STONEMEAL IN THE SOUTH OF MARANHÃO AND PIAUÍ STATES

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Abstract

According to forecast analysis based on strategic planning tools, the current model of agriculture practiced in the southern plains of Maranhão and Piauí states (Brazil) is unsustainable in the medium and long terms. Elaborated geological surveys in this region are pointing to large deposits of rocks and agrominerals, which can facilitate the practice of stonemeal. This could contribute to the conservation of soils and water resources.

Key words: stonemeal, scenario, sustainable development, agriculture.

Introduction

The territorial management experiences an impasse generated by the clash of two different visions: the conservationist versus the development vision and it does disseminate forms of planning that are unable to manage this conflict. The Renaissance, the Industrial Revolution and the emergence of economic science, had an ideal that future societies could be built on political and economic models. It was imagined to be possible to determine the future through forms of government and management for more than two centuries. These forms of governance and management were thought to be able to lead to a desirable scenario, characterized by economic growth with poverty reduction and collective comfort.

Nevertheless, societies and their civilizations remained dependent on physical-biotic environment, whose appropriation causes profound impact. It was also observed that environment analysis based in the capacity of the environment to support such activities are insufficient to achieve sustainability. Human creativity and good will should be allied with social, material, mental and spiritual necessities, using new planning tools, which were stablished in the document "future constructions through techniques of prospective scenarios," (GODET, 1985) and is the aim of this study.

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Literature Review

Scenarios

The "Scenarios" examine in a probabilistic way what restrictions may occur in a system, which will transform the current scene (diagnosed scene) to a new future state. They are based on applying conjugated techniques through well-known procedures for about half century.

Systemic vision

As a premise, the territorial analysis should address the interactions of multiple and complex systems, which consist of structural factors that are operationalized by processes already used or processes that will arise. The structural factors are climate, environmental or social resources, and the process is referred to changes that affect the future of the territory, such as social or technological changes.

Objectives and implementation of scenarios

The main objectives of the "Scenarios" studies are:

- Establishment of criteria for sustainable exploitation;
- Cost/benefit assessment of economic exploitation;
- Visualization of cross impact;
- Pre-restriction of public policies;
- Evidences of preventive, corrective and migration actions;
- Act as enabler instrument in formulate social pacts.

During the years of 2006 to 2009, the authors have developed studies of insertion of "Scenarios" in the ecologic-economic zoning (Zoneamento Ecológico-Ecômico – ZEE) of Piauí and Maranhão states, using a methodological scheme as shown in Figure 1.

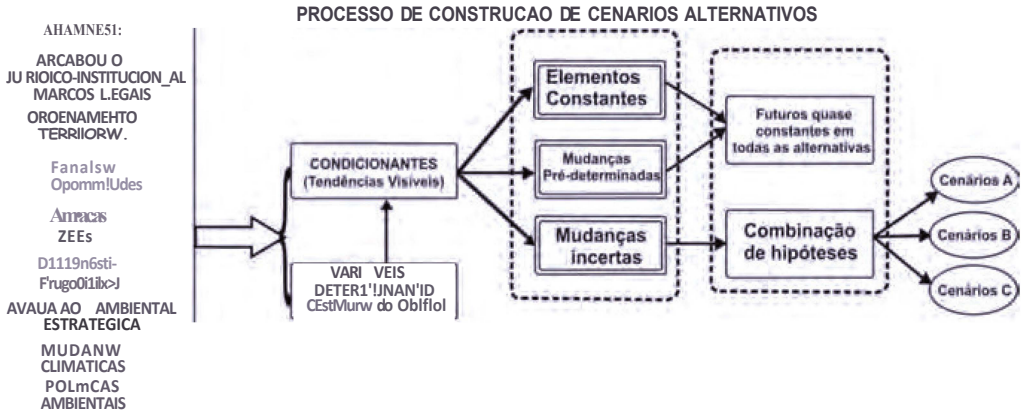


Figure 1. Methodology and techniques of building "Scenarios". Modified Buarque (2003).

