

TeMA

Journal of
Land Use, Mobility and Environment

This special issue collects a selection of peer-review papers presented at the 8th International Conference INPUT 2014 titled "Smart City: planning for energy, transportation and sustainability of urban systems", held on 4-6 June in Naples, Italy. The issue includes recent developments on the theme of relationship between innovation and city management and planning.

Tema is the Journal of Land use, Mobility and Environment and offers papers with a unified approach to planning and mobility. TeMA Journal has also received the Sparc Europe Seal of Open Access Journals released by Scholarly Publishing and Academic Resources Coalition (SPARC Europe) and the Directory of Open Access Journals (DOAJ).

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papers

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planning for energy, transportation
and sustainability of the urban system

Special issue, June 2014

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SMART CITY

PLANNING FOR ENERGY, TRANSPORTATION AND SUSTAINABILITY OF THE URBAN SYSTEM

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TeMA

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This special issue of TeMA collects the papers presented at the 8th International Conference INPUT 2014 which will take place in Naples from 4th to 6th June. The Conference focuses on one of the central topics within the urban studies debate and combines, in a new perspective, researches concerning the relationship between innovation and management of city changing.



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EIGHTH INTERNATIONAL CONFERENCE INPUT 2014

SMART CITY. PLANNING FOR ENERGY, TRANSPORTATION AND SUSTAINABILITY OF THE URBAN SYSTEM

This special issue of TeMA collects the papers presented at the Eighth International Conference INPUT, 2014, titled "Smart City. Planning for energy, transportation and sustainability of the urban system" that takes place in Naples from 4 to 6 of June 2014.

INPUT (Innovation in Urban Planning and Territorial) consists of an informal group/network of academic researchers Italians and foreigners working in several areas related to urban and territorial planning. Starting from the first conference, held in Venice in 1999, INPUT has represented an opportunity to reflect on the use of Information and Communication Technologies (ICTs) as key planning support tools. The theme of the eighth conference focuses on one of the most topical debate of urban studies that combines , in a new perspective, researches concerning the relationship between innovation (technological, methodological, of process etc..) and the management of the changes of the city. The Smart City is also currently the most investigated subject by TeMA that with this number is intended to provide a broad overview of the research activities currently in place in Italy and a number of European countries. Naples, with its tradition of studies in this particular research field, represents the best place to review progress on what is being done and try to identify some structural elements of a planning approach.

Furthermore the conference has represented the ideal space of mind comparison and ideas exchanging about a number of topics like: planning support systems, models to geo-design, qualitative cognitive models and formal ontologies, smart mobility and urban transport, Visualization and spatial perception in urban planning innovative processes for urban regeneration, smart city and smart citizen, the Smart Energy Master project, urban entropy and evaluation in urban planning, etc..

The conference INPUT Naples 2014 were sent 84 papers, through a computerized procedure using the website www.input2014.it . The papers were subjected to a series of monitoring and control operations. The first fundamental phase saw the submission of the papers to reviewers. To enable a blind procedure the papers have been checked in advance, in order to eliminate any reference to the authors. The review was carried out on a form set up by the local scientific committee. The review forms received were sent to the authors who have adapted the papers, in a more or less extensive way, on the base of the received comments. At this point (third stage), the new version of the paper was subjected to control for to standardize the content to the layout required for the publication within TeMA. In parallel, the Local Scientific Committee, along with the Editorial Board of the magazine, has provided to the technical operation on the site TeMA (insertion of data for the indexing and insertion of pdf version of the papers). In the light of the time's shortness and of the high number of contributions the Local Scientific Committee decided to publish the papers by applying some simplifies compared with the normal procedures used by TeMA. Specifically:

- Each paper was equipped with cover, TeMA Editorial Advisory Board, INPUT Scientific Committee, introductory page of INPUT 2014 and summary;
- Summary and sorting of the papers are in alphabetical order, based on the surname of the first author;
- Each paper is indexed with own DOI codex which can be found in the electronic version on TeMA website (www.tema.unina.it). The codex is not present on the pdf version of the papers.

SMART CITY

PLANNING FOR ENERGY, TRANSPORTATION AND SUSTAINABILITY OF THE URBAN SYSTEM

Special Issue, June 2014

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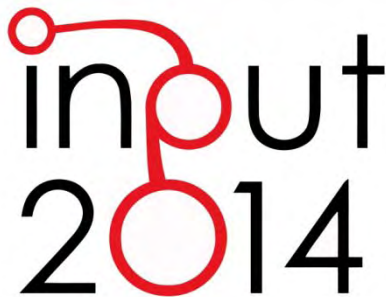
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SPECIAL ISSUE

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ASSESSMENT ON THE EXPANSION OF BASIC SANITATION INFRASTRUCTURE IN THE METROPOLITAN AREA OF BELO HORIZONTE - 2000/2010

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ABSTRACT

The Metropolitan Area of Belo Horizonte is consisted of 34 municipalities, however approximately 79,68% of its population is concentrated at the conurbation zone with 19 municipalities. This zone presented different expansion axis (North, South, West) throughout the time. This article intends to assess the investments made in basic sanitation infrastructure (access to water supply, sewage collection network and garbage collection service) within the period from the years 2000 to 2010. For this purpose, land cover maps for these years were created to identify the new urban expansion axis. Maps of the census sectors of both years were also made with the percentage of households attended by the basic sanitation services infrastructure, as well as the population density and average income of the householder. Considering the results, we have observed that the investments in basic sanitation infrastructure in the last ten years were not sufficient, given the fact that the region with the largest population of Minas Gerais still has precarious conditions regarding the access to water supply and sewage networks. The least of the problems, but still a problem, is the garbage collection services, given the fact that to collect, the investment is low but it is important to highlight that the data do not bring information about the treatment and disposal of the garbage or sewage, they only inform us were those types of residue are collected.

