchange ratio in June 2011 of U$ 1 = R$1.65

Population projections for small areas considering economic scenarios

Based on the population projections through the components and AiBi methods as described in the previous session, we further applied a third methodology to create alternative scenarios which consider the exogenous impact of economic growth and labor migration into the region. In this sense we consider three alternative scenarios: a) the trend scenario, built in the previous session; b) a first alternative scenario in which part of the confirmed investments in table 1, and c) a second alternative scenario which includes all investments in table 1 (confirmed and predicted).

We will provide a detailed description of our methodological approach in the full paper. Briefly, the methodology to create alternative scenarios was developed by CEDEPLAR (see description in FÍGOLI et al., 2007) and consists basically in relating the employment trend and the trend population. We also include in the estimates the impact of employment generation in the proportion of projected population commuting between the study region and others (particularly the Metropolitan Area of Belo Horizonte), which would otherwise inflate net migration estimates and thus increase the projected population in the region. Based on previous Brazilian censuses and the nature of future employment generation (occupation levels) and educational levels, and the proximity of the study area to the Metropolitan Area of Belo Horizonte, and consider that 7% of the employment generated will not be translated in labor migration but commuting to the study area.

Formally, we have:

$$V = \sum_{j=1}^{m}\sum_{i=1}^{n}\frac{Er_{t,nm}}{P_t} \qquad (2)$$

Where Er_t is the employment of residents projected to the period t with education level I and in the occupational sector. P_t is the population projected to period t. Thus, from Equation 1, we can obtain a function of coefficients, V, for every point in the projected period.

Overall, the methodology can be defined as part of a "family" of methods which consist in splitting the projected regional population growth in subregional populations through a technique based on models which consider the population stock in a given place (mass) as an element of population attraction. Thus the population growth in the alternative scenarios is given by the trend of population growth (without the employment scenarios) plus the additional population linked to the generation of a given number of direct and indirect job. This estimate considers implicitly the average household size and its relationship with each job generated. Formally, this technique is named *two-stage partition* and is described as (Equation 2):

$$P^{*}_{i,t} = \Phi_i + \left\{ [\beta (E^{*}_{r,t} - E_{r,t})] \left(\frac{M_{i,t-1}}{\sum_{i=1}^{n} M_{i,t-1}} \right) \right\} \qquad (2)$$

where $P^{*}_{i,t}$ is the population of the smaller area in the alternative scenarios (with employment generation) in period t, Φ_i is a function of the trend growth of the smaller area given the population growth of the bigger area given by the component method, $E_{r,t}$ is the predicted employment in the trend scenario, and $E^{*}_{r,t}$ is the employment predicted in the alternative scenarios; β is a coefficient which shows the relationship between employment and population, or the employment-elasticity of the population, $Mi_{,t-1}$ is the economic mass of the smaller area at time t-1 previously to the redistribution of population.

The relationship between the economic mass of the smaller area and the sum of the mass of all regions assures the following return condition (Equation 3):

$$\sum_{i=1}^{n} P_{i,t} = P_{r,t} \qquad (3)$$

As *mass* we consider the volume of employment (formal or not) of the region, its population, a synthetic indicator built from multivariate analysis or any proxy variable indicating the attraction capacity of the smaller areas given a volume of population to be distributed from the region, *r*. In this paper we used population as mass even considering that population do not reflect all the characteristics which makes an area to become more attractive. Furthermore we do not claim a causal relationship between population size and migration fluxes. Our claim is that population size is a proxy for an indicator of (especially urban) infrastructure and carrying capacity of a given area, given that an average population size remains in a given area according to the possibilities of maintaining basic material conditions for subsistence. Thus, population and population attraction have a positive, albeit not necessarily causal, relationship.

