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Methodology for Identifying Regional Poles under Territorial Engeneering Approach

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ABSTRACT: *This article develop a methodology for identifying regional poles under the concept of Territorial Engineering approach. The objective is to establish a methodology for identifying these poles, using specific social and economics characteristics, using ABC curves to select the productions in order to verify the economic productive vocation. The case study was applied to the areas of influence of the Tocantins Waterway. In the case studied, the strengthening of regional poles has the potential to attract the productive sector and increase the traffic flow, contributing to the viability of investments in the waterway infrastructure.*
Keywords: *Regional pole, Territorial engineering, feasibility of investment*

I. INTRODUCTION

Brazil has over 40.000 km of potentially navigable rivers; however, its commercial navigation occurs on over 13.000 km, especially in Amazonia (Ministério dos Transportes, 2010, [1]). Many factors are pointed as hindrances for a bigger exploration of this kind of transportation, involving since institutional issues to access infrastructure necessity and constructions to make the rivers navigable.

The waterway, from the Centro-Norte corridor, considers since Peixe/TO city to Tocantins river mouth. If necessaries improvement and viability works were done, the extensions of this Waterway could be nearby 1515 km, putting altogether; Brazil's center to the Belem (PA) and Vila do Conde (PA)'s ports.

One of the issues that makes the implantation of the Waterway impracticable, it's the prevision of transportation traffic under the necessary to make the dredging, overthrow, signaling and operation viable. With the goal of propose ideas that ensures the transportation demand and make possible the investments on infrastructure that used the concepts and tools from Territorial Engineering, with the conception from a Territorial Program.

According Aragão *et al*. (2012, [2]), Territorial Program is made of an integrated projects group from public and private initiative into a determined territory, which involves productive plants and infrastructure investments. This program would have by function make easier the strategical planning and make possible public and private investments with big scale. On the Fig. 1 are illustrated the Territorial Program Projects.

Figure 1: Group of projects that define the Territorial Program (Aragão *et al*. 2012, [2])

Having this concept as a base, the decision is by the construction of a Territorial Program that, through the concatenation of the already listed projects on the influence area and from others supplementary that improve even more the growth, might ensure the fiscal sustainability investment on the Waterway and from others infrastructure and public politics projects connected to this one.

On this perspective, this article shows some difficulties to the water transportation and the job of the Territorial Engineering as a promoter of its development based on these regional poles. Following, it is presented the proposed methodology to the determination of the regional poles that will be the growth engine generating flows. The propose was applied to the case of the Tocantins Waterway, which results are presented and discussed at the end of the article.

II. LITERATURE REVIEW

The water transportation way shows many advantages if compared to the land modalities: big load capacity, less fuel consummation per transported ton, less cost ton/km, less pollution and reduces the registration of accidents.

Even with these advantages, its participation on the internal cargo transportation matrix in Brazil is below desirable. There is necessity to implement ways that incentives the utilization of the waterway modal in order to invigorate the Brazilian transport sector and create greater integration between modes of transport, which will allow each one to be used according to its own advantages. Water and rail transportation would be responsible for the displacement of large volumes over long distances, while the road would focus on shorter distances and faster flows. According to the Confederação Nacional do Transporte (2013, [3]), in 2008, the waterway was responsible for transport 13.6% of the national domestic cargo, the highway 61.1%, the railroad 4.2% and the airway 0.4%.

In addition to the advantages of the transportation itself, the implementation of the waterway system can lead to indirect benefits such as the starting of new agricultural production, stimulated by the proximity of the waterway and by a more attractive freight. The job is created for the population of the region, due to the works and services necessary for the operation of the waterway and in function of the economic activities that will develop in their surroundings.

The implementation of a waterway also has negative impacts: suppression and possible destruction of vegetation, in function to the release of excavated and/or dredged material on the area of riparian forests, fields and forests.Temporary or permanent frightening of animals or death by burial is considered, also emission of noise by the movement and operation of the machinery, construction of dams with possible changes in river flow conditions and flooding of adjacent areas, increased water flow velocity with the correction of water courses, abrupt changes in transported sediment volume and increased levels of silting and turbidity. In addition, vessel traffic revolves sediment load, in suspension, from the bottom of the river channel and increases the rates of erosion of banks in the most critical areas, the emission of atmospheric pollutants and the risk of contamination of the aquatic environment with ballast water or of cargo handling failures (CARVALHO, 2008, [4]).

Such specific characteristics are quite different from land systems, already well consolidated in the country. This specificity involve different areas of knowledge in the evaluation of projects and in-depth analysis of support to decision-makers. As reinforced by Pompermayer *et al.* (2014, [5]), the waterway sector is relatively poorly known and explored by both the public and private sectors and, thereby, cannot sensitize the high authorities to decide in their favor, in terms of effectiveness of public policies and allocation of resources.

2.1 Tocantins Waterway

The confluence of rivers Paraná, Maranhão and Almas form the Tocantins River, in the south of Tocantins, traveling a distance of approximately 2400 km until it falls into Marajó Bay (PA). Drains an area of 306,310 km² before the confluence with the Araguaia River and 764,996 km² in the river mouth, including the drainage area of the Araguaia River. It presents characteristics of lowland river in the lower-middle stretch and plateau in the middle-upper section.

The river has a navigable extension of 1152 km divided into two non-continuous portions. The first stretch has 714 km and connects the river mouth to the city of Imperatriz (MA), being divided into three parts; river mouth – Tucuruí (PA) – Marabá (PA) - Imperatriz, and the second stretch has 440 km and connects the cities Estreito (MA) e Lajeado (TO). Still, there are links Imperatriz – Estreito e Peixe (TO) – Lajeado, which are navigable only during the flood season.