KEYWORDS

Basic sanitation, Metropolitan Area of Belo Horizonte, GIS, Population, public investment

2 OBJECTIVES

Identify the priority investment areas of basic infrastructure in the conurbation area of the RMBH, MG, Brazil.

3 METHODS

3.1 TEMPORAL STATIC ANALYSIS OF LAND USE AND OCCUPATION

For the land use analysis of the study area, LANDSAT imagery, with a resolution of 30 meters, and a WGS84 – Zone 23, UTM coordinate system, was acquired from the University of Maryland website, where the data from the 2000 period is available, and from the United States Geological Survey (USGS) the scenes of 2013. The images selected are in geotiff format and orthorectified.

Using Arcgis 10, a 432RGB of selected bands for the year 2000 scene and 543 RGB composition for the 2013 scene were made, however all the compositions refer to the wavelength within the interval between 0,5 and 0,9 micrometres, corresponding to the visible spectrum (green and red) and near infra-red (NIR).

The LANDSAT scene involves a area larger than the study area, in this sense, it was extracted only the area of interest using a mask with the same dimensions of the study area.

From this point forward, began the supervised classification process with Arcgis 10. To do such classification was created a polygon shapefile with samples of land use; the samples were manually selected for the following classes: Water, bare soil, dense vegetation, underbrush, urban/altered.

The applied method was the Maximum Likelihood Classification, from which the software searches for pixels of similar spectral behavior from previously selected samples, classifying them accordingly (Picture 10). The accepted similarity threshold selected was of 0.9, on a scale from 0 (zero) to 1(one).

Once the land use classification process was finished, the raster format was converted to polygons, which allowed the calculation of the area of each type of land use for each year.

3.2 RECOGNITION OF THE STUDY AREA

The following analysis and maps presented refer to a comparative analysis of the region based on data from the 200 and 2010 Census of IBGE. The data are on a 1:50000 scale, in census sector format. The analysis addresses variables like basic sanitation infrastructure (water, sewage and garbage collection), income and demographic density.

We calculated also the relative population growth index for the period from 2000 to 2010, expressed by the following equation:

$$((Nf-Ni)/Ni)/time)$$

Equation 1: Relative population growth index

The data was grouped into five classes with the same interval to enable the comparison. The option to express the basic infrastructure data as a percentage was made because we believe that in this format the comparative analysis can be more accurate. It is noticeable that in the 2010 data some sectors do not have information, this is due to lack of data provided by the IBGE.

4. LAND COVER ANALYSIS – 2000 TO 2013

In the years before 2000, the study area was characterized by a dense urban spot, concentrated in Belo Horizonte, presenting a growth tendency to West (Contagem and Betim). It presented also bare soil

distribution surrounding the urban area, showing new areas of interest for allotments intensifying the periphery and growth processes of Belo Horizonte tending to the North vector, which demonstrated also the high interest and investments of the real estate sector on the area.

In the year 2000, it is noticeable that the urban spot occupied practically the entire bare soil areal, remaining in this period around 42,55 Km² that corresponded to new areas of this typology (Picture 2). It is possible to observe also that the percentage of underbrush decreased, which demonstrates the pattern of occupation in the different typologies, where the urban occupies the bare soil at first and then the underbrush areas.

In Nova Lima it is easy to identify the urban spot growth in detriment to the underbrush. This phenomena refers to the one previously cited, characterized by the appreciation of the South axis and the peripherization process that led to some investments by the Government in the North axis, seen in Vespasiano, Ribeirão das Neves and Santa Luzia.

CLASS	AREA (2000)	AREA (2013)
Water	12.604	6.372
Bare soil	42.550	46.662
Urban	495.565	547.094
Underbrush	648.370	608.342
Dense Veg.	517.298	507.917
Total	1.716.389	1.716.389

