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Article

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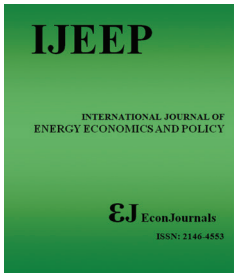

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Typifying the Demand for Rural Electrification: An Empirical Analysis for the Mesoregions of Minas Gerais State, Brazil

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ABSTRACT

The study proposed to analyze the different types of rural electrification demand existing in the state of Minas Gerais, Brazil, considering the period between the years 2000 and 2010. The work is based on the aegis of the theory proposed by Ranganathan (1993), in which are highlighted four possible roles that the electrification exercises in the life of its applicants. The multivariate analysis of cluster was applied, in order to divide the municipalities of Minas Gerais in terms of selected characteristics, focusing on socioeconomic issues. Among the main findings, we highlight the great heterogeneity of Minas Gerais municipalities regarding the socioeconomic characteristics analyzed, confirming the multiple faces of the possible benefits of electrification on the life of rural population. In addition, this great diversity could lead to the elaboration of local development policies, considering the provision of electricity and regional specificities.

Keywords: Rural Electrification, Cluster Analysis, Rural Development
JEL Classifications: H41, H53, I38, O13, O18

1. INTRODUCTION

The access and use of electric energy are seen as essential to everyday life, either because of their impact on the quality of life or because of its economic influence. However, instead of what many may think, electric energy is not yet accessible to a significant number of people located in various regions around the globe, with particular emphasis on rural communities in underdeveloped and developing countries. In this sense, rural electrification policies are included in social-political agenda of most of these countries. By providing access to electricity for isolated rural communities, governments in developing countries aim to improve the economic situation and living standards for the rural population and thereby reduce the disparity between rural and urban (Niez, 2010).

For the Brazilian case, the privatization process of state-owned enterprises of the electricity sector, started in the 1990s, can be seen as a preponderant factor for increasing the inequality of access to electricity supply between urban and rural areas. Based on an economic point of view, rural electrification is not attractive to concessionaires due to the high costs incurred to attend a general population of low income (Souza and Dos, 2007), which presents low energetic demand and is geographically dispersed. Left to free initiative, distributors would certainly restrict the offer of the service to the urban centers, aiming the economic returns to the activity. In this way, it is plausible to affirm that the presence of the State as a subsidy provider and manager of rural electrification programs facilitates the feasibility of electricity provision for rural and/or isolated areas.

Historically, several rural electrification projects were implemented in Brazil. Initially, these projects were implemented as regional initiatives that later evolved into national policies. However, by the end of the 1990s, these initiatives had not yielded satisfactory results. In this context, Decree 4,873 of November 11, 2003, created the National Program for Universalization of Access and Use of Electricity - “Luz para Todos” (PLT). This program, whose main objective is based on extinguishing the electric exclusion in rural areas, initially promised to provide access to electricity to about 10 million people by the year 2008. However, during the course of the program, data showed a high number of isolated households in rural areas without access to

electricity. The program was extended several times, increasing its coverage goals. Currently, the stipulated duration is up to 2018. Information available on the program's website shows that as of November 2016, 3,323,683 families, about 15.9 million people, were benefited by the actions of PLT.

The dichotomous ethos of electrification in rural and urban Brazilian zones, previously stressed, is also evidenced for the state of Minas Gerais. From the data shown in Table 1 it becomes clear that, in terms of access to electric energy, the urban zone has always been at the forefront of the countryside at Minas Gerais state. However, it is possible to notice that the difference between the areas has been mitigated, whereas the proportion of rural electrified households has increased since 2003.

According to IBGE, the Minas Gerais state is composed of 853 municipalities, divided in 12 mesoregions, distributed in 586.521,235 km² of territorial extension. Similarly to the Brazilian situation, the percentages of rural households registered for the years of 2000 and 2010 were, nearly to 16.7% and 14%, respectively. It is worth highlighting the strong socioeconomic heterogeneity observed among the mesoregions of this state, which, consequently, directly affects the demand for rural electrification perceived between them. Given this, we believe that the results obtained for Minas Gerais could serve as a proxy for the Brazilian case.

It should be made clear that this research does not seek to measure the impact that electrification of rural households can bring to the lives of the population attended by this service. On the other hand, we sought to investigate the nature of the demand for rural electrification in the Minas Gerais state. Considering certain characteristics that, in theory, could connect the access to electricity and the development of rural population, we tried to define homogenous groups of municipalities, highlighting the possible roles that electrification could have for each of these groups.