Aiming to narrow the focus of the "scenarios" investigations, information was grouped in database after they were geoprocessed in order to identify typified situations by variables essentials to territorial planning, such as: (i) location of potentialities; (ii) weakness of different environment resources; (iii) current and potential uses of the territory; (iv) areas of the "National System of Conservation Units" (Sistema Nacional de Unidades de Conservação – SNUC); (v) restricted areas by the Brazilian Forest Code; (vi) permanent protected areas; (vii) potential or existing conflict zones; (viii) economic areas (ix) areas for future reserves.

Uses of Territory

It was observed that the economic "scenarios" drawn up for the analyzed region, neglect the role of mineral resources, which, if justifiable by the small contribution of the mineral sector, hides the fact that a systemic perspective the mineral activities is fundamental to the emergence and development of different economic systems. It can also contribute adding value to environmental services.

Agribusiness

In addition to hosting important agricultural belts for export commodities, Maranhão and Piauí states should host important agro-industrial hubs in their southern-central portions. This is where these activities are already concentrated (mostly soy beans and other grains, but also livestock), and they will probably expand further. In this scenario, an increased demand on agriculture and water resources is expected. The comparative advantages represented by geographical and by the transport logistic network overlap different conditions of agriculture suitability, including vast fertile prospective territories to practice the most different kinds of agribusiness. Nonetheless, it is important to point that the current exploratory agricultural model leads to degradation of water resources.

Economic Vectors

The scenes, in the next 20 years, will be dominated by serving the need of grain productions for foreign markets, following the country predictable strategies. Among the mineral sector opportunities, in addition to gold, gypsum and construction materials, the geological context is favorable to discoveries of gems, industrial minerals, agrominerals (P, K, Ca, Mg) and rock dust. Groups of actions of different government institutions such as MME, DNPM and CPRM/SGB, better equipped and properly oriented, should be reflected in the form of great improvements, which will be able to influence the trend in this scenario through different options for resources exploitation.

Southern portion of Maranhão and Piauí: extensive grain cultivation

The landscape is dominated by plains, plateaus and “cuestas” sheltered by a warmer climate, well-defined seasons, where grain farming is practiced, especially of soybeans. The presence of mineral resources that can be applied in the correction of soil fertility is an element of comparative advantage. It would add up surface and underground water resources. The risks are related to the susceptibility of soil erosion and consequent siltation of drainages, with severe impact on surface waters.

The potential of groundwater is significant, but there is not enough data to enable its capture and safe use. It has to be considered that ground waters are non-renewable resources (in historic time). In "Vale do Gurgueia (PI)," for example, for about four decades, the indiscriminate use of underground wells has decreased water levels at rates of 1m/year. Considering that groundwater it not a renewable resource in the short term, it is important to consider the aquifer's recharge rate, in order to promote management practices for agriculture with adequate herbicide and fertilizer use. In the carved valleys, the most likely economic use is the development of agriculture, livestock and forest systems.

Determinant Variables (elements)

The regional economy is structured in two main lines of dynamism and modernization (i) agribusiness, with emphasis on the modern production of southern region, where it does expand the soybean crop and livestock; (ii) mineral and metallurgical complex, concentrated in the West region (Açailândia, Imperatriz and Santa Inês), in Northern region of Maranhão, and above all, in the surroundings of São Luís based on production and processing of aluminum, and iron mining, as well as, (iii) tourist activities related to the potential of coastal zone and some countryside regions that are favored by natural beauty and cultural richness, derived from pre-Columbian people and European settlements.