Tab. 1 Comparison between areas (Km²) occupied by different land use types

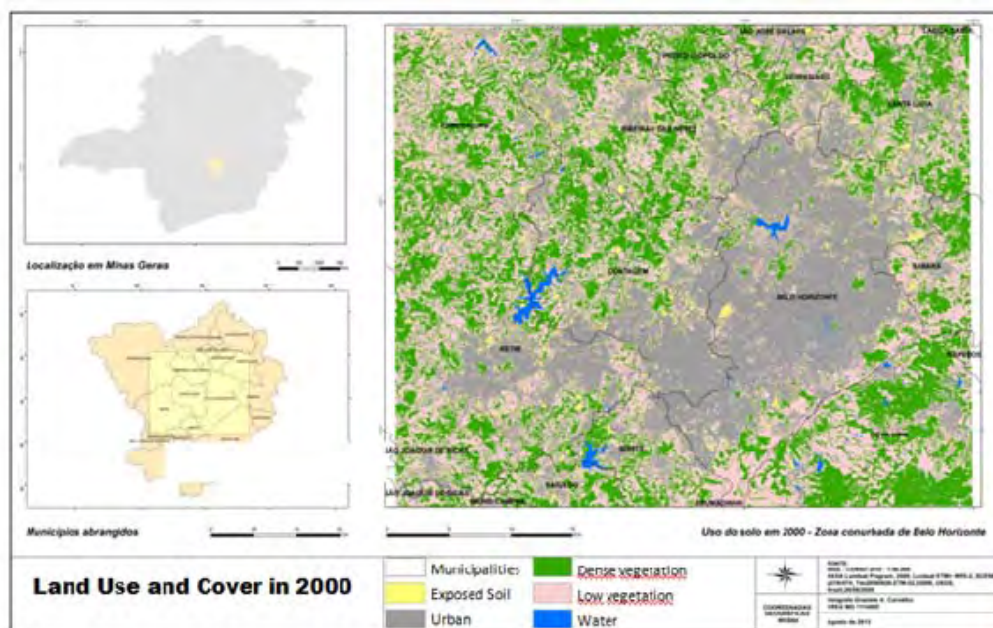


Fig. 2 Land Use and Cover in 2000 – Conurbation Area of Belo Horizonte

The analysis of the land use coverage of 2013 (Picture 3) shows clearly the build-up of sediment on the West branch of the Pampulha Lake and at Petrobrás Lake, between Ibirité and Sarzedo, completely filled by sediments in 2013, validating the data presented at Table 1, demonstrating the reduction of 6 km² in the area occupied by water. This is due to the sedimentation processes of other watercourses, or to the fact that some were covered by roads. Besides, we can observe that the urban spot grew around 50 km²; the

underbrush lost 40 km², and dense vegetation, for the first time lost its remaining 10 km². Moreover, the bare soil growth of 6km² refers also to the area exposed by the loss of watercourses.

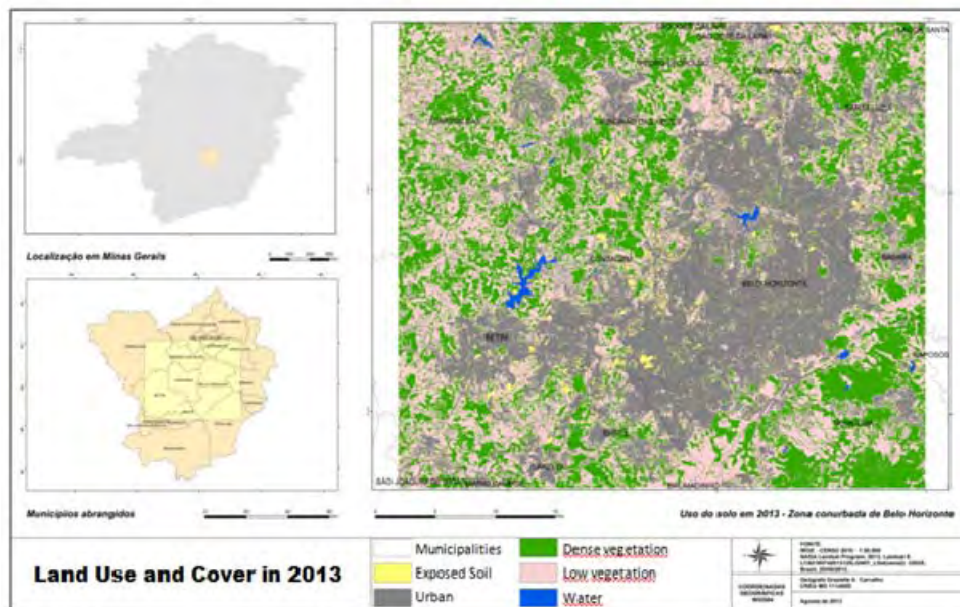


Fig. 3 Land Use and Cover in 2013 – Conurbation Area of Belo Horizonte

The map of land use and cover of 2013 also shows a larger concentration at the border between Nova Lima and Brumadinho, South Axis of Belo Horizonte, the proximity to the historical centre of Sabará (East of BH), and along the municipalities of the North axis: Vespasiano, Santa Luzia and Ribeirão das Naves. In Santa Luzia’s case, it can be explained by the implantation of the Cidade Administrativa (Administrative Centre of the State), that led to an increase of interest on the region by the real estate sector, implementing numerous urban projects, including the Federal Government housing program “Minha Casa, Minha Vida”.

5. POPULATION DENSITY AND INCOME

The analysis of the population density and income spatializes itself differently. We opted to analyse all the municipalities inserted completely or partially to avoid errors related to border effects that could occur when considering only part of a sector that was within the involving rectangle, but when selected, could bring the data of the entire sector.

Therefore, the study here relates to 19 municipalities, all of which touched by the involving rectangle that outlines the study area, with a total population of 4.615.888 inhabitants¹.

It was observed that the population growth in the years from 2000 to 2010 was generally low. Overall the average of residents per household (Picture 4) decreased in the last decade, even in municipalities previously considered as peripheric, that is the case of Lagoa Santa (East portion, from 4 - 6 to 2 - 3), Santa Luzia (South East portion, from 4 - 6 to 3 - 4) and Ribeirão das Neves (from 4 - 6 to 3 - 4).