The establishment of a fully navigable waterway depends on the construction of locks and terminals, dredging and overturning and signaling construction. Some necessary interventions are present on Fig. 2. According to the Executive Report of Ministério dos Transportes(2012, [6]), were estimated investments from the order from 5.7 billion of real (1 dolar = 3.5 real) on the Tocantins Waterway. Bringing to present value is 7.2 billion of real. It should be noted that the execution of bathymetry studies more detailed might interfere on this value. At the cost of implementation is added the cost of operation and maintenance.

The report produced by ANTAQ (2013a, [7]) presents a waterway demand forecast until the year 2030. According to this report, the demand grows from 9.6 million tons of cargo in 2015 to 33.8 millions of tons in 2030, which represents a total growth of 252%. The report estimates that the most important cargos to the

Tocantins-Araguaia Waterway, in 2015, should be the products from the Soy complex and the mineral coal, with participation of 36.1%. Together, they might represent 76% of the movement of the waterway. Starting from 2020, the oil and the bran soy stops showing themselves on the waterway movement. Just the soy grain will be moved, going over 2.8 million in2015 in 2015 to 12.2 million in 2030. This growth of demand elevates the soy grain participation on the total movement of the waterway. Except by the oil and the bran soy, no other cargo might present reduction on the movement between 2015 and 2030. In the same year, the flow projection for the Tietê-Paraná Waterway is 50.6 million tons (ANTAQ, 2013b, [8]). Despite the forecast of growth in Tocantins Waterway's demand, the data indicate the need to implement mechanisms to encourage production in order to increase demand and contribute to investment's viability. In this sense, the Territorial Engineering presents the concept of Territorial Program.

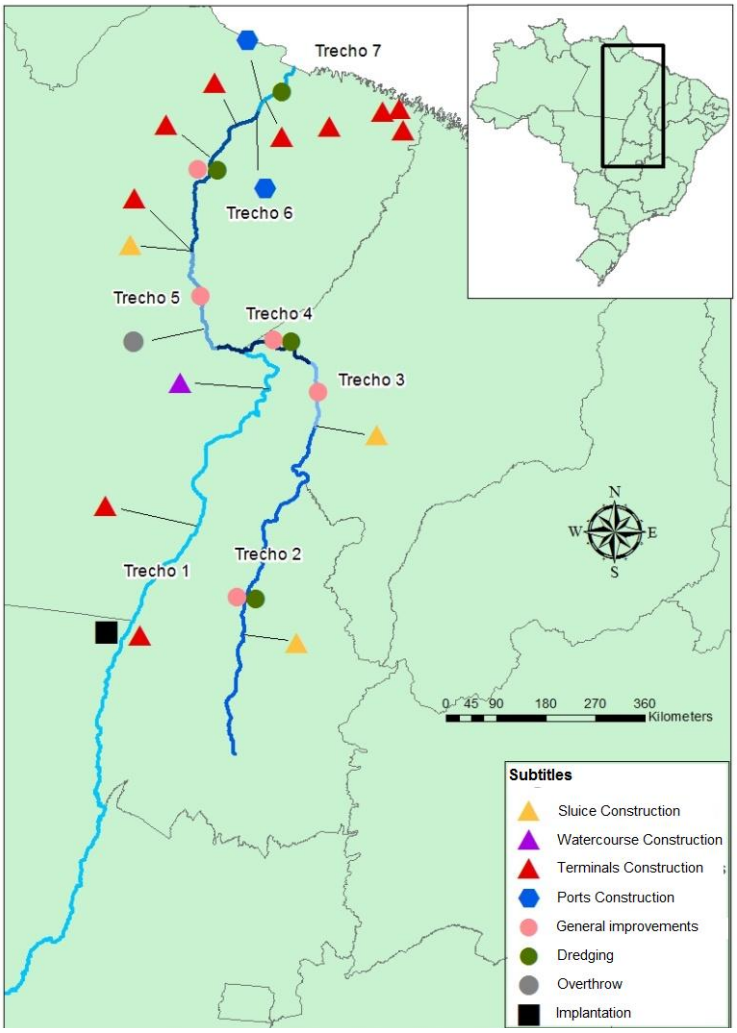


Figure 2: Localization of necessary interventions in Tocantins Waterway (Executive Report of Ministério dos Transportes (2012), [6])

2.2 Territorial Program

The territorial program contributes to economic growth, and fiscal balance of investments in infrastructure projects and public policies in according to Aragão *et al.* (2012, [2]). In this context, the determination of regional poles is important.

Perroux (1967, [9]) developed his Theory of Development Poles. It states that economic growth is not done comprehensively across a country's economic space, but only at specific points, called Growth Poles, with variations in their intensity, expanding through several branches with variable final effects on the space economy. According to Perroux (1967, [9]), economic growth is characteristic of areas favored by a variety of circumstances, where there is a driving industry, because of the action of this industry, growth spreads and expands, benefiting the surrounding regions, and these polarized. For the author, the growth pole arises due to forthcoming of a driving industry, In general, the driving industry, in its action of obtaining raw materials, attracts labor and production of various products and energizes the region, attracting other industries and

workers, which will stimulate development of agricultural and livestock activities in food and raw material supply regions. In this context, the industrial complex arises and is characterize by presence of a key industry, non-competitive regime between existing industries and territorial agglomeration.