For years, rural electrification has been present on the international research agenda. Focusing on developing countries, authors analyze different cases in Vietnam (Khandker et al., 2013), South Africa (Davis, 1998), Bangladesh (Rahman et al., 2013), Kenya (Kembo, 2014) and India (Bhattacharyya, 2006; Kamalapur and Udaykumar, 2011). In the Brazilian case, studies are mainly related to the effects of the process of rural electrification on the beneficiary population (Pereira, 2011; Oliveira, 2001; Souza and Dos, 2007; Echeverry, 2014; Marinho, 2009). However, there are no reports of studies that have analyzed the roles of the rural electrification demand, as sought by the present study.

Table 1: Evolution of access to electric lighting in private households in Minas Gerais (thousands)

Years	Urban		Rural	
	Electrified	Non-electrified	Electrified	Non-electrified
2001	99.30	0.70	85.15	14.85
2002	99.51	0.49	84.79	15.21
2003	99.63	0.37	86.58	13.42
2004	99.55	0.45	88.24	11.76
2005	99.73	0.27	88.90	11.10
2006	99.69	0.31	91.90	8.10
2007	99.88	0.12	95.10	4.90
2008	99.90	0.10	96.66	3.34
2009	99.85	0.15	95.87	4.13
2011	99.91	0.09	98.97	1.03
2012	99.96	0.04	99.11	0.89
2013	99.93	0.07	99.14	0.86
2014	99.98	0.02	99.15	0.85
2015	99.98	0.02	99.16	0.84

Source: PNAD/IBGE. Values in percentage

The importance of studying rural electrification demand features lies in the possibility of the elaboration of a panorama capable of counteracting the effective evolution of this process with characteristic socioeconomic factors of the different benefited geographic regions. In this way, a primary evaluation of the evolution of the electrification is possible regarding determinants of the demand for this service.

2. THEORETICAL FRAMEWORK

2.1. Access to Electricity and its Potential Benefits

Pereira (2011) is categorical in emphasizing that energy is indispensable for human survival, and its full supply to all citizens is necessary for the assurance of the social welfare and economic development of a country. However, even though the use of rural electrification as a rural development strategy is evident, identifying its real contribution to the life improvement of a benefited population by its access becomes a difficult task, especially in developing countries that face a range of social and economic constraints.

Besides the fact that access to electricity in rural areas does not have the power to immediately change the poverty situation of rural areas, Ribeiro and Santos (1994) propose that there are notable impacts of this access in the rural way of life. They analyzed beneficiaries of the Proluz program, implemented in Rio Grande do Sul state, Brazil, from 1990 to 1992. Among different aspects presented by the authors, it could be highlighted the positive impacts on quality of life, productivity and employment among the rural population.

The positive impacts of electrification on rural population's life quality are derived from the use of household appliances that facilitate housework, the improvement of health and education, and the access of information and entertainment through television. Concerning impacts on productivity, one could stress the issue of agricultural irrigation. Lastly, the possible impacts on employment are also highlighted, especially with regard to the maintenance of employment in the countryside and the consequent minimization of rural exodus (Ribeiro and Santos, 1994).

Furthermore, World Bank (2008) also cited possible health-related improvements for the rural population due to decrease of the pollution caused by the use of polluting fuels for food cooking and light generation, enhance of access to knowledge by media, and improvements in family nutrition due to this knowledge and the use of household appliances for food preservation. Still according to the World Bank (2008), it is observed the existence

of a relation between access of electric energy and progress of the study conditions, since the schools can acquire equipment that improves its infrastructure and the time of study at home can be lengthened.

Faced with so many potential socioeconomic improvements resulted from access to electricity, one could consider rural electrification as a positive externality capable of boosting communities development through the families benefited by this access. Still about its possible effects, it is important to emphasize that they go beyond the borders of the beneficiary rural communities, and can be used as an impulse to the economy - not only local - as a whole. For this purpose, there is a need for a set of policies and other governmental or social actions capable of taking advantage of potential socio-economic development generated by electrification (Oliveira, 2001).