¹ Bearing in mind that the population of the study area is 4.314.967 inhabitants, which leads to an increase of 300.921 inhabitants when considering the analysis of the municipalities and not only the census sectors that touch the involving rectangle. It is equivalent to an increase of 6,51% of the analysed population.

In Nova Lima, at its West portion, the residents' average has increased, that verified also on the east portion of Brumadinho, on its border with Nova Lima, as a reflex of the valorisation of Belo Horizonte's South axis. In Belo Horizonte, it is observed that the last decade cemented the movement of expulsion of residents from the central areas, and its peripherized area decreased the average from 4 – 6 to 2 – 3 residents. In general, the average of residents for the neighbouring municipalities of Belo Horizonte, previously considered periphery, decreased. Fact that makes us assume that the periphery is further from the capital, that the population has been led to live further away from the cultural, economic and service centre of Minas Gerais, due to the valuing of land property in this area.

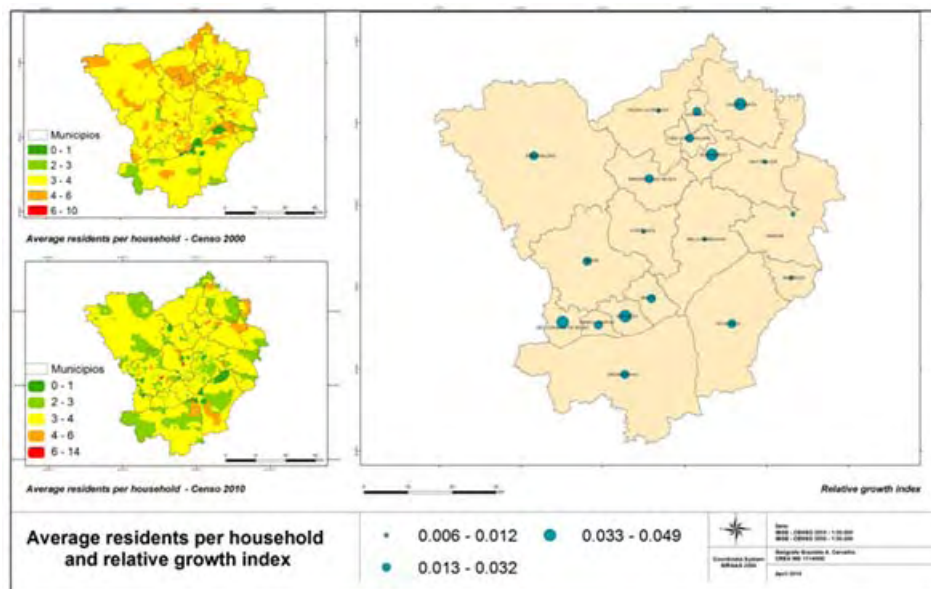


Fig. 4 Average residents per household and relative growth index

Regarding the monthly average income of householders per residence (Picture 5) it is noticeable a larger income distribution, yet not the ideal.

Except in Belo Horizonte, in the year 2000 it is observed that the predominant income of householders was under R\$800.00 (eight hundred reais) in all the municipalities. In the year 2010, we can still notice a significant occurrence of this class, but can also notice a larger distribution of the class corresponding to the income between R\$800.00 and R\$2000.00 (eight hundred to two Thousand reais).

On the other hand, the larger incomes occur in Belo Horizonte, as expected, but is important to also highlight Nova Lima, with incomes varying between R\$6000.00 (six Thousand reais) to R\$51000.00 (fifty one Thousand reais). These values also occur in Belo Horizonte, especially concentrated around the Pampulha Lake and South-Central region, which have the capital's most economically valued neighbourhoods.

In broad sense, we can verify that the regions with the lowest income are the ones that present the largest average of residents, and the ones with higher incomes, the lowest number of residents. This could be explained by the fact that living in those areas has become more expensive, with a heated real estate market, rental prices are expensive and apartments appraised overprice for sale. Therefore, to live alone in areas nearer the capital's centre is necessary to have a good monthly income, as well as in Nova Lima.

We have noticed here a very superficial income distribution, especially if compared that in the year 2000 the highest average income was of R\$10196.00, and in the year 2012 it is above R\$51000.00. However, the

areas where those values occur are the same in both years, meaning that the richest people in Belo Horizonte became even richer, about 400%, while the less favoured class, in the best scenario had an increase of 150%, where others have not had any change.