Might presume that the pole is the dynamic economic center of a region and its growth is felt over every region that surrounds it. Regional development always will be linked to the development of its pole.

Although Perroux (1967, [9]) developed its Polarization Theory according to industry, the author admits that the driving force can also extend to primary activities. Within the approach of Territorial Engineering, the poles give necessary dynamics to development of a region. Fig. 3 shows the pole spatial structure.

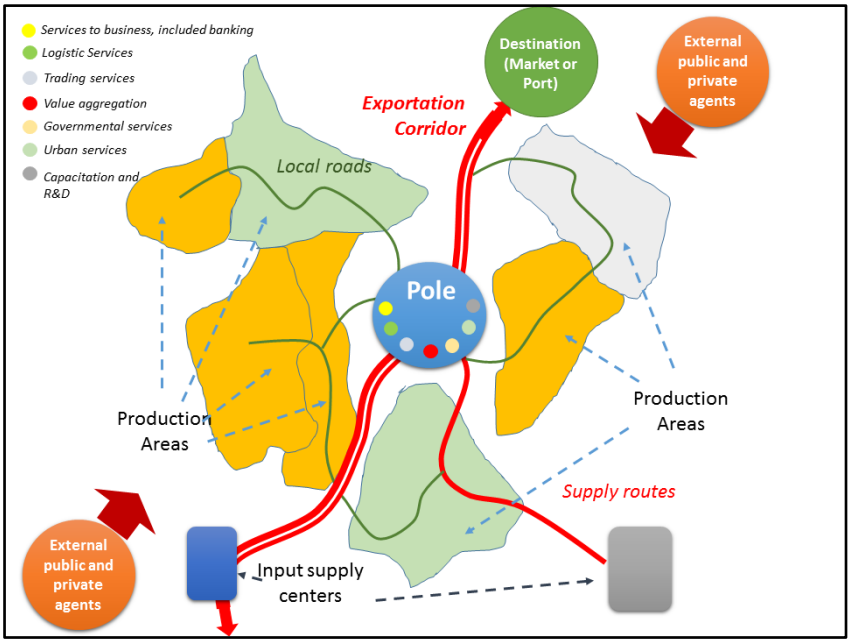


Figure 3: The pole spatial structuring (Aragão, 2014, [10])

III. METHODOLOGY

With the purpose of identify the Regional Poles capable of concentrate a Territorial Program that can enable the employment of a waterway transportation infrastructure, ensuring the fiscal sustainability of investment, was purposed a methodology applied to the case of the Tocantins Waterway.

This purpose is divided into steps and each one of them, as their used technical procedures and the products that forms the database to analyze, are illustrated on the Fig. 4.

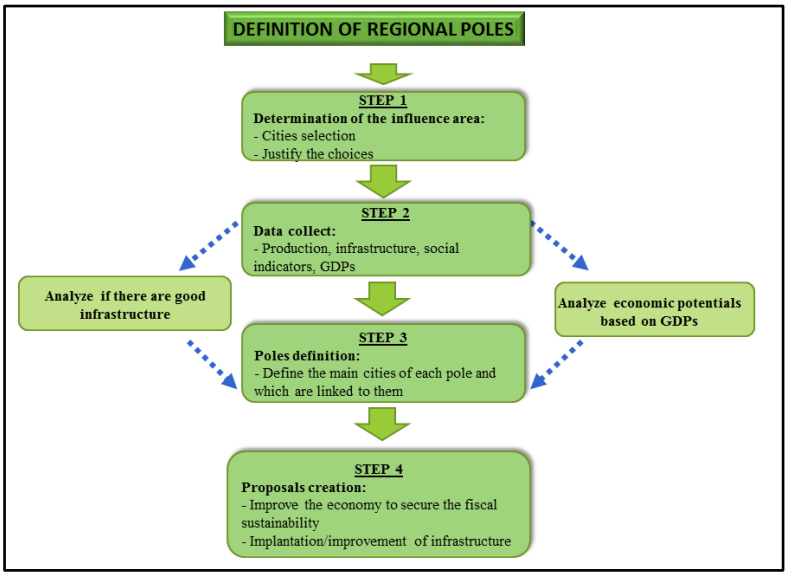


Figure 4: Definition of Regional Poles Methodology

Step 1 - Determination of the influence area: let it well defined, because the commodity flow that will enter on the fiscal sustainability validation might vary as a result of the number of cities and its importance.
Step 2 - Data collect: there are many ways to make the data collect, but it is advised to use data of official national data collector -IBGE. The important aspects are: define which data are important to the waterway modal, organize them in spreadsheets to help on the observation that will define which one are the city's economic potential; analyze if there are good infrastructure to have intermodal integration and production access to the terminals.
Another aspect that might be considered are the social indicators: illiteracy rate, human development index, medical conditions and GDP. Those are important to identify the local workers qualification.
Step 3 - Poles definition: Through the data collected, follows the cities selection according to the proposed method on the Fig. 5. It might observe which cities have bigger relevant products production to the waterway modal and the case of the infrastructure to make a decision; existence of a density and paved highway network, airports and ports.
Step 4 - Proposal definition: Might be created proposals to improve the economy to secure the fiscal sustainability, not just from the waterway investment, but also from another infrastructure and public politics projects. To this step, it might be taken as a base the stronger sectors at the poles.