2.2. The Demand for Electricity and Rural Electrification Roles

The demand for rural electrification could arise from different necessities regarding security, financial, particular/familiar, social or work-related issues. In the view of Ranganathan (1993), the different roles that electrification plays in its applicant's life can influence this demand. Electricity can then be classified as a commodity, an input, an infrastructure or as a basic need good. In this sense, the present topic is formulated based in theoretical constructions of the aforementioned author.

Based on the assumption of rural electrification as a commodity, the author extols the need of a high per capita income at the places interested in the realization of this process. Given this, rural areas with low income should wait until a future development arising from other public programs, which will enable them to have a sufficient income increase for the financing of rural electrification. This could be seen in locations where rural electrification is considered as a final consumption good, been predominantly used in routine household chores, with low use for production purpose.

In case of its role as a production input, instead of the dependence of a high income level for its use, rural electrification is perceived as an income-generating characteristic capable of greatly exceeding its own costs by enabling the introduction of necessary equipment for the improvement of local production. In this sense, electric energy could be understood as an input capable of improving the results of productive enterprises already established in rural areas.

Based on Hirschman (1958), pioneer in the ideology that investments in social capital (such as roads and electricity) would induce investments in productive activities, potentially reducing the production costs, Ranganathan exposes the role of rural electrification as an infrastructure. From this perspective, the establishment of rural electrification could create the necessary bases for the direct investment in productive activities. In addition, secondary benefits could arise, such as increasing the security of rural communities by providing street lighting.

Finally, the role of rural electrification as a basic need good is observed in poor regions, due to the fact that electricity - just like drinking water and health care - is commonly considered as an elementary service to the population. In the case of governments of countries with the lowest rates of development, the provision of this service to rural communities is considered an obligation and is generally financed by budgetary resources or by the institution of cross-subsidies by the concessionaire to other consumers.

We believe that it is possible to identify, through regional socio-economic studies, the needs of each population with regard to rural electrification and which of these roles would be exercised in each of the different regions benefited by this access. Therefore, specific socioeconomic characteristics could guide different approaches in government-led rural electrification programs for different regional levels. For example, considering its national scope, the PLT faces a wide range of geographical regions with the most different socioeconomic levels.

3. METHODS

Seeking the empirical identification of rural electrification demand types for the municipalities of Minas Gerais state, Brazil, we conducted this investigation through a quantitative approach. We applied multivariate analysis to data of the years 2000 and 2010, working with rural households of the Minas Gerais municipalities. Considering the differences between the municipalities of our sample and possible similarities relating to aspects that according to literature could be changed with the access to electricity by rural households, we opted for a cluster analysis. For the composition of the clusters, we selected variables related to socioeconomic aspects, referring to the rural population's way of life that can undergo positive modifications from the access to electric energy by households that did not previously have it, together with data related to the access of this service in the rural area for the year surveyed. These variables are shown in Table 2, accompanied by their respective descriptions and theoretical contribution.

We built the clusters with the Ward method. This hierarchical method uses the Squared Euclidean Distance and tends to generate clusters with great internal homogeneity. After building the clusters, we applied the Kruskal-Wallis non-parametric test, aiming to analyze the variables whose distribution does not meet the assumption of normality. From random samples of the defined clusters, we wanted to test the hypothesis of the existence of a common location parameter. Given the validation of the formed clusters, we used descriptive and visual statistics tools - together with the theory underlying the study - for the interpretation of the results and their characterization. Groups were appointed based on this interpretation. Thus, selected variables were taken as reference for the validation of the clusters, based on comparative descriptive analysis, which, as highlighted by Santos and Ferreira (2008), is commonly used in applied social sciences.

4. RESULTS AND DISCUSSION

Initially, we intended to analyze rural households in all municipalities of Minas Gerais. However, due to the presence of municipalities considered as outliers, we reduced our sample to rural households of 562 Minas Gerais municipalities. Criteria for