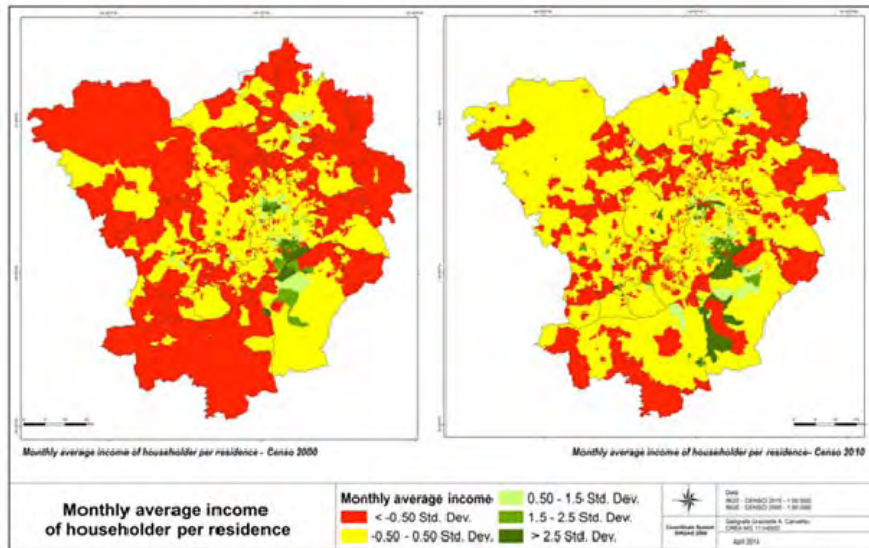
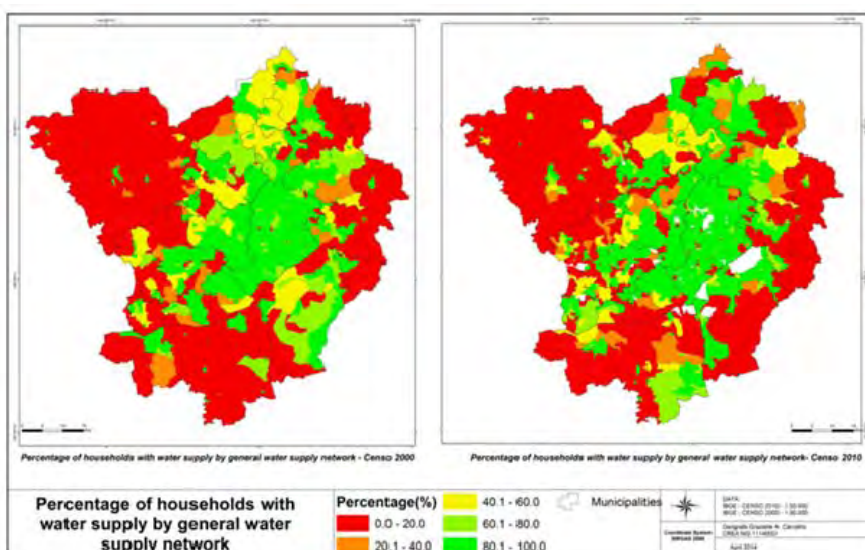


Fig. 5 Monthly average income of householder per residence

6. BASIC INFRASTRUCTURE: ACCESS TO WATER, SEWAGE AND GARBAGE COLLECTION

When analysing the percentage of households with water supply by general network (Picture 6) we observed that Belo Horizonte, except in some villages and favelas, is completely covered by the water supply service. However, the same situation does not occur on the neighbour municipalities.



Picture 6: Percentage of households with water supply by general water supply network

On this map, we can observe three scenarios: improvement on service provision, worsening on service provision or no change.

The unaltered spot can be understood as: there was no increase on the demand for the service and because of that, no investments; or there was a demand for the service but the investments made were enough to maintain the percentage of the attended population the same as in the year 2000.

Improvements are noticed in the municipalities of São Joaquim de Bicas, Southeast portion of Brumadinho, west and north portions of Nova Lima, central portion of Lagoa Santa, the entire municipality of Confins, the central portion of Esmeraldas, border with the West portion of Ribeirão das Neves, in which improved also the percentage of attended population. These areas correspond to those where investments were made to increase the access of population to the general water supply network.

Worsening are noticed in the Southeast portion of Nova Lima, where its population contingency increased in the last decade, but the service did not accompany this growth, as well as the east portion of Sarzedo and South of Pedro Leopoldo, centre of Contagem and south portion of Betim. The ones that maintained the same percentages of attended population in the year 2000 were Sabará, Raposos, São José da Lapa, Esmeraldas (except its centre) and Vespasiano.

The municipalities that have most of their population without access to water supply network, that is the case of Esmeraldas, this service is provided through wells or spring water (Picture 7). This scenario is verified also at the south of Nova Lima and central area of Brumadinho, due to these areas having a resident average close to 1 or 2. In this sense, Esmeraldas' situation is more serious, as well as the South portion of Sarzedo, since the average residents in those places are of 3 - 4.