Results

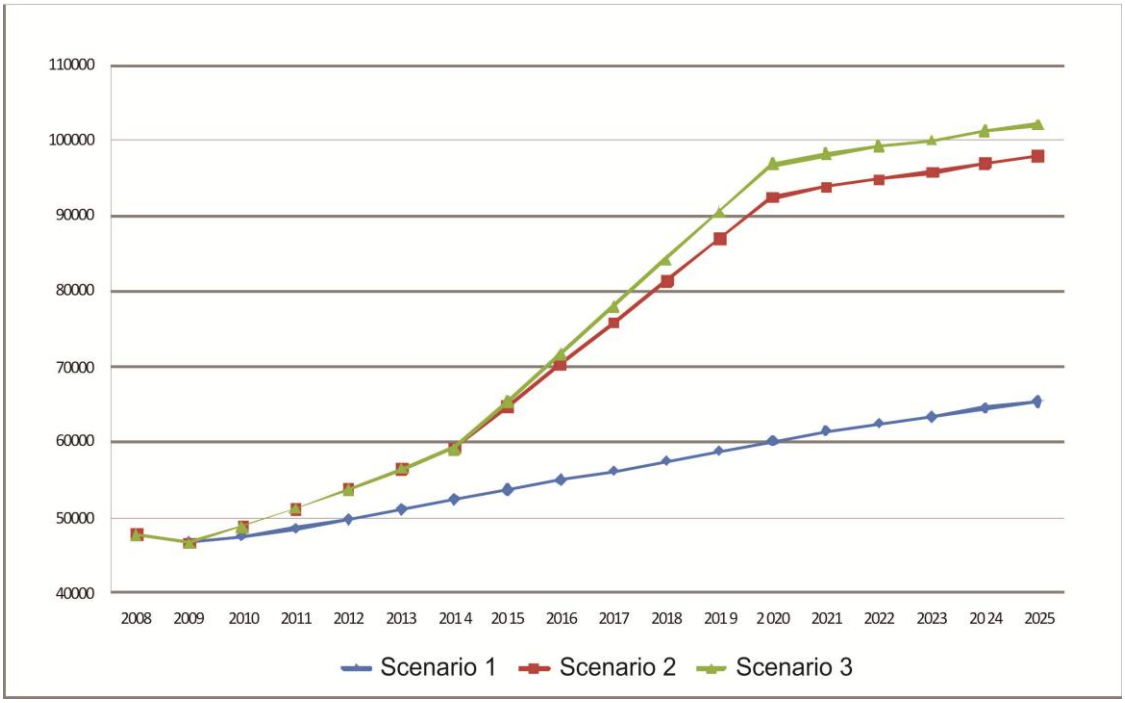
We show below tables and figures with some of our main results. We will include a detailed description and interpretation in the full paper about the main trends in the projection period, for the three scenarios, for the whole region and each municipality.

We will show how these results will imply a strong restructuring of the territory and strong challenges for regional planning. In particular, we will show, based on public data on predicted investments for the region and interviews with local and State

policymakers, that the projected investments in urban infrasctructure (particularly housing and sanitation), services (particularly health) and transportation are in an inadequate scale given the future population demands.

Furthermore, given the proximity of the CODAP region to the Metropolitan Area of Belo Horizonte, it is likely that in the long run the expansion of the last in direction to the CODAP region, and the expansion of CODAP in direction to the the MA, will create great mobility of people , goods and services and may create a process of conurbation between the two regions. An analysis of the Plan for Development of the Metropolitan Area of Belo Horizonte (PDDI), and also planning initiatives for the CODAP region do not address adequately the future pressures and social demands.

Figure 2 – Population projected for the study area in the Alto Paraopeba study area, according to scenario



Source: Elaborated from MTE-RAIS, IBGE-Censos Demográficos

Table 2 – Population projections according to economic scenario - 2010-2025

Scenario 1 (Trend)	***2010***	***2015***	***2020***	***2025***	***Growth rate 2010-25 (%)***
CODAP	220243	227125	232671	236469	7,37
Belo Vale	8060	8240	8385	8485	5,27
Congonhas	45198	46935	48335	49294	9,06
Conselheiro Lafaiete	112052	116115	119389	121632	8,55
Entre Rios de Minas	13689	13942	14146	14286	4,36
Jeceaba	5543	5294	5093	4955	-10,61

Ouro Branco	32363	33236	33940	34421	6,36
São Brás do Suaçuí	3338	3363	3383	3397	1,75
Scenario 2	***2010***	***2015***	***2020***	***2025***	***Growth rate 2010-25 (%)***
CODAP	226222	273789	358386	379123	67,59
Belo Vale	7663	8322	9495	9782	27,66
Congonhas	47877	61125	84686	90462	88,95
Conselheiro Lafaiete	108754	129607	166691	175781	61,63
Entre Rios de Minas	13736	15304	18093	18777	36,7
Jeceaba	9242	11663	15970	17025	84,22
Ouro Branco	34700	42405	56108	59467	71,37
São Brás do Suaçuí	4250	5363	7343	7828	84,22
Scenario 3	***2010***	***2015***	***2020***	***2025***	***Growth rate 2010-25 (%)***
CODAP	226222	276825	375047	395782	74,95
Belo Vale	7663	8364	9726	10013	30,67
Congonhas	47877	61971	89326	95102	98,64
Conselheiro Lafaiete	108754	130937	173994	183084	68,35
Entre Rios de Minas	13736	15404	18643	19326	40,7
Jeceaba	9242	11818	16818	17873	93,39
Ouro Branco	34700	42897	58807	62166	79,15
São Brás do Suaçuí	4250	5434	7733	8218	93,39

Source: Elaborated from MTE-RAIS, IBGE-Censos Demográficos.

