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INTERESPAÇO
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Land use planning creating rural territories with and without electricity in Maranhão, Brazilian Amazon

O ordenamento do território produzindo espaços rurais com e sem energia elétrica no Maranhão, Amazônia, Brasil

Planificación espacial produciendo espacios rurales con y sin electricidad en Maranhão, Amazonia brasileña

Luciano Rocha da Penha
Doutor em Geografia pela Universidade Federal do Pará – UFPA. Professor do Curso de Licenciatura em Ciências Humanas-Geografia e do Programa de Pós-Graduação em Formação Docente e Práticas Educacionais da Universidade Federal do Maranhão – UFMA.
penha.luciano@ufma.br / http://orcid.org/0000-0001-5717-1618

José Antônio Herrera
Doutor em Desenvolvimento, Espaço e Meio Ambiente pela Universidade Estadual de Campinas – UNICAMP. Professor e Pesquisador do Curso de Geografia do Campus de Altamira e Programa de Pós-Graduação em Geografia da Universidade Federal do Pará – UFPA.
herrera@ufpa.br / http://orcid.org/0000-0001-8249-5024

Maria Backhouse
Doutora em Sociologia pelo Instituto de Estudos Latino-Americanos da Universidade Livre de Berlim, Alemanha. Professor de Sociologia Ambiental no Centro de Resiliência Climática, Universidade de Augsburg, Alemanha.
maria.backhouse@uni-a.de / http://orcid.org/0000-0001-9103-9637

Marcos Nicolau Santos da Silva
Doutor em Geografia pela Universidade Federal de Minas Gerais – UFMG. Professor do Curso de Licenciatura em Ciências Humanas-Geografia e do Programa de Pós-Graduação em Geografia da Universidade Federal do Maranhão – UFMA.
marcos.nicolau@ufma.br / http://orcid.org/0000-0003-0311-4559

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Abstract

This article deals with the rural electrification policy in the state of Maranhão, Brazilian Amazon. The purpose of the research was to analyze the spatial distribution of municipalities of this state, of which some residents, according to results of the 2017 Agricultural Census, declared they had access to electricity, while others declared they did not have access to electricity. It is known that the Amazon region is the largest producer of hydropower in Brazil. The analytical basis of the article was carried out through an approach on land use planning, rural electrification policies, and energy generation in the Amazon. For the data survey, the results of the Agricultural Census (Excel format) were used, as well as the Municipal Agricultural Production and the energy generation data from ANEEL (National Electric Energy Agency). The combination of these data was included in the ArcGIS software, generating a map of spatial distribution of rural electrification in municipalities of the state of Maranhão. The results indicate that the diffusion of electric energy in the rural areas of

Maranhão is predominantly distributed in municipalities that produce soy. It is concluded that the policy of land use planning, based on rural electrification in the Amazon, favored agribusiness territories and produced areas with and without electricity.

Keywords: Rural Electrification; Land Use Planning; Amazon; Maranhão.

Resumo

Este artigo trata da política de eletrificação rural no estado do Maranhão. Teve como objetivo analisar a distribuição espacial dos municípios desse estado, o qual alguns moradores, conforme os resultados Censo Agropecuário de 2017, declararam terem acesso à energia elétrica, ao passo que outros declararam não terem acesso ao serviço. Sabe-se que a região amazônica é a maior produtora de energia hídrica do Brasil. A base analítica do artigo foi realizada através de uma abordagem sobre ordenamento do território, políticas de eletrificação rural e produção de energia na Amazônia. Para o levantamento de dados foram utilizados a base dos resultados do Censo Agropecuário (em formato Excel), bem como da Produção Agrícola Municipal e os dados de geração de energia da ANEEL (Agência Nacional de Energia Elétrica). A combinação desses dados foi incluída no software ArcGIS, gerando um mapa de distribuição espacial da eletrificação rural nos municípios do estado do Maranhão. Os resultados revelam que a difusão da energia elétrica no espaço rural do Maranhão está predominantemente distribuída em municípios que produzem soja. A conclusão é a de que a política de ordenamento do território, a partir de eletrificação rural na Amazônia, privilegiou os territórios do agronegócio e produziu espaços com e sem energia elétrica.

Palavras-chave: Eletrificação Rural; Ordenamento do Território; Amazônia; Maranhão.