Table 2: Variables used in the composition of clusters

Variable	Description	Theoretical contribution
Households headed by women	Percentage of rural households headed by women, a proxy for the estimation of female labor in rural areas	In electrified households, it is possible for women to increase their workload due to the fact that they can carry out household activities during the night and engage in other activities during the day (World Bank, 2008)
Literacy level	Percentage of literate rural population per municipality	It is observed the existence of the relationship between access to electricity and improvement of study conditions, since schools can acquire equipment that improves their infrastructure and the time of study at home can be lengthened (World Bank, 2008)
Refrigerator Television	Percentage of rural households that owned these consumer goods	These goods ensure the inclusion of the rural dweller through contact with life beyond the countryside, providing access to technological comfort and improving health through the conservation of perishable foods (Camargo et al., 2008)
Rural employment	Percentage of rural population engaged in paid and/or productive activity	Access to electricity can be considered as a factor of production, economic development, and generation of employment and income (Sauer et al., 2003)
Agricultural GDP	Percentage of municipal GDP related to agricultural production	Cruz et al. (2004), says that the access to electric power would subserve the introduction of irrigation and drainage of flooded areas, as well as the possibility of conservation of products such as milk, fruits and vegetables. In addition, producers could add greater value to production from the initial processing of their products
Labor productivity	Ratio between agricultural GDP and number of employed people in rural areas	
Street lighting	Percentage of rural households whose surroundings had electric lighting	The lack of public lighting (according to reports from rural dwellers) can lead to acts of violence (mainly to girls), hindering the movement of people during the night (Trigoso, 2004)
Rural electrification	Percentage of electrified households (2000)	We decided to introduce this variable in the cluster analysis in order to homogenize the clusters formed

Source: Made by the authors, GDP: Gross domestic product

the exclusion of 291 outliers were considered for the statistical analysis:

- Fully urbanized municipalities that, in 7 of the 8 variables collected for the elaboration of the analyzed constructs, presented zero value (5 municipalities);
- Municipalities with more than 95% of rural households with access to electricity in 2000 (281 municipalities);
- Municipalities that presented a negative variation in access to electricity between 2000 and 2010 (5 municipalities).

Even after this filtering, it is still possible to conduct a mesoregional level analysis, because there are still a significant number of municipalities for each of the 12 mesoregions of Minas Gerais. They were divided as follows: 3%, 15%, 9%, 4%, 7%, 4%, 11%, 14%, 4%, 7%, 4%, 18% of the sample. Following a division order in mesoregions based on criteria of IBGE: (1) Campo das Vertentes, (2) Central Mineira, (3) Jequitinhonha, (4) Metropolitana de Belo Horizonte, (5) Noroeste de Minas, (6) Norte de Minas, (7) Oeste de Minas, (8) Sul e Sudoeste de Minas, (9) Triângulo Mineiro e Alto Paranaíba, (10) Vale do Mucuri, (11) Vale do Rio Doce, (12) Zona da Mata.

In this way, an exploratory data analysis was pursued, seeking a better understanding of the relationships between the variables to be analyzed. It was considered, at first, the total set of municipalities analyzed in this study, without distinction by clusters. We hoped, therefore, that these general observations would help in the specific analysis of the data of each grouping of municipalities to be generated by the cluster analysis. We chose to analyze the main descriptive measures of central tendency (mean) and dispersion (minimum, maximum and standard deviation).

At first, from the observation of the data presented in Table 3, we evidenced a large disparity between the descriptive measures analyzed, mainly among those variables measured in percentage. For example, while relatively low values were observed for the percentage of rural households headed by women, one can consider theoretically high values for the percentage of rural employment.

Analyzing the minimum value of each variable, it was observed that, in 2000, there were municipalities where <5% of the rural households were headed by women, with a value close to those who had a refrigerator or television employed. It is also pointed out that there was, in that year, a municipality in which <10% of the rural households were electrified. It should be noted, furthermore, that even working with a sample already filtered by possible outliers, some municipalities presented complete absence of street lighting in rural area. In addition, there was at least one municipality for which the agricultural production had almost none contribution to the total municipal agricultural gross domestic product (GDP). On the other hand, it is worth noting the observance of municipalities with labor productivity of more than 110 thousand reais per worker.

Table 3: Exploratory data analysis, 2000

Variable	Minimum	Maximum	Mean±SD
Households headed by women[1]	0.0308	0.3184	0.1264±0.0501
Literacy level[1]	0.2459	1.0000	0.6632±0.1445
Refrgerator[1]	0.0229	0.9220	0.5134±0.2206
Television[1]	0.0389	0.9461	0.6050±0.2215
Rural employment[1]	0.6364	1.0000	0.9266±0.0587
Agricultural GDP[1]	0.0000	0.7118	0.2385±0.1366
Labor productivity[2]	226.12	114.645.98	10,368.72±14,992.61
Street lighting[1]	0.0000	1.0000	0.2412±0.2064
Rural eletrification[1]	0.0922	0.9498	0.7548±0.1886