Figure 3 – Scenario 1 of population projection to the Alto Paraopeba valley (CODAP)

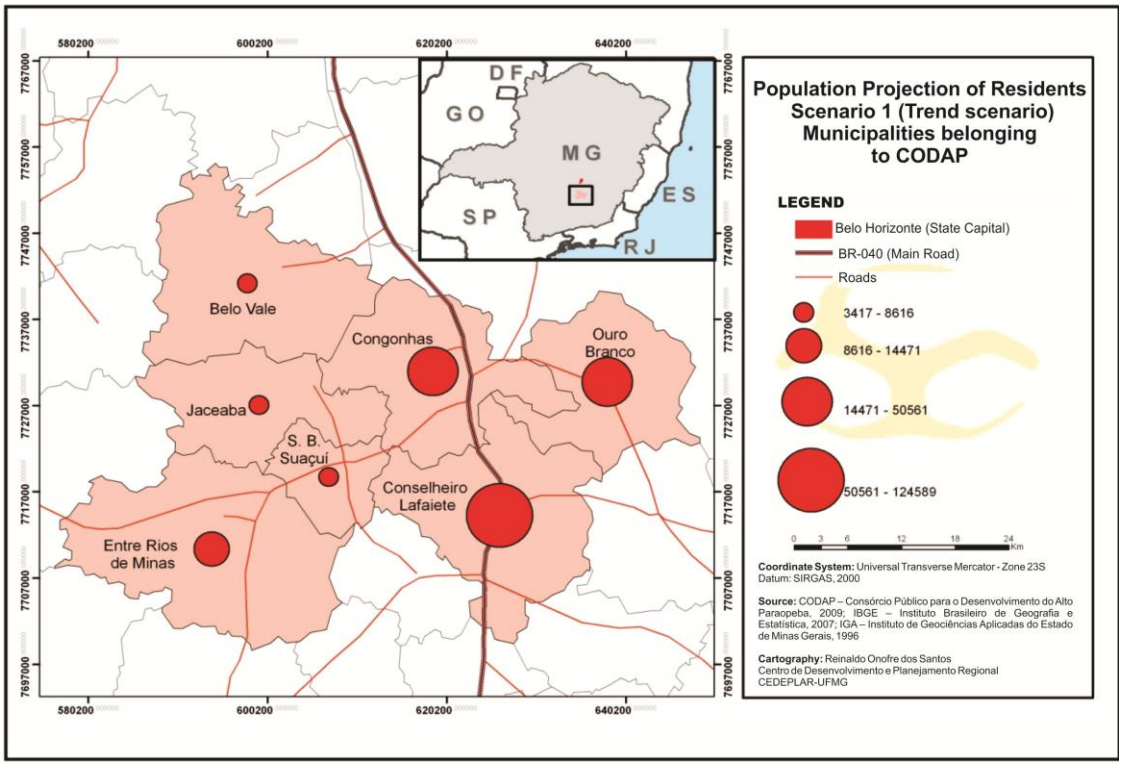


Figure 4 – Scenario 2 of population projection to the Alto Paraopeba valley (CODAP)