Infrastructure

The infrastructure is connected to a set of multimodal transport, which corresponds to the North-Central of Central region of Brazil, and North/Northeast Corridors, that goes throughout the waterway of Araguaia-Tocantins, the North/South Railroad; Carajás railroad corridor, and integrated to the traditional road system and to the rail system of railway company of Nordeste (CFN). Maranhão state articulates itself within this privileged mode, with other extensive regions of the country, covering all or part of the State of Piauí in the Northeast region of Pará, Tocantins, Bahia and Mato Grosso. Maranhão state also articulates itself with the rest of the country and abroad, via cabotage (coastal navigation) through the port complex of Itaqui waterway formed by the rivers Tocantins, Araguaia and Mortes, which are integrated to road segments to North-South railroads and Carajás.

Emerging Factors

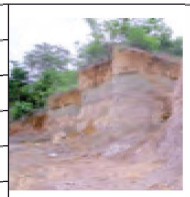
Recent factors are notable (past two decades) such as the emergence of intensive agriculture in the plains of Southern Maranhão state and of Piauí and Tocantins, as well as, the great hub development in Carajás (Pará), with deep changes in the regional economy, which were already impacted by the creation of State of Tocantins.

Constraints

Occurrences of carbonate lenses on the edges of the plateaus should be highlighted, where actually happen the large agricultural practices, and to which it has to be added that the geological surveys carried out in the Parnaíba basin, has emphasized the geological potential of sedimentary formation, regarding agrominerals, dolostone, limestone, gypsum and phosphate, mostly.

The occurrence of extensive volcanic formations represented by extensive basalts spills and diabase dikes of Mosquito formations, in Maranhão state, and Sardinha, in Piauí state in the Northeast region, illustrate the potential for the production of rock power for stonemeal, and the possibility of finding specialized alkaline lines, should not be ruled out. These alkaline lines consist of ultra-potassium rock (kamafugitics), which are common in this type of terrain. In order to investigate, even preliminarily these geological environments, recent fieldwork from programs that study the regional geodiversity, collected samples to perform chemical analysis, as illustrated in Table 1. It was observed different quimism and conditions of outcropping of “Pastos Bons” formation and of Mosquito and Sardinha basalts.

Table 1. Analytical results from samples collected in the project "Survey of Geodiversity in Maranhão".

IDENTIFICACAO DAS AMOSTRAS								
Amostra	**TAF980**		**TAF981**		**TAF982**			
Ambiencia	Siltite esverdeade da forma<;ae Pastes Bens		Calcarenite fine da forma<;ae Pastes Bens		Sequencia de pelites na fo Pastes Bens			
Si02	60,18		68,07		65,37			
Ti02	0,87		1,86		0,17			
Al203	16,39		15,63		5,72			
Fe203	8,19		6,49		1,54			
MnO	0,03		0,08		0,06			
MgO	4,36		2,15		1,78			
Cao	0,63		0,33		10,42			
Na20	0,21		0,14		0,27			
K20	5,91		3,89		1,89			
$P20_5$	0,02		0,28		0,05			
P.F.	5,75		4,8		8,48			
Soma	102,57		103,73		95,77			

Regarding the sediments of "Pastos Bons", it is emphasized that the sedimentary record is still unknown and the extension and location of their potential, lack complementary studies. The samples collected showed a very promising chemical composition for stonemeal practice, including the presence of carbonate and some phosphorus. The geographic extension, the variability of faceis, and the fact that these sediments are poorly consolidated, flat and with high surfaces, gives them a favorable exploitation through open-pit benches characteristic.

The sedimentary package has compositional characteristic, highlighting zeolites that cement the sandstones of Corda formation, interspersed with basalts of Mosquito formation (Rezende 2002). Although the occurrence of zeolites through supergene processes in sandstones associated with volcanic rocks has been well known for a long time, it should be emphasized the excellence of the geological conditions that characterize the Southern region of Maranhão state, which are explicit by their occurrence in the surface (Figure 2) and subsurface.

It turns out that what the economy sought to achieve in the previous research was directed to the use of zeolites as pure specie, which makes it more difficult by the fact that we are dealing with an universe of 200 mineral species. In the case of stonemeal, there are factors regarding the crystalline grid type arising from small changes in their chemical content that not have the same relative importance (restrictions), once compared to the uses that monomineralic rocks require.