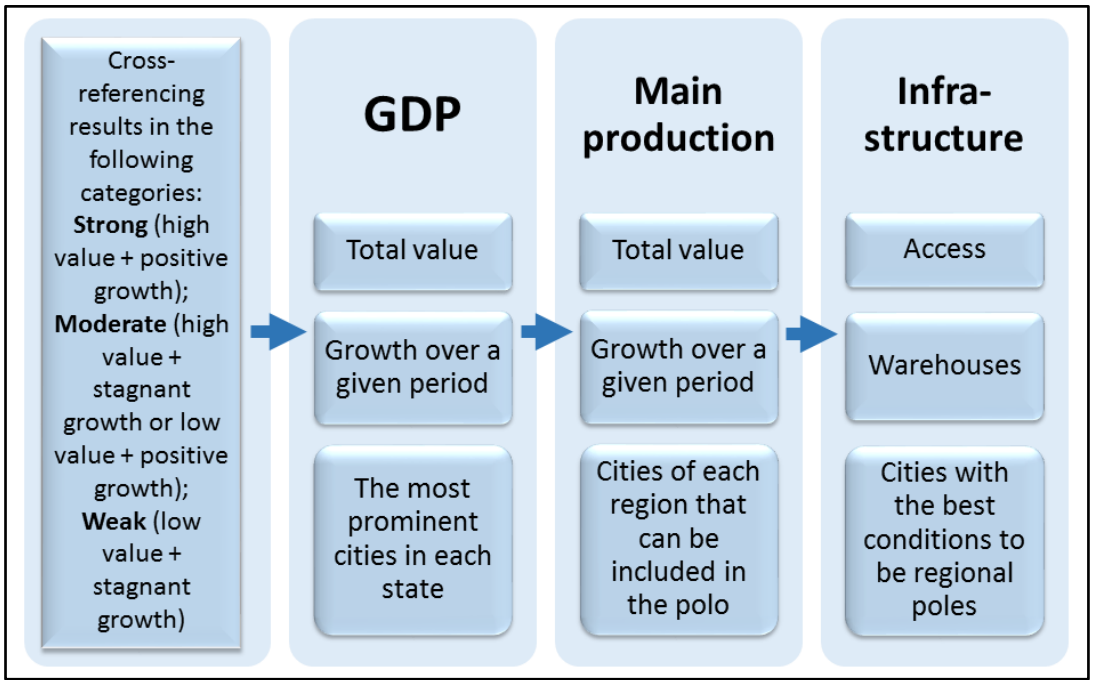


Figure 5: Pole Cities Selection Method

IV. METHOD APPLICATION: CASE STUDY OF THE TOCANTINS RIVER

In this section, it is presented how the city selection methodology was applied on the Tocantins River case.
Step 1 - Determination of the influence area: the material used as a base to the definition of the influence area was the National Agency of Waterway Navigation-ANTAQ technical report of the Tocantins-Araguaia river bay from February 2013. To define which cities would be part of the influence area, the study used the entry and exit cost variable to the closest port in relation to the important products transportation on the waterway. As this article is just focused to the Tocantins river, some modifications were made to adapt the region excluding the river Araguaia areas, keeping those ones that influences the Tocantins river. It is important to show that other cities also influence the area, but a more conservator scenario was chosen.
It is also added the Balsas, Tasso Fragoso, Riachão e Alto Parnaíba cities that were not presented on the ANTAQ's report about influence area (2013, [7]) for standing out when related to the agricultural production and to be close to the highways that is connected to the waterway. On this way, the result was the final influence, shown on the Fig. 6.

Step 2 – Data collect: The production data were taken from the IBGE Automatic Recovery System, which shows spreadsheets on excel format, with the production since 1999 to 2012 of the economically viable products to be transported by the waterway.

Data from the soy, corn, sugar cane, hen, beef, milk, cotton, cassava, swine and rice were collected. Beyond those data, information about the highway network were collected, location of mineral deposits, warehouses, exportation refrigerators, port, railways and airport terminals.

Step 3 – Poles definition: it was realized observations of the bigger productions and the cities that shows bigger growth in some of the fourteen years observation sector and then the the most important products were chosen to a detailed analysis. Between the chosen cities, were observed the infrastructure and social index present.
Through the highway network and the territorial proximity, were observed the outflow potential production from closer cities to the pole cities, each one being added to a determinate pole. The Fig.7 shows the evaluation worksheet. Seven poles in total were defined, one from Pará, two to Maranhão and four to Tocantins State.

Step 4 – Poles definition: the definition wastaken based on the most important products of each city, but aiming at a greater homogenization of the pole to which they belong. In addition, some suggestions in terms of improvement to the cities that was considered with low or none infrastructure.

