AGROCLIMATIC ZONING FOR SUGARCANE IN RIO GRANDE DO SUL, BRAZIL: SPATIAL DISPERSION, RISKS FOR ACTORS AND CAPACITY DIMENSIONING

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ABSTRACT: Edaphoclimatic conditions are essentials on sugarcane feasibility, but not enough. MAPA (*Ministério da Agricultura, Pecuária e Abastecimento*) defined sugarcane agro-climatic zoning on April, 2009 for Rio Grande do Sul (RS) state, Brazil, based on granulometric criteria. The ethanol self-sufficiency for this state, however, depends on climatic conditions and land occupation patterns, which depend on agreement of involved actors. An agro-industrial capacity model will be posed to discussion.

KEYWORDS: ZONING, SPATIAL DISPERSION, AGRO INDUSTRIAL CAPACITY.

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ZONEAMENTO AGROCLIMÁTICO PARA A CANA-DE-AÇÚCAR NO RIO GRANDE DO SUL, BRASIL: DISPERSÃO ESPACIAL, RISCO DOS ATORES E DIMENSIONAMENTO DA CAPACIDADE

RESUMO: Condições edafoclimáticas são essenciais à exploração da cana-de-açúcar, mas não suficientes. O zoneamento para o Rio Grande do Sul, Brasil, definido pelo MAPA (Ministério da Agricultura, Pecuária e Abastecimento) em Abril de 2009 determina critérios granulométricos. A auto-suficiência do estado na produção de etanol, no entanto, depende do clima e da transformação do padrão atual de ocupação espacial, que depende do consenso entre os atores envolvidos. Um modelo de capacidade agro-industrial será colocado em discussão.

PALAVRAS-CHAVE: ZONEAMENTO, DISPERSÃO ESPACIAL, CAPACIDADE AGRO INDUSTRIAL.

INTRODUCTION: Spatial dispersion/density is the concentration degree of a given activity in the geographic space. In agribusiness (farmers/producers and agro-industry), this ratio depends on endogenous factors (management and chosen technology) and of exogenous ones, such as climatic and soil conditions and sharing patterns of land occupation. The latter, is the object study focus, and performs in the continuum monoculture-diversification. As *vontünian* approach points, the costs transportation feasibility of an agro industrial raw material is trapped inside a circular area, where the center is the industry itself (ABLER, 1977:347). The capacity limit is determined by the concentration degree of that raw material inside that circular area. In Figure 1(a) the low raw material (RM) offer determines a smaller industry capacity. In Figure 1(b) the industrial capacity can be augmented due to the higher offer. The capacity limit would end on the maximum that circular area performs. But the minimum feasible capacity is governed by market costs and investments. If RM offer is less than the feasible, the industry would be smaller and unfeasible too, or will work on idleness, while negotiations with owners' of no productive/other activities areas performs ('beehive', in Figure 1). In practice, economical, political, social and institutional constraints of a constituted society are the truly restrictions for the availability (or not) of the remained reachable (due to transportation costs) areas occupied with other activities. The *RACM* (*Relative Agro-industrial Capacity Model*) searches to enlighten this problematic and will be applied to '*Agro-climatic risk zoning for sugarcane in Rio Grande do Sul*' (RS), resolution published by the Brazilian federal administration through *Portaria 54*, April 16 of 2009 (MAPA, 2009). RS state spatial dispersion patterns will be confronted with the São Paulo state's ones.

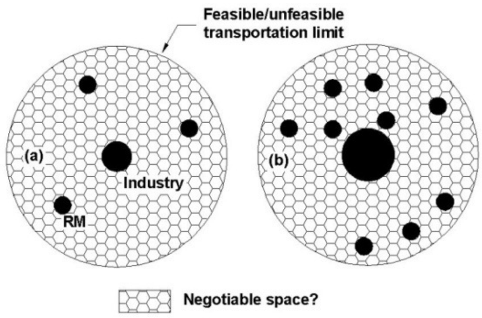

Figure 1: Spatial dispersion phenomenon.

MATERIALS AND METHODS: This study is based on IBGE-Sidra agrarian 2007 county data and base maps are IBGE source. Both data were processed on Esri ArcGis. The basic assumption is that <u>current density/dispersion of such occupied area is the initial pattern to evaluate the room to needed area</u>. The ratio between current area and available area determines the current dispersion. Constraints of sugarcane culture are: (i) feasible distance from industry to sugarcane suppliers (due to transportation costs), (ii) sugarcane density/dispersion in that circular area (shared areas with other activities), (iii) sugarcane hectare productivity and, (iv) ATR (*Açúcar Total Recuperável* – total sugar content) of sugarcane variety. Variables (iii) and (iv) will be accounted as only one: productivity (P=tons/Ha).