Figure 2. Outcrops of zeolite sandstones

In regards to the basalts, two major magmatic pulses exist aging between 160-190 m.a (Mosquito formation), which occupies a westernmost position in Maranhão basin. The other magmatic pulse, aged between 115-122 m.a (Sardinha formation), is on the eastern shore of the basin.

These two distinct geochemical features, which allows us to predict their use as remineralizers of soils, will reveal distinct results. Highlighting that the Eastern province has the largest content in Fe, Ti, Mn, Na, K and P and lowest content in Mg (Table 2).

Table 2. Comparison between basalts of Mosquito and Sardinha formations, sample from this study.

Elementos	Provincia Ocidental - Baixo Ti Formayao Mosquito ldade: 160-190 m.a.	Provincia Oriental - Alto Ti Forma<;ao Sardinha ldade: 115-122 m.a.	Amostra TAF983 Forma<;ao Mosquito
$Si0_2$	51,5-53,5%	49,20-53,00%	49,79%
$Ti0_2$	1,03-1,8%	2,5-4,14%	1,73%
Al_20_3	14-15%	12,8-14,5%	14,83
Fe_20_3	9,5-10,3%	12-13,8%	12,69%
MnO	0,14-0,18%	0,17-0,20%	0,2%
MgO	6,0-8,0%	4,2-5,3%	5,61%
CaO	9,3-11,6%	5,4-9,10%	9,5%
Na_20	1,80-2,50%	2,5-4,0%	1,75%
0	0,60-1,50%	1,5-2,5%	1,88%
P_2O_5	0,14-0,19%	0,5%-1,0%	0,15%

Fonte: Fodor et al. (1990), modificado.

Uncertain changes

Even though the economic development from the perspective of meeting the external demands for commodities over the next 20 or 25 years come to confirm itself and the pre-conditions referred by ZEE and Economic Scenarios studies, the following questions should be made: a) "Do the zoning and the scenarios carried out, cover all the facets of a project of sustainable development?"; b) "How will the preservation of environmental services be carried out?"; c) "What are the strategies for improvements in economic processes, with a view to environmental sustainability (economic, social and natural environment)?" This study focused especially on scientific researches and promoting the technological innovations such as stonemeal, in order to enable a future that, in addition to expanding the economic opportunities, it also incorporates environmental sustainability to agribusiness.

Conclusions

Combining all the elements of knowledge of the geodiversity mentioned before, we can highlight some basics of a general strategy to guide the sustainable development in Maranhão state. The first point to consider and the prediction of the most likely scenario according to FAO (Food and Agriculture Organization) will be marked by a large increase in world's demand for food. Such prediction took into account the economic growth of emerging economies on the planet and social ascension of a large poor social segment. According to these predictions, Brazil must contribute to 40% of this demand.

The strategic point of view, at a national level, shows that the major bottleneck, today, is the logistic of transport to the drain ports, since; regionally the area studied has a relatively privileged situation. The modern agribusiness is based in climate + water + soil correctives, and in this context, the availability of classic agrominerals and the discovery of other types, which are beginning to be evidenced, configure themselves as fundamental elements for sustainability of this economic axis. The mining role in the capital accumulation and gross domestic product (GDP) is well known, and the states of Maranhão and Piauí still have not revealed their potential due to the lack of suitable geological knowledge.

The exploitation of construction materials, agrominerals and gems create opportunities for new public policies that promote associativity and the local productive arrangements (LPA), seeking to meet the demand for an inclusive economic growth.

Lastly, permeating all the lines of development, it is worth mentioning that the strategic role of education and technological research that should be aligned to the strategic plan under penalty of the final scene be characterized by a low local social development and economic, which results in a rush into other decision-making cores, leaving to the local populations to inherit the environmental liabilities.

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