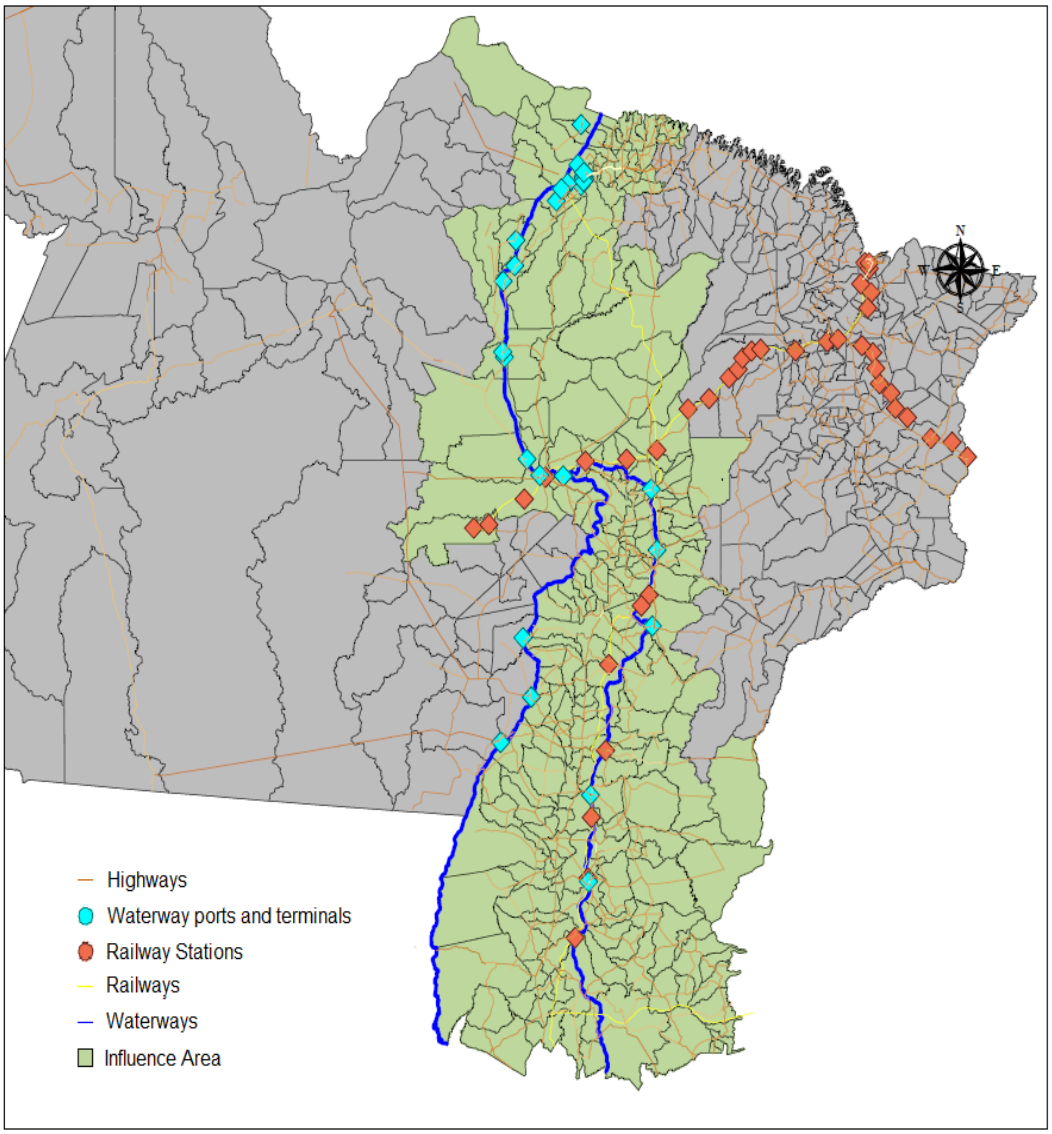


Figure 6: Tocantins river waterway influence area

Pole	Cities	Potencial - general					Railway terminal	Airport	Main production	Main industry
		Services	Farming	Industry	Total	Infrastructure				
1	Rondon do Pará	Weak	Moderate	Weak	Weak	Weak	-	-	Cattle breeding	-
	Marabá	Strong	Strong	Strong	Strong	Strong	existing	existing	Cattle breeding	Refrigerator, Steel mill, Furniture
	Novo Repartimento	Moderate	Strong	Weak	Moderate	Moderate	-	-	Cattle breeding	-
	Itupiranga	Moderate	Strong	Weak	Weak	Moderate	-	-	Cattle breeding	-
	Parauapebas						existing	-	Ores	Steel mill
2	Imperatriz	Strong	Moderate	Strong	Strong	Strong	existing	existing	Poultry farming, Cattle breeding	Construction, Paper industry, Furniture
	Açailândia	Strong	Strong	Moderate	Strong	Moderate	foreseen	-	Cattle breeding, Ores	Steel mill
3	Darcinópolis	Weak	Moderate	Weak	Weak	Strong	-	-	-	-
	Araguaina	Strong	Weak	Moderate	Strong	Moderate	existing	existing	Cattle breeding	-
	Aguiarnópolis	Weak	Weak	Weak	Weak	Strong	existing	-	Poultry farming	-
4	Carolina	Weak	Strong	Weak	Weak	Strong	-	-	Soy, Cattle breeding	-
	Porto Franco	Moderate	Moderate	Moderate	Moderate	Strong	existing	-	Cattle breeding	Bioenergy
	Estreito	Weak	Weak	Weak	Weak	Moderate	existing	-	Poultry farming, Cattle breeding	-
	Alto do Parnaiba	Weak	Weak	Weak	Weak	Weak	-	-	Soy, Corn, Cotton	-
	Balsas	Moderate	Strong	Moderate	Weak	Strong	foreseen	existing/ out of operation	Soy, Corn, Poultry farming, Cattle breeding	-
	Riachão	Weak	Moderate	Weak	Weak	Weak	foreseen	-	Soy, Corn, Poultry farming, Cattle breeding	-
	Tasso Fragoso	Weak	Strong	Weak	Weak	Weak	-	-	Soy, Corn	-
5	Guarai	Moderate	Moderate	Moderate	Moderate	Strong	existing	-	Cattle breeding	Bioenergy
	Pedro Afonso	Moderate	Strong	Moderate	Moderate	Strong	-	-	Sugarcane	-
	Carolina do Tocantins									
	Tupirama	Weak	Moderate	Weak	Weak	Strong	-	-	Sugarcane	-
6	Porto Nacional	Strong	Strong	Moderate	Moderate	Strong	existing	existing/ out of operation	Soy, Cattle breeding, Poultry farming	Bioenergy, Construction
	Palmas	Strong	Weak	Moderate	Strong	Strong	existing	existing	-	Construction
	Paraíso do Tocantins	Moderate	Weak	Moderate	Moderate	Weak	existing	-	Cattle breeding, Poultry farming	Bioenergy, Pottery
	Miracema do Tocantins	Weak	Weak	Moderate	Weak	Strong	existing	-	Cattle breeding, Poultry farming	Hydroelectric plant
8	Gurupi	Strong	Weak	Moderate	Strong	Strong	existing	existing	Cattle breeding, Industria, Rice	Refrigerator, Furniture, Rice industry
	Peixe	Moderate	Moderate	Strong	Moderate	Moderate	-	-	Cattle breeding, Industry	Paper industry
	Alvorada	Moderate	Moderate	Moderate	Moderate	Moderate	existing	-	Soy	-
	Lagoa da Confusão	Moderate	Moderate	Moderate	Weak	Weak	-	-	Soy, Cattle breeding, Ores	-
	Formoso do Araguaia	Weak	Moderate	Weak	Weak	Weak	-	-	Soy, Cattle breeding	-