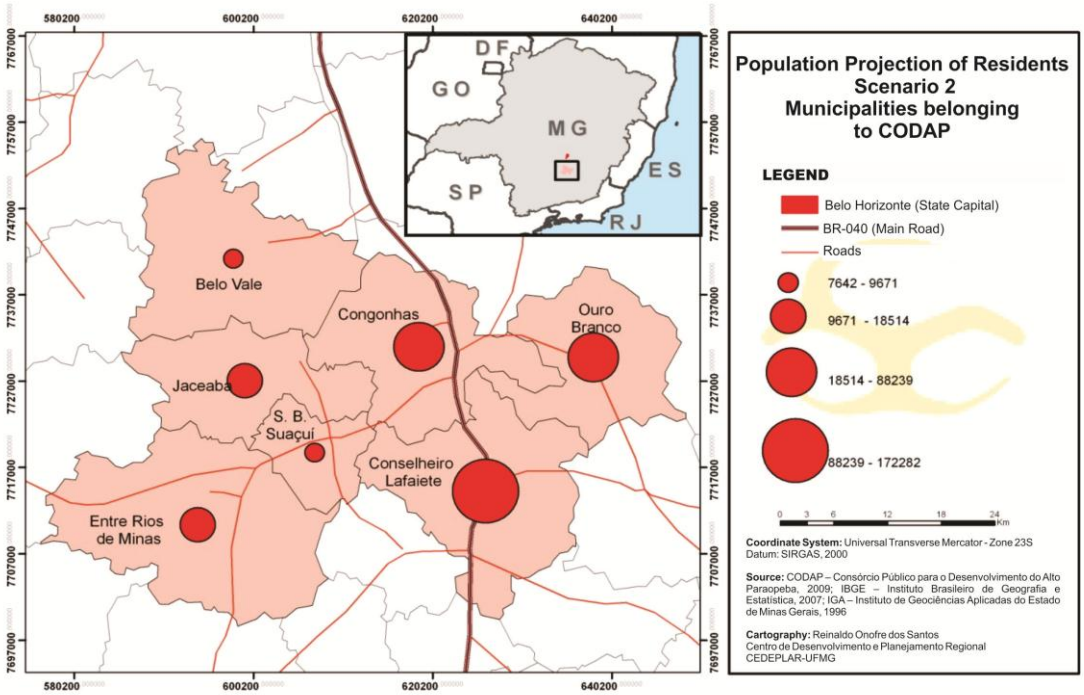
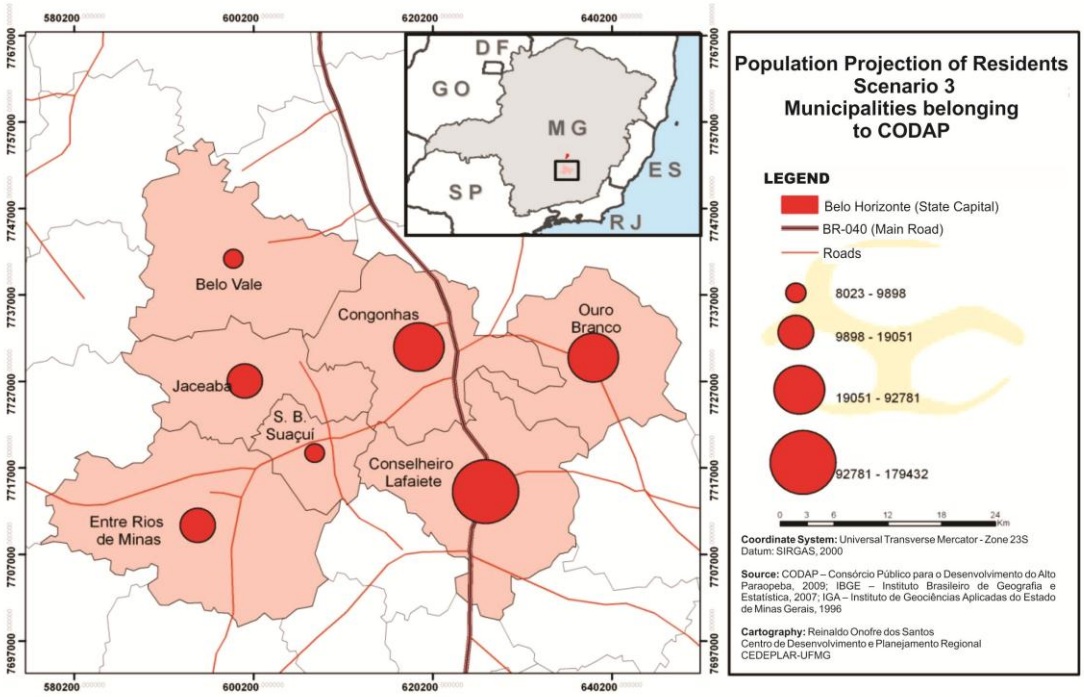


Figure 5 – Scenario 1 of population projection to the Alto Paraopeba valley (CODAP)



Discussion and conslusion

In this section we will discuss the importance of developing methodologies in demographic analysis which may provide policymakers the ability to anticipate regional demands from population growth, particularly migration, in terms of urban infrastructure, services and transportation. We discuss how the scale and speed of economic investments has usually bypassed the scale and speed of these social investments. Adequate regional planning and policymaking, informed by adequate technical knowledge may help bridge the gap, although this is not usually the case in many developing countries or regions.

We will also discuss how the investments may accelerate urbanization process in the region, both in terms of concentration of population, infrastructure and services but also due to its higher articulation with the Metropolitan Area of Belo Horizonte. Again, these urban demographic scenarios impose important challenges which have not been adequately addressed.

Finally we will discuss how the results and discussion of our study area may contribute to the extant literature on demography, development and planning in developing countries. We will address the need of incorporation better methodological approaches to bridge the gap between demographic and planning analysis.

In particular, we will address the need of better addressing the temporal and spatial scales involved in the relationship between population and planning and development.

We claim the need to improve methodologies in demographic analysis for small areas or regions which incorporate economic scenarios and their impacts on migration, the population component most sensible to varying regional economic scenarios.

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