Resumen

Este artículo aborda la política de electrificación rural en el estado de Maranhão, Amazonia brasileña. El objetivo de la investigación fue analizar la distribución espacial de los municipios de este estado, cuyos residentes, según los resultados del Censo Agropecuario de 2017, declararon tener acceso a la electricidad, mientras que otros declararon no tenerlo. Se sabe que la región amazónica es la mayor productora de energía hidroeléctrica de Brasil. El análisis del artículo se basó en un enfoque de planificación territorial, políticas de electrificación rural y generación de energía en la Amazonia. Para el levantamiento de datos, se utilizaron los resultados del Censo Agropecuario (formato Excel), así como los datos de Producción Agropecuaria Municipal y generación de energía de la ANEEL (Agencia Nacional de Energía Eléctrica). La combinación de estos datos se integró en el software ArcGIS, generando un mapa de la distribución espacial de la electrificación rural en los municipios del estado de Maranhão. Los resultados indican que la distribución de energía eléctrica en las zonas rurales de Maranhão se distribuye predominantemente en los municipios productores de soja. Se concluye que la política de ordenamiento territorial, basada en la electrificación rural en la Amazonia, favoreció territorios del agronegocio y produjo áreas con y sin electricidad.

Palabras clave: Electrificación Rural; Ordenación del Territorio; Amazonia; Maranhão.

Introduction

Electricity distribution in Brazil began in the 19th century. However, its diffusion was intensified from the 1970s onwards (Santos; Silveira, 2004). This diffusion occurred in a regional and unequal way in the national territory with hydropower as the main source, highlighting the Small Hydroelectric Plants (PCHs), and then the Hydroelectric Power Plants (UHEs).

This diffusion focused on energy logistics for urban and industrial demands.

However, it is noteworthy that other sources of energy, besides hydroelectric ones, are important to society, such as sources of oil, natural gas, nuclear power plants, thermal energy, biomass, solar photovoltaic and wind power.

For this article, the focus was on hydroelectric power, which has potential for growth in Brazil, since the country has large hydrographic basins, mainly the basins located in the Amazon and Cerrado biomes. In addition, the basins located in these two biomes have 64% to 66% of their hydric capacities together for installations of UHEs and PCHs (EPE, 2006).

The objective of this article was to analyze the spatial distribution of electricity in rural houses in the municipalities of the state of Maranhão, a state located in the Legal Amazon. Connections were made between the spatial locations of the large enterprises of the agricultural industry, with the increase of electric energy generation in the region and the distribution of electric energy in rural houses.

The survey was based on the results of residents' declarations for the 2017 Agricultural Census. Some residents declared they had no access to electricity, while others declared they had access to electricity. This article is relevant because it considers that since the beginning of the 21st century, the Brazilian Government has been carrying out territorial planning policies in which one of the dimensions is the current rural electrification, the Luz Para Todos Program (PLPT).

From that century onwards, Brazil's energy policy has been expanding the construction of UHEs and PCHs, especially after the privatization process of energy services. Energy policies can be considered as territorial planning policies (Morais, 2005), since they demand infrastructure.

It is considered that a new energy land use planning has been underway in Brazil since the 1990s, when forms of reorganization such as privatizations and concessions have taken place so that private companies can manage energy policies from the generation, distribution, transmission, and use of electricity (Tolmasquim, 2015).

This article is justified by researching because in 2012 the Estreito Hydroelectric Power Plant (UHEE) was inaugurated in this state, whose power generated is 1,087 MW. It is noteworthy that the direct impact on urban and rural populations reached 10 municipalities in the state of Tocantins and two in the state of Maranhão (CESTE, 2021).

Therefore, in Maranhão's agrarian areas, there is a spatial distribution of soy, corn and large livestock monocultures (IBGE, 2021a). As well, it appears that after the construction of the UHEE, the energy logistics system began to intensify the agricultural industrial process (Rocha da Penha; Barros, 2021).

The methodological approach of the article was based on the discussion on land use planning, rural electrification policies and energy production in the Amazon. For data survey, the primary database was used, obtained by website in 2021, from the 2017 Agricultural Census. Brazilian Institute of Geography and Statistics (IBGE) released this Census. Another database was the Municipal Agricultural Production of 2019, also released by the IBGE (2021b). Finally, the database of the Generation Information Bank (BIG) of the National Electric Energy Agency (ANEEL) was also used.

These data were made available by the mentioned government institutions, in Excel format. The combination of these data was included in the ArcGIS software in the Geographic Information System (GIS) to generate a map informing the spatial distribution of rural spaces with and without electricity. On the same map, the five municipalities with houses in rural areas with the highest incidence of electricity and the least incidence of electricity were shown.

This article is divided into four parts, in addition to the introduction and conclusion. The first part presents the discussion on land use planning; the second part presents the rural electrification policy in the Brazilian Amazon; the third part presents the current energy situation in the state of Maranhão. Finally, the fourth part presents the spatial distribution of electricity in the rural areas of the state of Maranhão. In this same part, the distribution is related to the spatial locations of soy production in the municipalities.

Finally, it is concluded that the territorial planning policy, based on rural electrification in Maranhão, privileged the agribusiness territories and produced areas with and without electricity, making the agrarian space not just an isolated situation. This is the current reality of rural populations in the Brazilian Amazon, located in rural areas that do not live in the vicinity of the agricultural industry.