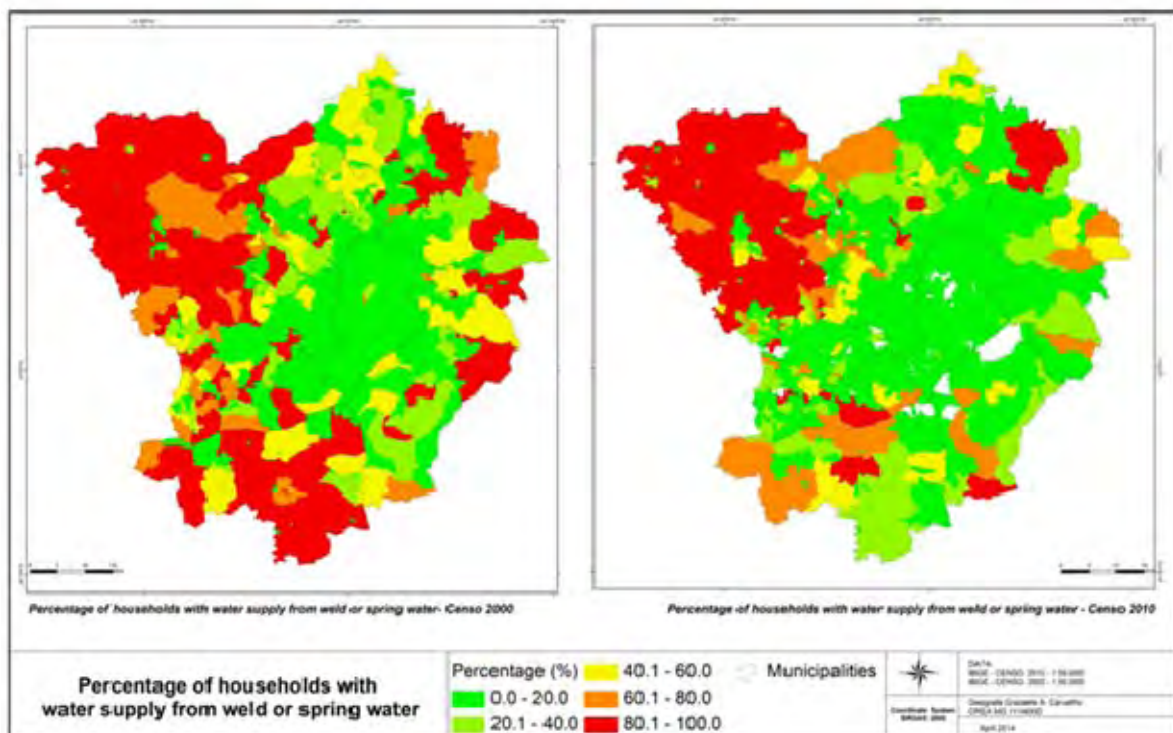


Fig. 7 Percentage of households with water supply from well or spring water

When analysing the scenario presented by the percentage of households with bathroom and sewage collection by general sewage or pluvial network collection, we are assessing the percentage of households that have sewage collection and not necessarily if this residue is treated or not. Since the data provided does

not discriminate which ones go to the general sewage collection network or to the pluvial collection network. Anyway, it is a chaotic scenario. Different from the water supply, the sewage collection is restricted to Belo Horizonte. What we observe both in year the 2000 and 2010 is a big red stain, informing us that about 80 – 100% of the population in those areas does not have access to this service (Picture 8). Being that, the scenario for the other municipalities are of sewage collection by improvised tanks (Picture 9) and sewage collection by septic tanks (Picture 10).

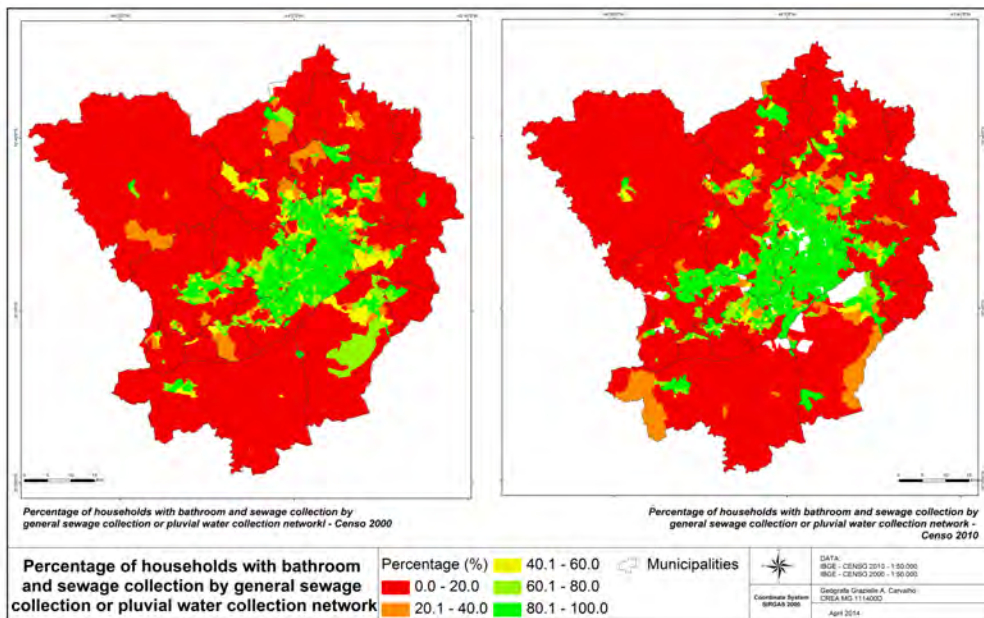


Fig. 8 Percentage of households with bathroom and sewage collection by general sewage collection or pluvial water collection network