Source: Research results. [1]Values in percentage, [2]Values in reais (R$). SD: Standard deviation, GDP: Gross domestic product, SD: Standard deviation

Regarding the maximum values presented by each variable analyzed in this study, we observed municipalities that, as of 2000, had a 100% level of literacy. Some municipalities also had the entire rural population employed, and, in others, all rural area had street lighting. Other variables with expressive high values were the percentage of rural households with refrigerator/television and the percentage of electrified rural households. On the other hand, the maximum percentage of rural households headed by women was only slightly higher than 30%. Other variables, such as literate rural population, presence of refrigerator and presence of television in rural households, were also higher than 50%. That is, on average, in the sampled municipalities, more than half of the rural households had a refrigerator and/or television, and more than half of the rural population was literate. On the other hand, relatively low mean values were presented by the variables related to households headed by women and those with illumination in the surroundings.

Finally, the analysis of the values obtained by the standard deviation can provide a basis for the variability of the results of each variable within the sample of municipalities analyzed. Among the variables with the lowest standard deviations, we highlight those referring to households headed by women and literacy level. While the former is homogeneous at relatively low values, the opposite is valid for the latter. The variables that affect the possession of durable consumer goods and street lighting, in turn, were those that had the highest standard deviations, indicating greater variability among the municipalities of the sample.

In general, we have noticed a great distinction between the variables analyzed in this study regarding the descriptive measures. There were, in 2000, municipalities where no rural household had street lighting nearby, while in other municipalities this street lighting was general. Another great disparity is related to the productivity of the agricultural labor force, given the large amplitude of the sample results, besides the fact that the standard deviation of this variable was higher than the average for the observed one. With this analysis, we evidenced the great diversity and heterogeneity concerning the characteristics analyzed here among the municipalities of Minas Gerais, supporting the use of cluster analysis to achieve the objective of this research.

4.1. Interpretation of Clusters Formed by Cluster Analysis

A priori, we pointed out that the Kruskal-Wallis test showed that the clusters formed had different distributions for all the analyzed variables, statistically validating the segregation of the municipalities. In view of the options presented by the results of the analysis, we chose to divide the studied municipalities into three distinct groups. For the naming of these groups, we verified the average values related to the variables used to form the clusters and one or less one standard deviation.

It is extremely important to note that the variables chosen for the procedure were standardized, mitigating problems related to the different scales of the variables analyzed. Therefore, the variables used in this study were standardized on Z score, where their mean values were presented near 0 (zero) and their standard deviations indicated values close to 1 (one). Thus, from the average generated for the variables analyzed in each cluster, the names were assigned: low (values less than the mean); medium (values between the mean and the mean plus a standard deviation) and high (values greater than the mean plus a standard deviation). Table 4 shows the information about the clusters formed.

It should be noted here that groups 1 and 2 obtained, for the most part, values considered in the average. These two groups are differentiated by the fact that the former presented mean values closer to 1 (mean plus standard deviation), while the latter had mean values closer to 0.

In the Medium-high group, the variable of households headed by women presented a negative mean value, referring the descriptive analysis previously done, where this variable had values (minimum, maximum and average) considered low for all municipalities analyzed. Surprisingly, this same variable did not presented a negative mean value for the Medium-low group. However, the averages of the variables employment of the rural population, agricultural GDP and labor productivity were negative for this cluster, as shown in Table 5. In the third group, named as Low, all variables analyzed presented negative averages, except, as in the second group, the variable households headed by women. It Should the information obtained by analysis of this variable be an indication that, in rural areas (and perhaps not only in this environment), families that tend to have greater socioeconomic stability tend to opt for women, in many cases mothers, to devote themselves to household chores? Such questioning deserves due and appropriate investigation, however, is not within the scope of this research.

As for the amount of electrified households per municipality in 2000, it can be seen that in the group whose mean values for the analyzed variables were concentrated at low levels, there were just over 50% of households with access to electricity. After 10 years, in 2010, about 80% of the energy demand for these municipalities was met. Such demand for the Medium-high and Medium-low groups, which already had a relevant average of electrification, also presented a high attendance of about 86% and 84%, respectively. That is, although the evolution of electrification was perceptibly higher in the municipalities of cluster 1, all three groups reduced the share of households with lack of access in a relatively homogeneous way.