Land use planning in Brazil

Land use planning in Brazil is based on several State policies. However, after the privatization process, land use planning began to be carried out jointly with national and multinational private companies. Therefore, the management of land use planning goes through privatization processes, which consist of total or partial sales of the shares of state-owned companies or in the form of transfers from public services to private companies. These last-mentioned processes are called concessions.

Likewise, land use planning, private companies as well as concessionary companies are controlled by State regulatory agencies. Therefore, the occurrence of privatizations and concessions evidence the transference of some basic and essential services for society, such as electricity, fuel and water distribution.

Then, the land use planning policy applied in the Brazilian territory is based on the European concept, which was inserted in the Federal Constitution (CF) of 1988 (Galvão, 2005). Thus, the Federal Government is responsible and protagonist for organizing the territory in all dimensions of society. It must be taken into account that society is divided into social classes, which have specific demands, beliefs, values and daily claims, political and economic interests.

It is also worth mentioning that in Brazil, the land use planning policy is at the base of the State reform initiated in the 1930s (Rückert, 2005). The reforms carried out in that decade and in the following decades consolidated the effective management of the national territory. Therefore, ordering on a national scale became effective due to institutional State policies.

The theoretical approach to land use planning is multiple and controversial (Rücket, 2005), mainly because it is in the variable of analysis and discussion of the various concepts of territory and land management. The important thing is to understand how land use is manifested in geographic space.

Based on the above, it is necessary to understand that spatial planning is conceived as a State policy (Ferrão, 2010). In the same line of understanding, Costa (2005) understands that the State must be strong and present when proposing and executing such planning. Also, the State must be present to arbitrate the disputes and contradictions of the society that seeks access to resources (Moreira, 2007).

Furthermore, land use planning has the initial idea that ordering has the meaning of reaching a purpose (Moreira, 2007). According to this idea, the consummation takes place in space and time, from the distribution of the order in the spatial locations. These locations can be: rural agrarian reform settlements, Quilombos, indigenous territories, economic-ecological zoning, conservation Units, rural and urban resettlements of populations affected by dams, municipalities and states. Thus, distributions and locations combine as dialectical pairs (Moreira, 2007).

Also, for Moreira (2007), "the purpose of territorial planning is the regulatory control that contains effects of the contradiction of the spatial base on the global movements of society functioning according to its societal reality" (Moreira, 2007, p. 77). In the author's quote, the relationships between social control, contradiction and the reality

of society are verified.

From a geographical point of view, it can be said that the mentioned relationship depends on a location: whether the location of people, groups, social classes or the locations of geographical objects (Santos; Silveira, 2004). Land use planning organizes and reorganizes, values and revalues spaces according to state and private actions verified in the geographic distributions in the national territory.

Geographic objects can be units of UHEs, PCHs, transmission lines, gas pipelines, industrial units, large agribusiness farms, highways, railways, waterways, ports, silos, warehouses, slaughterhouses, dams, pipelines etc. (Santos; Silveira, 2004).

Due to the land use planning being is manifested in spatial locations, it results in conflicts of economic, political, cultural and environmental interests of social classes. As a result, the State will have to carry out territorial governance. Ultimately, this governance is related to land use planning and the participation of actors in the cooperation regime (Ferrão, 2010). Therefore, territorial governance needs a basis for political understanding between the different actors.

Furthermore, land use planning: "...is an instrument of cross-sectoral and inter-institutional articulation that aims at an integrated and spatialized planning of the action of government action" (Moraes, 2005, p. 46). This has to do with the extent to which the action of force and power of the State has to arbitrate its actions in the territory.

In Brazil, land use planning has been taking place based on State actions, which were intensified after the 1988 Constitution Promulgation, but following the guidelines of Neoliberalism. Actions are still ongoing and increasingly expanding, thus forcing not only Brazil, but also underdeveloped and developing countries to privatize their territories (Harvey, 2007). Privatizations are occurring to the detriment of non-business and non-financial social classes that need orderly space to produce their territories from their territorialities.

Thus, one of the dimensions and facets of State action is the ordering of energy resources, such as the current electricity market in Brazil. This market has been thought of since the mid-1990s (Bresser-Pereira, 1998). When the State de-verticalized the energy production chain, until then of vertical state domain, establishing the energy production chain in the following sequence: production (generation), transmission, distribution, commercialization, and consumption (Tolmasquim, 2015).

Thus, private companies, based on energy auctions, began to obtain licenses for concessions for the generation, distribution, transmission, and sale of electric energy. As

well as the way in which the State started to act, is as a controller of the supply of energy service.

It is true that land use planning encompasses all spatial scales in the countryside and in the city of the entire country. Even more so because the dimensions and the different forms of use of the territories require that the ordination be carried out taking into account the demands, both in the countryside and in the cities, of the social classes (Moraes, 2005).

What is found in the dimension of energy policies in Brazil is that the structure of the current model of the electricity sector is articulated without the relationship of society's participation. The processes of privatization of energy services did not involve consultation with society.