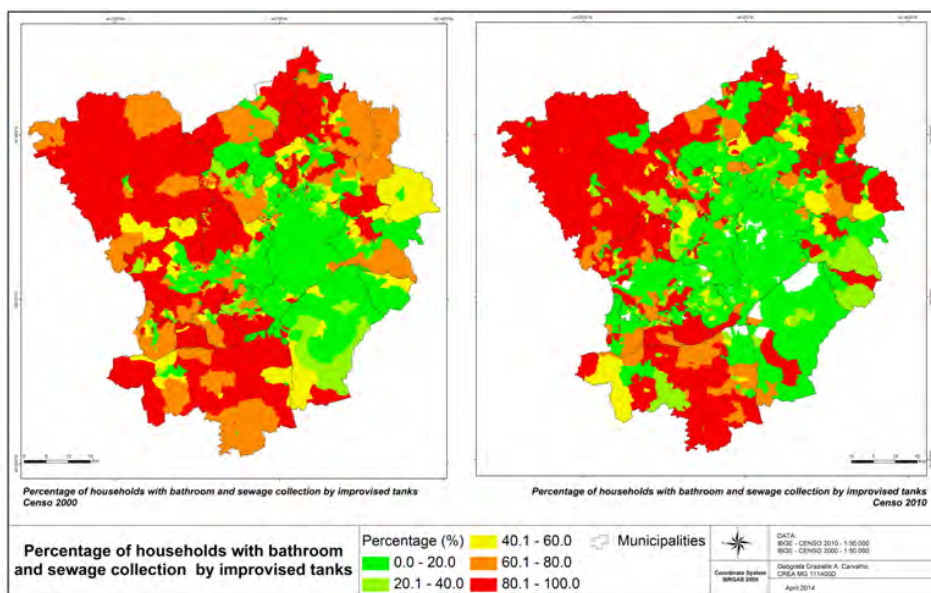


Fig. 9 Percentage of households with bathroom and sewage collection by improvised tanks

For the improvised tank, we have noticed a significant increase on the Nova Lima region that also presents the largest resident average (4 - 6); access to water is predominantly by well or spring water and have the lowest income. We can highlight the area as one that needs more attention from the Nova Lima government.

Sabará presented an improvement on the percentage of the population depending on improvised tanks on its South portion (less populated) and worsening on the north portion (more populated, Ravena district). This worsening is also verified in Betim (South portion), Raposos and Santa Luzia (north portion). Contagem (at its North portion), Ribeirão das Neves, São José da Lapa, Vespasiano and Lagoa Santa's centre presented a decrease on the percentage of population depending on improvised tanks. This happened because of more investments on septic tanks, which improves the environmental condition but not recommended as best alternative for treating sewage residue. It is noticeable that the areas that presented a decrease on the sewage collection by improvised tank are the ones that now appear as septic tank: Contagem, Ribeirão das Neves, São José da Lapa, Vespasiano e o centro de Lagoa Santa. This also occurred in Nova Lima, which on its case refers to the real estate developments that moved to the municipality supported by an environmental speech and for such, would be contradicting to install improvised tanks, which are highly polluting.

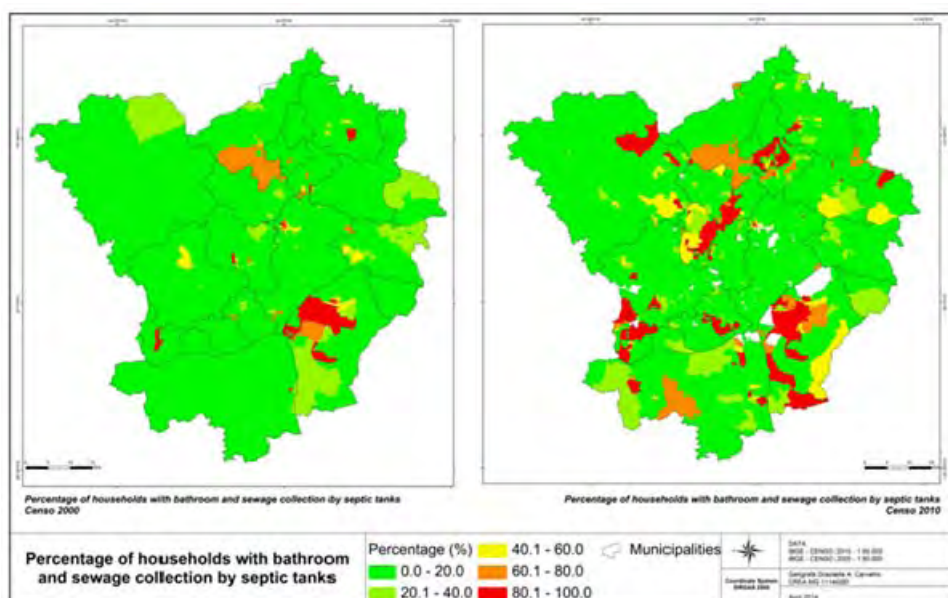


Fig. 10 Percentage of households with bathroom and sewage collection by septic tanks

Regarding the urban cleaning services (Picture 11), we can observe a much more positive scenario, with substantial improvements in the North axis municipalities (Vespasiano, São José da Lapa, Confins, Ribeirão das Neves, Lagoa Santa – West portion, e Santa Luzia – Southeast portion) as well as in the South axis municipalities (Nova Lima, Brumadinho, Sarzedo e Mario Campos).

Santa Luzia and Sabará located east from Belo Horizonte, presented improvements regarding the service provision in garbage collection as well, although they present large areas still unattended. On the West side of Belo Horizonte, the worst scenario is in Esmeraldas, although its centre presented improvements on the service as well as the northeast portion of the municipality.