Table 5 presents average values of standardized variables, for each retained cluster. As we previously exposed, the Low cluster

Table 4: Names and composition of the clusters with electrification data for 2000 and 2010

Cluster	Name	Municipalities	Average electrification percentage in 2000 (%)	Average[1] increase in electrification between 2000 and 2010
1	Medium-high	193	83.88	13.85 p.p.
2	Medium-low	199	86.06	11.65 p.p.
3	Low	170	53.57	37.34 p.p.

Source: Research results. [1]Percentage points variation

presented negative average values for almost all the analyzed variables, evidencing the worst socioeconomic conditions between all three clusters. These values subside the theoretical definition that, for households in this group, rural electrifications would be faced as a basic needs good, supporting government action to this end.

On the other hand, the medium-low cluster instances the electrification's role as a production input. Positive mean values were found for social-related variables, while those related to production presented negative values. Therefore, for those municipalities, it can be pointed out that the focus of rural electrification would be directly related to the possible unfolding of agricultural production, given the use of electric energy as an input capable of improving the productive process, generating better economic results for farmers.

It is noticed, for the Medium-high cluster, the proximity of its socioeconomic reality with the vision of rural electrification as a commodity, focused primarily on household consumption. In this group, both social and economic variables presented positive values, providing evidence of a relatively advanced level of social and productive development. In this way, rural electrification would be seen essentially as a final consumption good, not observing major impacts on the already established local productive activities and developed social levels.

Values extracted from the Brazilian open data portal (dados.gov.br) showed that, between 2004 and 2010, more than 200 thousand connections were consolidated through the PLT among rural households and establishments (such as cooperatives and milk cooling tanks) in the state of Minas Gerais. Meanwhile data from the IBGE demographic census indicate that in the year 2000 there was an electrification demand of more than 150 thousand rural households in this state. In addition, between 2000 and 2010, about 53 thousand new households were registered in the rural areas of Minas Gerais. Therefore, a large part of the electricity demand supply in rural areas, in this period, can be attributed to this program.

Figure 1 shows the configuration of clusters regarding the mesoregions of Minas Gerais. It is clear, at first, the expressive concentration of Low cluster's municipalities in the northern range of the state. More specifically, this group, endowed with the worst socioeconomic indicators, mainly comprises Vale do Mucuri, Jequitinhonha and Norte de Minas regions, as well as the northern portion of Noroeste de Minas mesoregion. Meanwhile, the remaining municipalities classified in this group are scattered between Vale do Rio Doce, Metropolitan de Belo Horizonte and Zona da Mata mesoregions. It is worth mentioning that among the

Table 5: Mean values of the standardized variables, by clusters

Variables	Clusters		
	Low	Medium-low	Medium-high
Refrigerator	−1.139	0.4304	0.5602
Television	−1.2547	0.5112	0.5780
Literacy level	−1.095	0.3551	0.5990
Households headed by women	0.5881	0.2692	−0.795
Rural employment	−0.105	−0.444	0.5511
Agricultural GDP	−0.236	−0.433	0.655
Labor productivity	−0.427	−0.2027	0.5852
Street lighting	−0.0951	0.6675	−0.6044