There are contradictions in the process of access to electric energy by the whole society, since the land use planning verified in the dimension of the constructions of the engineering systems, which are the infrastructures, advance in the growth of UHEs and PCHs units in the Brazilian Amazon.

On the contrary, there are environmental, social, economic and cultural criticisms when engineering systems such as UHEs and PCHs are built. On the other hand, there are inequalities in the implementation of energy infrastructure in Brazil, since there are people in rural areas, still in the 21st century, without access to electricity.

This contradiction is amplified because the abundance of water for the generation of UHEs and PCHs in the Brazilian Amazon is vast. Thus, the energy land use planning is not resulting in better conditions for the populations directly impacted by the UHEs' dams.

An example of this is the construction of the Belo Monte Hydroelectric Power Plant in the state of Pará (UHBM). The historical-geographical trajectory of the referred power plant led to the creation of divided spaces, since the land use planning favored the installation of the UHEBM to the detriment of local populations, although there were indemnities and construction of collective resettlements (Moreira; Herrera, 2016).

In the same line of discussion of the authors, another example is that of Tavares et al (2018), who also discussed and presented the precarious situation of the peasants affected by the dam when the UHEE was built in Maranhão.

Therefore, land use planning is presented in an almost harmonious way in which the state organizes resources and mediates conflicts of interest. However, when the occurrence of land use planning in the energy sector in the Brazilian Amazon is verified, conflicts of interest are not effectively arbitrated by the State. This results in inequalities in access to electricity, as well as can be understood through the understanding of rural electrification policy.

The rural electrification policy in the Amazon

The spatial distribution of UHEs and PCHs in the Brazilian Amazon is directly related to the large projects implemented. According to data from ANEEL (2020), from the privatization of energy services, the number of UHEs and SHPs units installed in the states of the Amazon has increased.

Between 1970 and 2001, there were 9 UHEs in operation in all the states of the Brazilian Amazon. However, after the new operation of the Brazilian electrical system, from 2003 to 2020, 24 UHEs and PCHs come into operation (ANEEL, 2020). Also, the growth in the supply of hydropower in the Amazon is directly related to the locations of the large hydrographic basins of the Amazon and Cerrado biomes (ANEEL, 2020).

In this way, the expansion of electricity supply and its transmission lines opened opportunities for the rural electrification policy to carry out distribution to all rural populations in the state of Maranhão and the Brazilian Amazon. In addition, the construction of UHEs and PCHs units close to the locations made it easier to carry out the distribution of the electricity grid.

On a national scale, this policy has been carried out in a contradictory way (Leal; Alva, 2021). As well, it has presented confusions of understandings and operationalizations during the state intervention, either as an executor or as an inspector (Jeronymo; Guerra, 2018).

Regarding energy sources to be used in rural electrification in the Amazon, it is more beneficial to use the renewable model to the detriment of the non-renewable one (Nerini et al., 2014), with the understanding that solar energy is introduced (Valer, et al., 2017). In the analysis that considers satisfaction and life improvement, rural electrification had successful results for some families (Bezerra et al., 2017).

Nevertheless, when the situation of rural electrification in the state of Maranhão is verified, the economic and productive dynamics such as soy must be understood, highlighting the logistics of the export networks inserted in the dynamics of commodities (Farias Filho et al, 2021). This dynamic, which is characteristic on a global scale, is fundamentally supported by the relationship between technology, division of labor, energy, and production of goods (Harvey, 2014). In addition, there is the production of space to increase the circulation of capital on a global scale (Harvey, 2014).

The distribution of rural electrification policy must be understood in a broad way, observing not only the sectorial analysis. Furthermore, relating, connecting, and identifying who are the actors that are benefiting from the policy, as well as, if the entire population in

the surroundings had access to electricity in fact, since the purpose of rural electrification is to promote access for rural populations, without distinction of social classes.

The PLPT is the current land use planning policy in place since 2003. Nevertheless, the rural electrification policy began in the 1970s (Jeronymo; Guerra, 2018). In the official document of Centrais Elétricas Brasileiras S. A. (Eletrobras), the PLPT: "... aims to provide electricity service to the portion of the Brazilian rural population that still does not have access to this public service, until the year of 2022" (Eletrobras, 2021, p. 92).

Also, in the PLPT's conception, rural electrification results in socioeconomic development, poverty reduction, improvement in economic and social conditions and a decrease in the rural exodus (Eletrobras, 2021). The context of social exclusion due to lack of access to electricity was one of the main reasons for the implementation of this program.

Table 1 - Population (thousand) served by the *Luz Para Todos* Program in Brazil from 2012 to 2020.

	2012	2013	2014	2015	2016	2017	2018	2019	2020
Brazil	**443**	**322**	**284**	**237**	**296**	**280**	**284**	**318**	**202**
North	146	93	127	127	146	125	112	130	58
Northeast	250	203	127	94	134	142	143	146	116
Southeast	7	6	3	5	1	-	-	-	-
South	7	7	7	0	-	-	-	-	-
Midwest	33	13	20	11	14	13	29	41	28

Source: EPE (2020).