GDP	
Strong	High GDP and positive growth in the last 6 years
Moderate	High GDP and stagnant growth or low GDP and positive growth
Weak	Low GDP and stagnant growth

Infrastructure	
Strong	3 ways
Moderate	2 ways
Weak	Just highways

Industry GDP high: above 240.000
Farming GDP high: above 70.000
Services GDP high: above 400.000
Total GDP high: above 1000000

Figure 7 - Worksheet to define the pole cities

V. RESULTS

Thematic maps were created to make the visualization of the results easier. Fig. 8 shows the seven poles selected for the study region.

The Pole 1 presents as main products cattle breeding and mining in Parauapebas city. For this pole, it is proposed the optimization of meat supply chain and implantation of steel mills.

The Pole 2 presents as main products cattle breeding, poultry farming and iron. The proposition for pole 2 is optimization of the meat production chain, implementation of export refrigerators and investment in infrastructure to optimize industrial production of steel in order to promote development of industries that make use of the steel.

The Pole 3 presents as main products cattle breeding and poultry farming. In addition, there is an export refrigerator in Araguaína city. An investment in agriculture-related industry was proposed to decentralize the economy of services sector and take advantage of the potential related to infrastructure of this pole. There are airport, many highways, railroad and port construction projection.

The Pole 4 has same main products identified in Pole 2. Therefore, the propositions are identical.

The Pole 5 main product is sugarcane. There is also considerable cattle breeding. In Pedro Afonso city, there is a sugarcane plant and bioenergy, and then it was proposed the implementation of technical schools for training professionals of this sector and encouraging production of biofuels and the implementation of new industries.

The Pole 6 presents as main products biofuels and soybeans. There is a hydroelectric plant in Miracema territory. For this pole, it is proposed the optimization of soybeans supply chain.

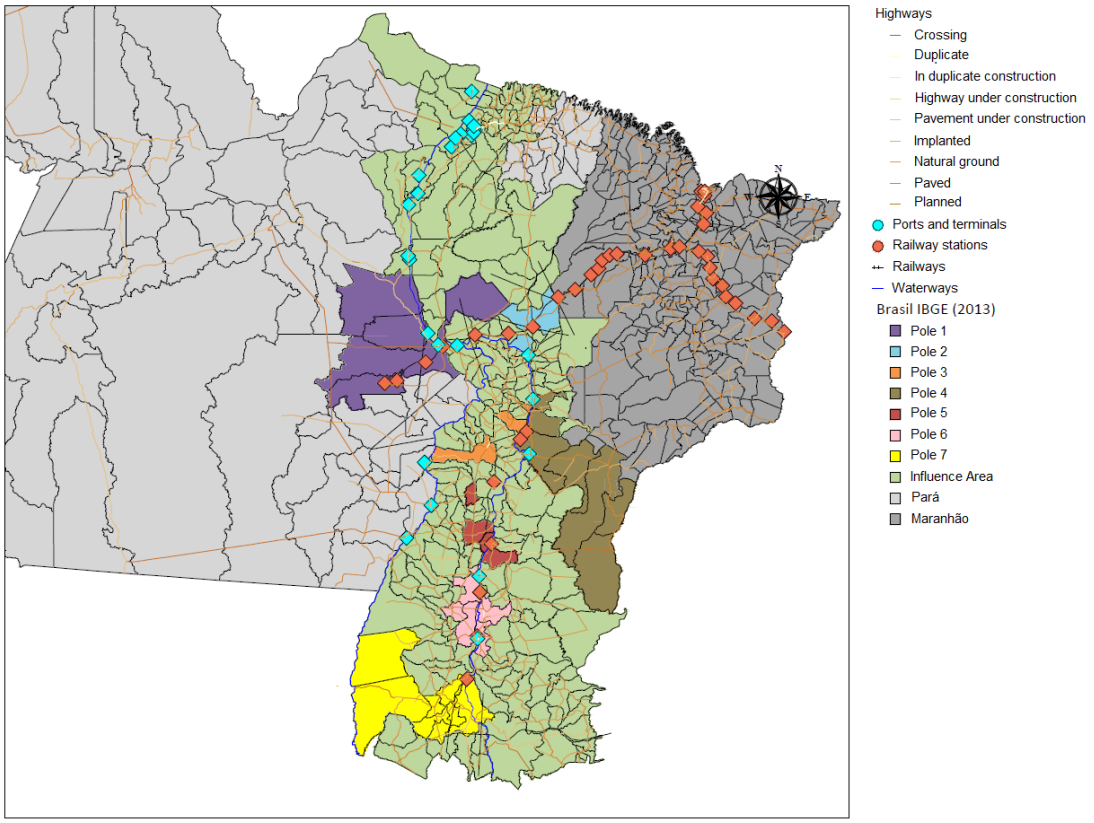
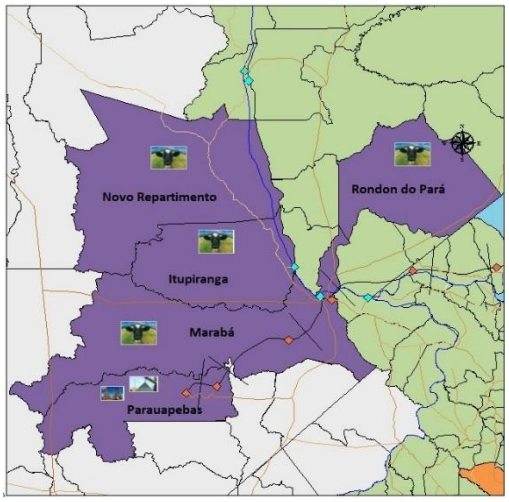