Source: Research results. GDP: Gross domestic product

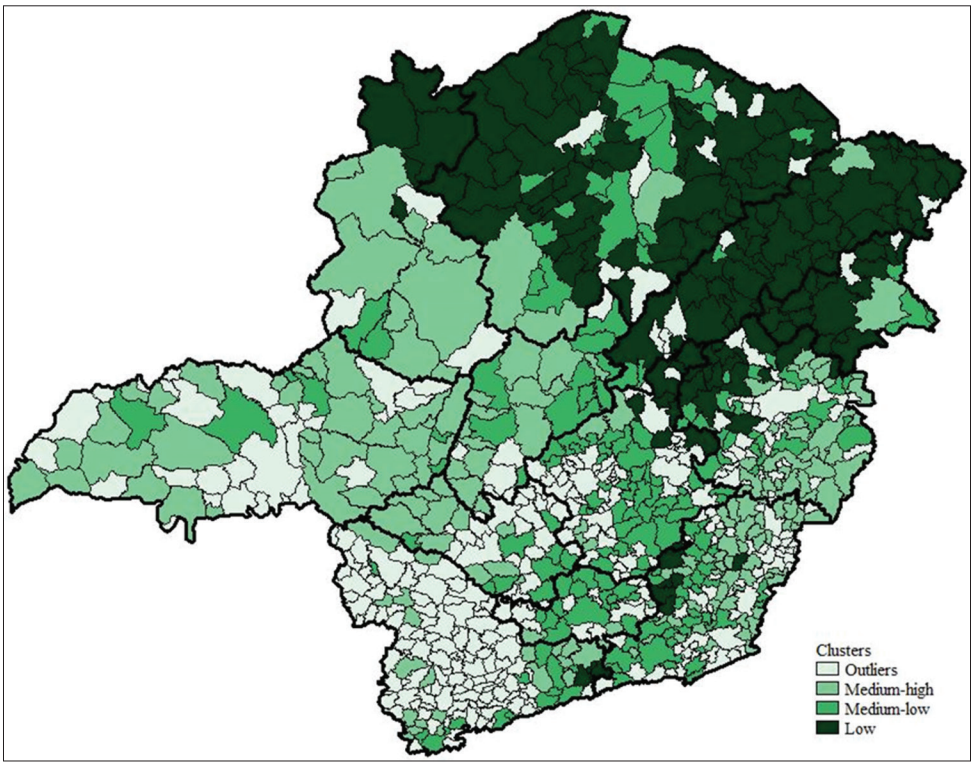
50 municipalities with the lowest per capita GDP of the state in 1999, 20 of them are located in the first three previously mentioned mesoregions (Fundação, 2003).

On the other hand, it is observed that municipalities of Nordeste, Triângulo Mineiro/Alto Paranaíba and Sul/Sudoeste regions predominantly fit in the Medium-high cluster, characterized by high social and agricultural production indexes. This scenario matches with data presented by João Pinheiro (2003), which indicate that these mesoregions accounted, respectively, for 6.7%, 26.7% and 23.8% of Minas Gerais' agricultural GDP in 1999. In spite of a greater concentration in Metropolitana de Belo Horizonte, Campo das Vertentes and Zona da Mata mesoregions, we can notice the presence of municipalities belonging to the Middle-low group in all the studied mesoregions.

It was observed that, in one hand, mesoregions with a high concentration of households were identified in the Low cluster, as in the case of the Nordeste and Norte of Minas Gerais. On the other hand, some mesoregions had a high concentration of their households in the Medium-high cluster, such as Central Mineira, Metropolitana de Belo Horizonte and Jequitinhonha mesoregions. One can also highlight those mesoregions that had their municipalities relatively evenly distributed among the three clusters, with emphasis on the Sul de Minas mesoregion. In this sense, the characteristic heterogeneity of Minas Gerais state is evident regarding the socioeconomic aspects raised in this research.

In a way, some results provided by the clusters' generation were in agreement with the theoretically expected by the socioeconomic inequality present in Minas Gerais state, which was already observed at the time to which the data used in this research refer. The fact that most of the municipalities of Central Mineira and Metropolitana de Belo Horizonte regions are in the Low cluster, may show that, within these regions, there is great divergence

Figure 1: Spatial distribution of clusters by mesoregions in the state of Minas Gerais



Source: Research results

between rural and urban areas referring to socioeconomic aspects, given that these mesoregions are not known as the poorest in the state.

5. CONCLUSIONS

This research aimed to divide the municipalities of Minas Gerais into homogeneous groups regarding variables related to the potential impact that access to electric energy could cause in the rural population. According to census data, the effectiveness of PLT in the state of Minas Gerais, in terms of its purpose of providing rural electrification in needy households, can be perceived in a short space of 7 years. However, there is a need for a more specific investigation into the scope of this governmental program, since official statistics do not discriminate the origin of electrification, i.e. whether it was carried out privately or through government subsidies.

It is evident, from results obtained, that municipalities in a same region presents a wide social and economic diversity and, consequently, different governmental approaches are needed to the achievement of their socioeconomic development. The elaboration of an analysis based on the theoretical apparatus given by Ranganathan (1993) can thus provide governments of developing countries, after the implementation of rural electrification in their municipalities, the formulation of new regional policy agendas with strategic use of electricity, considering the role it must play in promoting local development.

We highlight as a major contribution of this analysis, the paving of an empirical basis for further studies that could come to measure and analyze the impacts of the rural electrification process on the rural population regarding the most different aspects related to the development problem. From the results presented here, potentially interesting municipalities could be highlighted to carry out research with a greater qualitative focus, seeking to analyze the issue of electrification under the optics of those directly benefited.

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