Table 1 shows the number of populations served by the PLPT in the range from 2012 to 2020. This shows that the regions most served were the North and Northeast. In the data obtained by the EPE (2020) data by state were not disclosed. Still on the table, it is inferred that the PLPT should continue to be implemented in the North and Northeast regions.

Nerini et al. (2014) were concerned with analyzing the PLPT through the implementation of renewable energy and using it as a way to replace oil source energy such asdiesel oil. However, in some places it was only possible to use the mentioned oil for rural electrification.

Bezerra et al. (2017) analyzed the PLPT on a national scale and concluded that there was an improvement in the quality of life of rural populations in all Brazilian regions. This was possible because the *Bolsa Família* Program added to the rural electrification facilities, connecting with the Human Development Index indicator.

In another analysis, Valer et al. (2017) researched the implementation of solar energy in rural electrification by the PLPT. The authors found deficiencies in the

functioning and operation of the equipment due to the lack of attention on the part of the State regarding the management of maintenance and handling of the devices after installation.

Leal and Alva (2021) analyzed the PLPT from the perspective of the fundamental right to basic public services present in the 1988 Constitution. On the one hand, the authors show successful results regarding the improvement in the quality of life of the populations served. On the other hand, they showed that the North Region still needs many facilities in rural houses.

Therefore, the PLPT had both successful and unsuccessful results, as the conclusions of the research results presented were analyzed. The works described were carried out on a regional scale.

The current energy situation in the state of Maranhão

The analysis of the geographic scale of the state is important to have an overview of the spatial distribution of rural electrification in Maranhão from the PLPT. Even more, because in the Maranhão countryside there are installations of geographic objects due to their productive variety in the agricultural industry.

Therefore, the current energy situation in the state of Maranhão, is materialized by highlighting the UHEE. It is considered a large power plant because it generates 1,087 MW of power. Its location is in the middle course of the Araguaia-Tocantins Hydrographic Basin, on the border between the states of Maranhão and Tocantins, a biogeographic spot in the transition areas from the Amazon biome to the Cerrado biome.

It was inaugurated in 2012, but started operating in 2011, with the promise of improving the quality of life of the populations of both states. It is worth noting that the current Brazilian electrical system allows UHEs to have the concession and use of 100% of the production/generation of electrical energy for consumption by the company or consortium holding the concession. It is also known that the UHEE is a product of the Macro Policy contained in the *Brasil em Ação* Program in Fernando Henrique Cardoso's administration (1995-2002) but was incorporated into the *Programa Aceleração do Crescimento* (PAC) a program of the government of Dilma Roussef (2011-2016) (Rocha da Penha; Barros, 2021).

The programs were for land use planning through increases and improvements to infrastructure logistics, implementing hydroelectric plants, highways, railways, waterways, ports, and other engineering systems. Santos and Silveira (2004) called this type of logistic

relationship as spatial circuits of production. When relating physical adjustments to geographic expansion of capital, Harvey (2014) also refers metaphorically to the "adjustment" solution linked to crises of capital overaccumulation through long-term investments in geographic expansion.

According to ANEEL (2020), the energy variety in the state of Maranhão is formed by 10.39% wind energy, 0.01% solar energy, 26.51% UHE and 63.10% thermoelectric energy. This variety illustrates that Maranhão has a diversified energy matrix. Thus, it is understood that the population of this state does not use the energy of the UHEE for consumption, since it is known that residential consumption in the state of Maranhão comes from the Tucuruí Hydroelectric Plant, located in the state of Pará.

In 2019, according to ANEEL (2020), the percentage of electricity consumption in Maranhão was 44% residential consumption, 20.6% industrial consumption, 16.6% commercial consumption, 3% consumption in the rural space, 5.7% for public consumption, 5.5% for public lighting, 4.4% for public service and 0.1% for the state's own consumption. It is then verified that most consumption was from residential, followed by industrial.

As part of the diffusion of electrical energy geographic objects, ANEEL (2020) records what is described in Table 1, which is the list of PCHs under study in Maranhão. All these PCH projects are close to soybean monoculture areas. As they are all PCHs, it is understood that the expansion becomes faster because the PCHs are considered renewable energy generators, since they have little environmental impact due to the height of the dam being much lower than the UHEs.

Chart 1 – PCHs under study in Maranhão State in 2020

State	Name	Type	Water course	Micro-basin	Company	Power (Mw)
MA	Aurora	PCH	Pindaré, Itapecuru, Mearim and others	Mearim	Rodrigo Pedroso Energia Ltda.	9,1
MA	Cachoeira	PCH	Parnaíba	Cachoeira	PEC Energia S.A.	9
MA	Côco	PCH	Pindaré, Itapecuru, Mearim and others	Mearim	Rodrigo Pedroso Energia Ltda.	13,7
MA	Gado Bravo	PCH	Parnaíba	Das Balsas	Atiaia Energia S.A.	23
MA	Matão Novo	PCH	Parnaíba	Das Balsas	Atiaia Energia S.A.	19

Source: ANEEL (2020) – Information Bank of Generation (BIG).