It is seen that the garbage collection by container (Picture 12) is not very used, which leaves very unsustainable options to try and understand what is done to the garbage that is not collected by public service or container, leaving the following options of throwing in abandoned lots, burned, buried or dumped in the rivers. Anyway, if the garbage is not collected it does not receive the proper treatment needed to avoid environmental problems such as soil, water and other types of contamination.

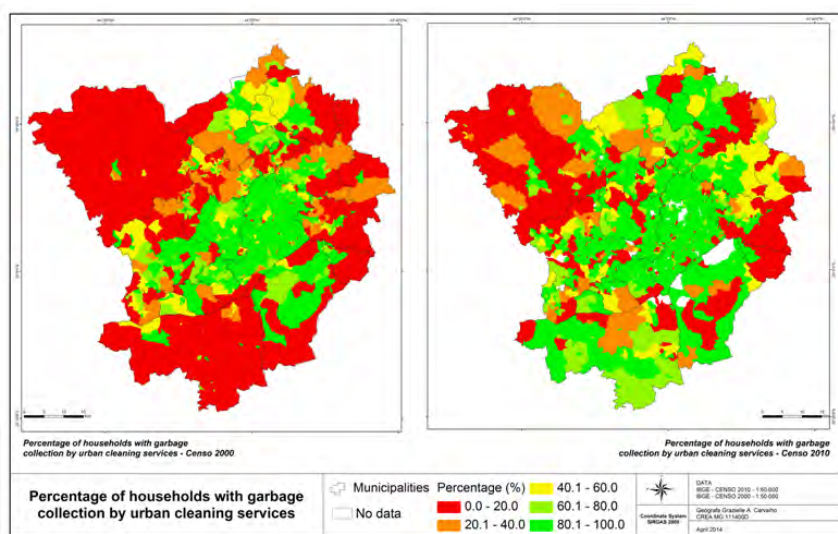


Fig. 11 Percentage of households with garbage collection by urban cleaning services

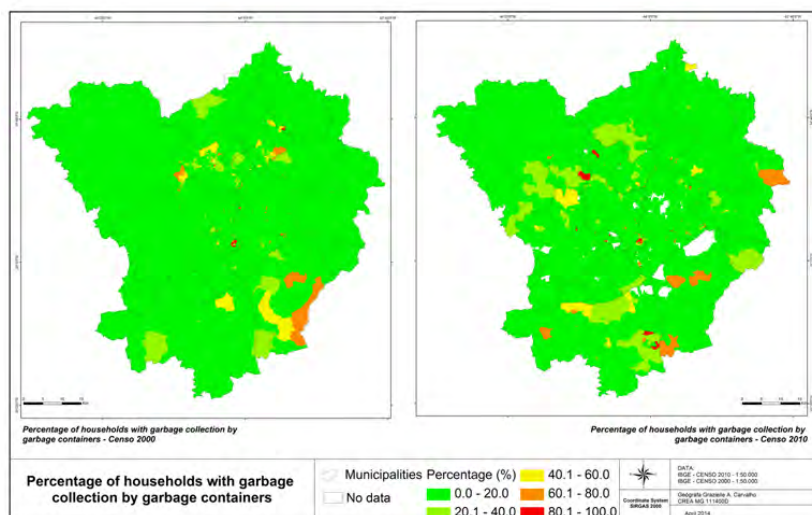


Fig. 12 Percentage of households with garbage collection by garbage containers

7 FINAL CONSIDERATIONS

Facing the presented scenarios, we have observed that the investments made in basic sanitation infrastructure in the last 10 years were insufficient. The area with the largest population contingency of Minas Gerais is still in precarious conditions regarding the access to water supply network and even more sewage network.

There is a high correlation between income and investments made on infrastructure, where places that present population with a higher income average are the ones with the higher percentage of households with installed infrastructure. It is noticeable that the population with lower income, located on the periphery or at the new growth axis of the urban fabric, still present the lowest indexes of access to basic sanitation services.

It is noteworthy that Belo Horizonte is characterized as a monopolizing centre of investments on sanitation infrastructure, which can be explained because of the larger population contingency and being one of the richest municipalities in Minas Gerais. However, its neighbours do not count on the same amount of investments. Although Belo Horizonte is responsible for about 45% of the RMBH's population, the remaining

residents are living in precarious conditions of basic sanitation or not having access to the services. We can observe the segregation pattern of the capital reflecting on the RMBH.

Another limitation we had on the analysis of the data was the way they were presented, once we have the information about the garbage and sewage collection, but not the information regarding the final destination of those residues, if they are treated or not.

If at the RMBH we have scenarios of a large population percentage that does not even have access to the service of garbage collection and sewage, we can imply that regarding the disposal of these residues the situation is even worse.

This article comes to demonstrate that even with a simple method of map overlaying is possible to identify priority areas for investments. These areas, in the RMBH's case, are located along the middle and lower class population and it makes necessary ensuring the rights regulated by the Brazilian Civil Constitution of 1988, which guarantees access to the services of basic sanitation infrastructure, but is being neglected by the Government's administrations of those municipalities.

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IMAGES SOURCES

All images are from the author.

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