Figure 8: Identification of thePoles in the influence area

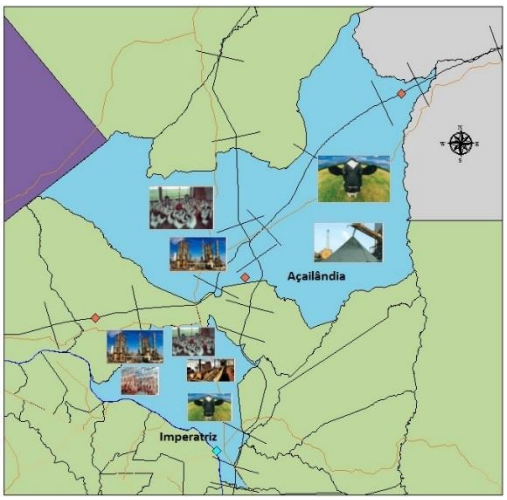
Finally, Pole 7 shows as main products cattle bredding, soybeans and mining extraction. It is proposed the meat supply chain optimization to let price more competitive, implementation of export refrigerators, infrastructure investment to reduce services sector dependence and implantation of industries that uses mining to produce products of high value.

The Fig.9 and Fig.10 illustrate the proposals for each pole.

Pole 1



Pole 2



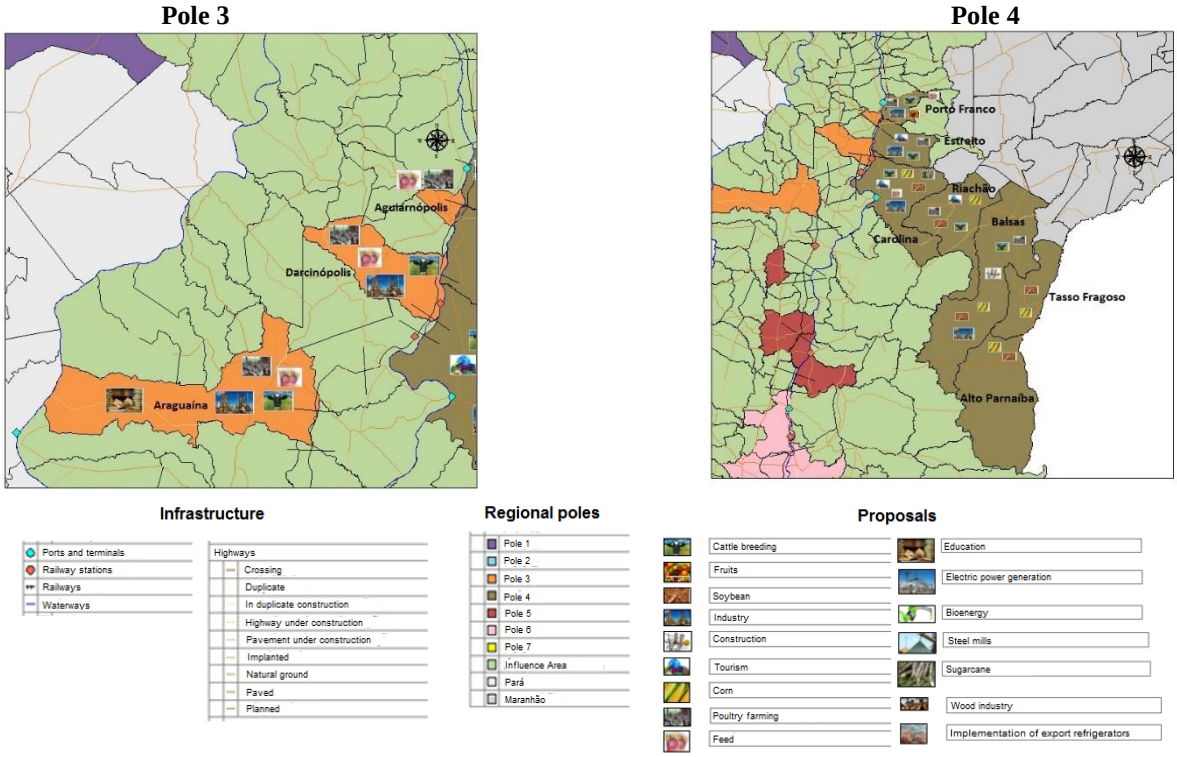
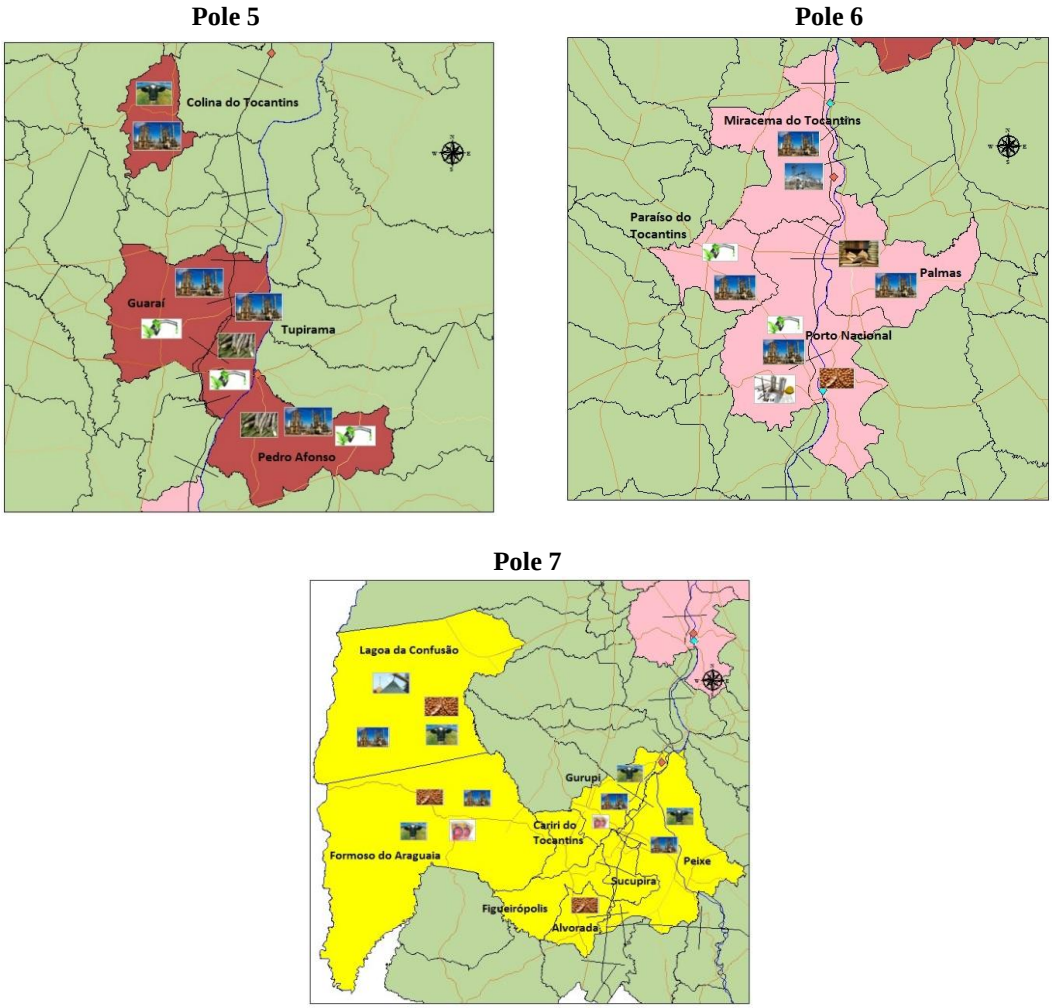


Figure 9: Propositions for Poles 1, 2, 3 e 4



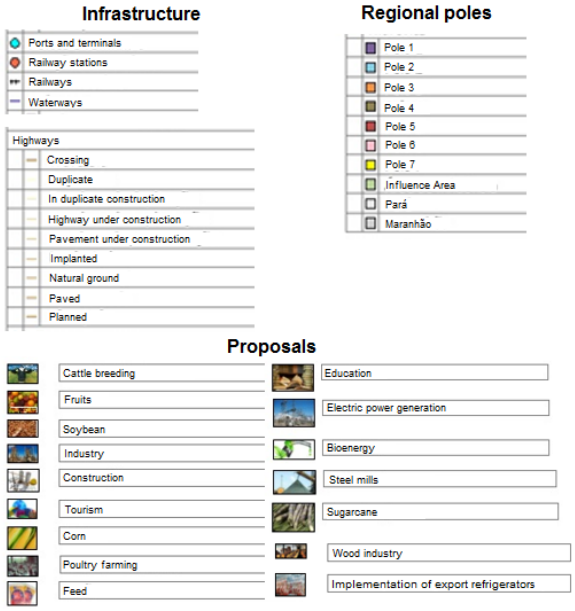


Figure 10: Propositions for Poles 1, 2, 3 e 4

VI. CONCLUSION

It is verified through this study that presented methodology is valid and that its importance in the new vision of poles, for the economic and social consolidation of a region. For Brazil with a continental dimension, it is important for national integration and reduction of social and economic inequalities. The methodology is simple, easy to use, so that small municipalities can use without great complexity, making use of data collected at the national level. It has been verified that regional development depends on investments in regional poles that they can offer infrastructure and services to fix the productive sector that is fundamental for regional and local growth and development.

Finally, it is necessary that regional poles have investment, increasing their capacity of attraction mainly of the productive sector, thus generating new fiscal spaces that will allow investments in the public services that are lacking in these regions of the interior of the country. Thus the identification of the poles, are part of the approach of territorial engineering to generate growth and development in the region.

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