Therefore, the reservoir floods few rural areas and in the city. It also emits few greenhouse gases, and when it is built on a run-of-river basis, there is no construction or dam to build lakes and dams.

Chart 2 below shows 11 PCHs projects and 1 UHE with open processes for study in Maranhão. In addition to what was shown in Chart 1, in Chart 2 there is a demand for energy construction greater than the projects under study. Thus, this diffusion does not yet show that rural electrification will be for agriculture or for houses in rural areas.

When looking at charts 1 and 2, it is understood that the construction process of PCHs and UHEs in the case of Maranhão occurs due to the demand of agriculture, since it is known that the hydrographic

Thus, the current variety of energy in Maranhão tends towards hydropower. This can be understood as the state spatial distribution following the global and national trend of renewable energies.

Chart 2 – PCHs and UHEs with open processes for study in Maranhão in 2020.

Enterprise	Type	State	Power (MW)	Watercourse	Sub-basin	Date/act
A2E7	PCH	MA	6,47	Das Balsas	Parnaíba	17/06/2014
A2E9	PCH	MA	8,5	Das Balsas	Parnaíba	17/06/2014
Araguanã	UHE	MA/PA/TO	960	Araguaia	Baixo Araguaia	06/09/2000
Ásia (Antiga A2E8)	PCH	MA	7,1	Das Balsas	Parnaíba	17/06/2014
Cachoeira da Ilha	PCH	MA	5,7	Farinha	Tocantins, entre os rios do Sono e Araguaia	20/12/2000
Corredeira do Porão	PCH	MA	5,6	Farinha	Tocantins, entre os rios do Sono e Araguaia	20/12/2000
Engenho	PCH	MA	12,2	Mearim	Pindare, Itapecuru, Mearim e outros	02/12/2003
Ferrugem (Antiga A2E13)	PCH	MA	16,57	Das Balsas	Parnaíba	03/09/2014
Grajaú	PCH	MA	11,4	Grajaú	Pindaré, Itapecuru, Mearim e outros	02/12/2003
Rocha Baixo	PCH	MA	9	Mearim	Pindaré, Itapecuru, Mearim e outros	02/12/2003
São Gregório	PCH	MA	14,29	Das Balsas	Parnaíba	17/06/2014

São Pedro	PCH	MA	12,12	Das Balsas	Parnaíba	03/09/2014

Surce: ANEEL (2020) – Information Bank of Generation (BIG).

The emergence of rural spaces with and without energy in Maranhão

Land use planning in the state of Maranhão, through the PLPT, resulted in spatial differentiation of access to electricity. The 2017 Agricultural Census surveyed 219,765 families in the state of Maranhão. Of the total, 133,546 reported having access to electricity in their homes. However, 76,430 families reported having no access to electricity (IBGE, 2021a).

Therefore, the data are shown in Figure 1, represented by a map that reveals the presence of areas divided with energy and without energy. It is through the rural spatial distribution of the municipalities that the results of the PLPT in Maranhão emerge. Figure 2, which represents the geographic distribution of the amount of soybeans produced in the Legal Amazon from 2015 to 2018, also illustrates the geographic distribution of soybeans in the state of Maranhão.

When verifying the locations of the results described in Figure 1, we turn to Weber (2012, p. 89) who argues: "[..] in the case of energy installations that can only be used rationally when they are used simultaneously in a large number of homogeneous, uniformly organized work processes [...]". In the passage in question, the author states that the installed energy can serve for a homogeneity of work, that is, the appropriation through the fixed capital of the means of production (Weber, 2012).

Although Figure 2 has different years, due to the data from the Agricultural Census and the Municipal Agricultural Research being published on different dates[1], it demonstrates, when related to Figure 1, that the Legal Amazon, in its eastern area, contains the largest distribution of soybean plantations, as well as in the state of Maranhão, in its central-south area, the largest quantities of this monoculture are located.

In the discussion of energy locations analyzed by Brücher (2009), this author states that there is a dispute over energy resources predominantly for the space of capital or, as he himself states: *energy for space*, which is energy production in the Fordist model of mass production. The author understands that actors compete for areas close to spatial locations.

[1] There are differences in dates in the publications made by the Brazilian Institute of Geography and Statistics (IBGE), due to the 2017 Agricultural Census being published in 2018. However, the Municipal Agricultural Survey, published in 2020 and whose reference was the year of 2019, shows complementary information between the two publications. Therefore, in the global analysis, the interpretations and conclusions about the spatial distribution of soy and electric energy in the field are not harmed.