The most localization/capacity models assumptions (i.e. *weberian* triangle – WEBER (1929)) are concerned to <u>yet established</u> demand (people/industries needing products/services/raw materials) and over that conditions, dimensioning/locating can be estimated. Differently is when planners must consider the <u>all</u> supply chain (farmers and industry availability) <u>before</u> both installations. That seems to be the case of RS state, because Brazilian high developed sugarcane market/technology dictates exigent rules against low tradition of sugarcane exploitation in RS state, with less room to reformulations.

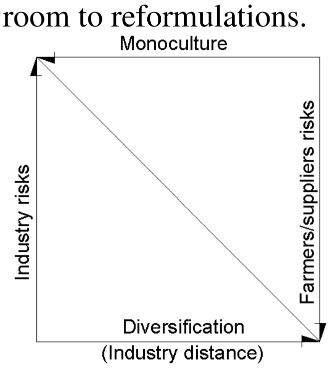

Figure 2: Agro-livestock risk-dispersion trade-offs.

Through the *agro-livestock risk-dispersion diagram* of Figure 2, we can observe contradictions above described. The industry risk is affected directly proportional to distance/variety, and farmers/suppliers are affected inversely proportional. Industry prefers monoculture, but farmers distrust about it preferring their revenues as outcomes of some variety of activities. The length of operating radius is in the continuum monoculture-diversification.

The economic logic of efforts for agreement pursues negative synergy. The problematic is nearer to game theory than of location theories, because uncertainty about risks (ABLER, 1977:478).

RS state consumes more than one billion ethanol liters due to its fleet of flex fuel cars. Southeast region yields 6.3m^3 ethanol/Ha with productivity of 78 ton/Ha (MARIANTE, 2007). So, needed area (NA) would be:

$$NA = \frac{1{,}000{,}000}{6.3} = 158{,}730\ Ha$$

But this implies that all this area is filled with sugarcane with density of 100%. The effective area depends on productivity and density. So, computations are not so easy. This business is mutual dependent of industry and suppliers because capacity depends on area density. The effective occupied area (EA) inside the available area (AA) determines the density ratio ($0 \leq EA/AA < 1$). The feasible distance (FD) to/from raw material, and productivity (P), are also determinants of capacity. So, a *relative agro-industrial capacity model* (***RACM***) will be formulated for estimate the available capacity (AC), where:

$$AC = \frac{EA}{AA} \times P \times \pi FD^2$$

where AC and P are in tons; EA and AA are in Ha, and FD = hm (km x 10).

Example:

FD = 30 km; AA = 20 million Ha; EA = 3 million Ha; P = 100 tons Ha^{-1};

$$AC = \frac{3}{20} \times 100 \times \pi 300^2 = 4.241.150\,tons$$

Although RACM cannot be considered deterministic, it is a good approximation for evaluating starting point, relative to current spatial dispersion in the magnitude range. As seen below, manipulating the same formula, FD can be estimated for minimum feasible industry capacity.

RESULTS AND DISCUSSION: The basic recommendations of *Portaria 54* for RS state are: 214 counties (*municípios*) with soils type 1, 2 and 3 (gritty, medium, and loamy, respectively), where 181 of them are recommended for ethanol production because their less than 12 degrees slope. The remaining are indicated also for fodder, spirits, etc. (MAPA, 2008; MAPA, 2009). Past hydro climatic studies did not recommend RS state for sugarcane production and only were included some areas as "*marginal-thermal restricted*" (CAMARGO, 1976). This is confirmed today, when analyzed over than 500 Ha effective 2007 county production inside recommended areas of RS and compared with SP standards, what results in a very differentiated dispersion/density patterns (see Figure 3).

Recommended zoning for RS performs an area of 9.281.773 Ha yielding 962.480 sugarcane tons in 2007 in 23.575 Ha produced (an average of 40.8 ton. Ha^{-1}), with spatial density/dispersion of 0.00254, or approximately 0.3%. Because that low ratio and for comparison purpose, it was applied a filter cutting areas lower than 500 Ha of sugarcane/county production, because (as seen in Figure 3, right) most of SP counties are over that reference. Doing so, only seven RS counties in 2007 had a minimum of 500 Ha (Figure 3, left, red symbols). In accordance with that contrast, maximum RS county production was 1,950 Ha in a density of 5%, while correspondent SP county production was 93,000 Ha, with a density of 63%.