The agrarian space of Maranhão, in its central-south location, presents characteristics in which soybean monoculture, cattle ranching and the paper and cellulose industry predominate (Rocha da Penha; Barros, 2021). In the same way, for the mentioned economic triad to work, some engineering systems are needed (Santos; Silveira, 2004). This is shown in Figure 1, since the facilities of the UHEE and the PCHs under study are in the surroundings of the agricultural industry.

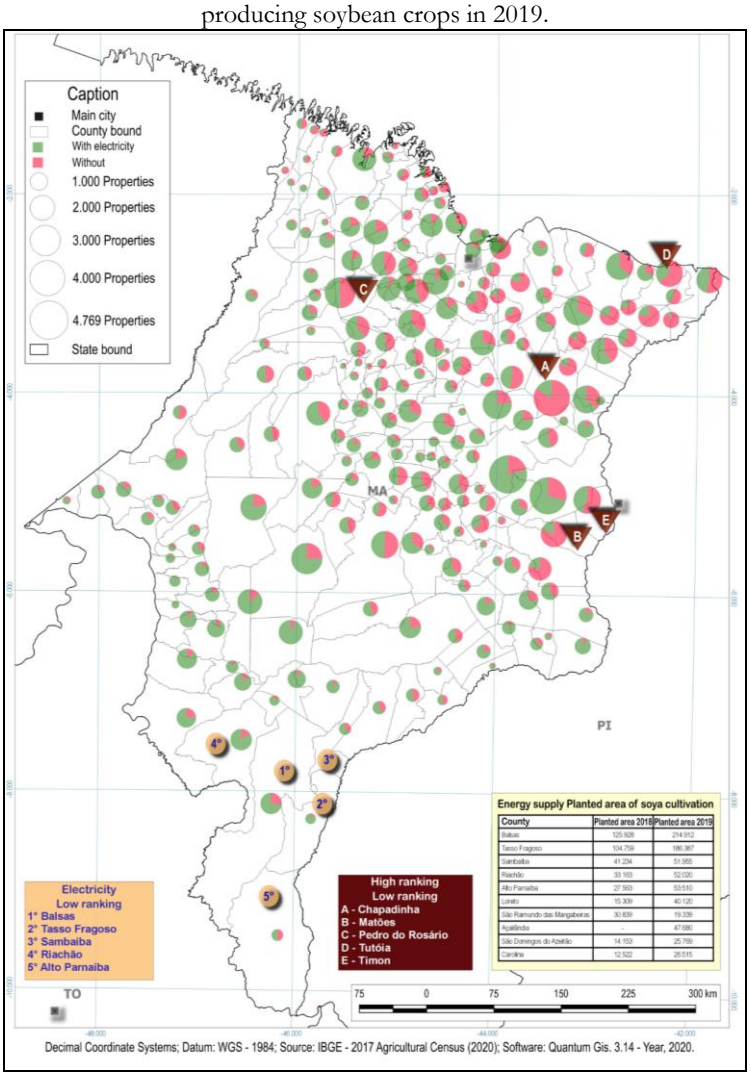
However, distant locations can be overcome due to electrical power transmission and distribution network facilities being available to meet demand. Likewise, engineering systems do not operate exclusively in the state of Maranhão, as they work on a national and global scale, obviously within the pattern of the international and territorial division of labor (Santos; Silveira, 2004).

Therefore, the spatial location of energy logistics is fundamental for the functioning of the production chain of the agricultural industry, since it demands the following engineering systems: irrigation machines, silos installations, warehouses, and cold storage facilities. Thus, it demands units of UHEs and PCHs close to agro-industrial locations.

It can also be seen from Figure 1 that the agrarian space of Maranhão presents Bright rural spaces, with energy, in the spatial location of the soy monoculture complex. The process that the world goes through at all spatial scales in relation to the agricultural industry is the territory that is being monopolized by agricultural business (Oliveira, 2015).

At the same time, opaque rural spaces are also visible, with no energy at the location. Bright spaces and opaque spaces are terms used by Santos and Silveira (2004), where they differentiate these spaces through the load of technical density and typical geographic objects of large agriculture (Santos; Silveira, 2004).

Figure 1 - Map of rural spaces with and without energy in Maranhão in 2017: highlighting municipalities producing soybean crops in 2019.

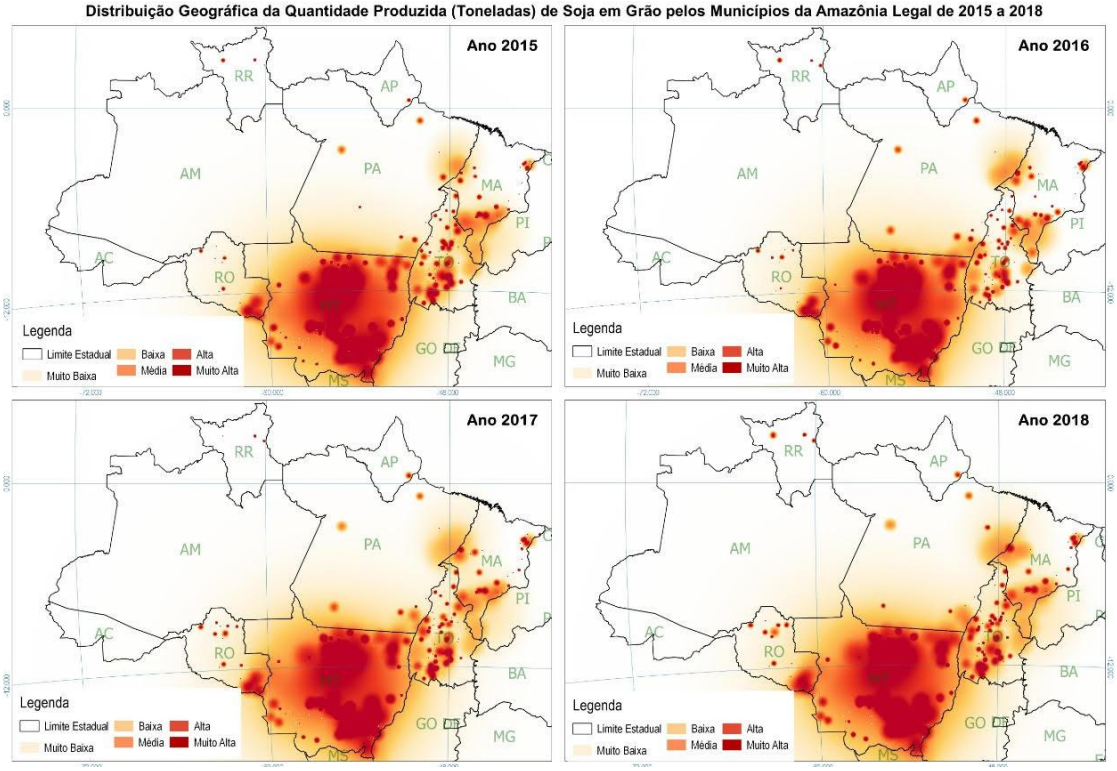


Source: IBGE (2021a; 2021b) - Agricultural Census 2017 and Municipal Agricultural Production 2019.

Figure 1 highlights the five municipalities with the most rural areas with electricity and the five with rural areas with less electricity. In addition, the ten largest soybean producing municipalities in Maranhão are shown. Thus, the dispute over energy resources is presented as a form of political power (Brücher, 2009) for the domination of space in the conflict of interests over land use.

Figure 1 also shows that the municipalities that produce the most soy are the ones that have the most rural areas with electricity. From this finding, it can be stated that the agricultural industry has a monopoly on the total industrial location that encompasses land and available resources (Harvey, 2014).

Figure 2 - Map of the geographical distribution of the amount of soybeans produced in the municipalities of the Brazilian Amazon[2]



Source: authors (2021).

Figure 2 also reveals that there was a slight increase in the amount of soybean produced in the years 2015 to 2018. In addition, the states of Mato Grosso, Maranhão and Tocantins have the largest areas occupied by soybean monoculture. The agricultural industry is capital and energy intensive and generally requires very little labor. Large agriculture tends towards monoculture, extraction, and almost endless expansion (Harvey, 2014).

Figure 2 shows that the case of municipalities in the state of Maranhão may be the case for other municipalities in the Legal Amazon. Therefore, more research is needed on the spatial distribution of the absence of electricity in rural areas where soybean monoculture is not yet established.

Conclusion

The results demonstrate that land use planning, based on the energy aspect in Maranhão, has tended to implement electricity networks for spatial locations. In these locations there are large geographic objects of extractive industries, agricultural industries, processing industries. The extraction, storage, production, transformation, and export units

[2] Figure 2 is included in a publication in Portuguese.

are part of the location complex.

Although the transmission networks are extensive and complex, they serve, in the case of Maranhão, enterprises in the upper circuit of the rural economy. Linked to the energy logistics system and the relationship with the agricultural industry, there may have been a change in the land use system in the state of Maranhão. There is no doubt about this, because even after the UHEE was built, it became necessary to understand why land use planning through energy policy did not democratize access to electricity for rural populations in the state of Maranhão.

The production of unequal and divided rural spaces through soy monoculture in Maranhão has been occurring since the 1990s. From the energy land use planning, these inequalities and divisions are deepening. Populations that should have minimal access to electricity are not having this opportunity. It is expected that the PCHs under study and designed for the state will be able to serve the 76,430 people.

This situation in Maranhão can be extended to the states of the Brazilian Amazon since the forms of implementation of UHEs and PCHs tend to favor agricultural business. In the case of Maranhão, the privilege was proven by the Geographic Information System.

Therefore, studies for other states, applying the same methodology to understand how land use planning policy, through rural electrification, is being conducted in the various rural areas of the Amazon.

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