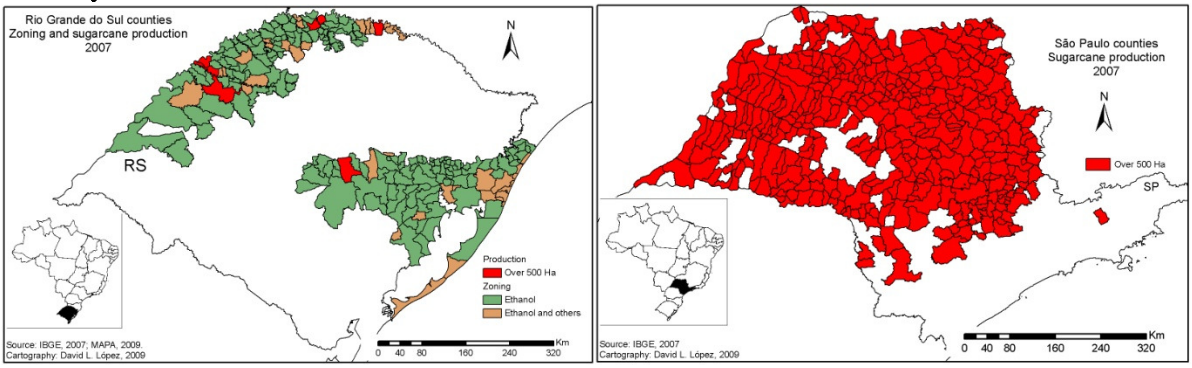

Figure 3: Recommended zoning for RS and compared production with SP – IBGE (2007), MAPA (2009).

Sugarcane industrialization force suppliers' location within 30 km of industry. (RODRIGUES, 2008; CHIARA, 2003). In searching more productivity, newer industries are being installed in SP, GO, MT and MG (central states) with mill capacity from two to four million tons/yr. (UDOP, 2006). See in Figure 4 a 30 km buffer in SP state (394 counties with 500 ≤ Ha produced ≤ 93,000). See also that Marília micro region (green) has no industries because has no sugarcane, confirming that location is critical in this industry.

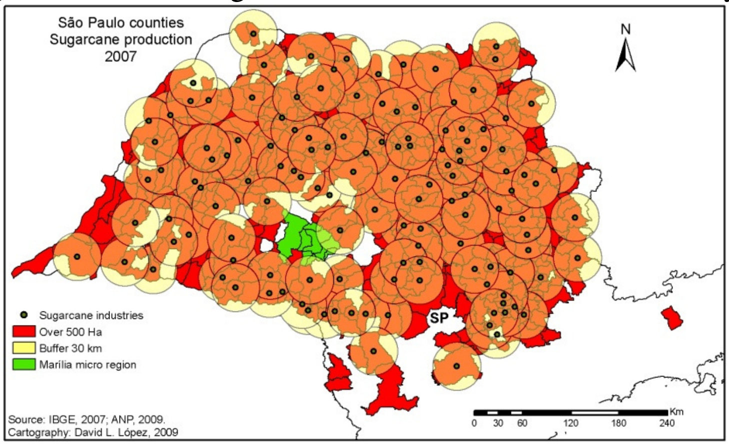

Figure 4: Sugarcane industries in SP state in a 30 km buffer.

Analyzing soil occupation related with other activities in SP it was found a dispersion/density of 22.3%. Applying RACM to four million tons industry capacity, with productivity of 80 tons ha^{-1}, we can verify the statement of 30 km. So,

If, $AC = \frac{EA}{AA} \times P \times \pi FD^2$, *then* $FD = \sqrt{\frac{AA}{EA \times \pi \times P} \times AC} = \sqrt{\frac{4.000.000}{0{,}223 \times \pi \times 80}} = 267 \text{ or } 26.7\ km$

Computing with two million tons capacity, the distance is reduced to 19 km. So, if industries were closest among them, would be less risks of idleness and lessen risks of lack of row materials.

However, in RS, the spatial analysis points a very low spatial density of sugarcane. Applying RACM to only two million milling capacity, with the state density of 0.3% and productivity of 41 ton/Ha, would be necessary a 228 km radius to reach the necessary raw material (almost 8 times the feasible cost distance). So, the capacity must be reduced to approximately 50,000 tons/yr. When considered the seven counties with more than 500 Ha, 52 tons/Ha productivity and 1.5% density, the theoretical capacity grows to 220,000 tons/yr (something attractive). However, the distance jumps to 230 km among them (see red scattered counties in RS map - Figure 3). Even considering the optimist average yield of 52 tons/Ha, for a one billion liters demand, would be necessary effective 250,000 Ha of sugarcane and 260 processing small industries, or 60 of 220,000 tons/yr. (even though, between ten to twenty times smaller than SP ones).

CONCLUSIONS: This study is neither conclusive nor predictive. The restraints are only pointed; local society actions will determine the timing of changes. This approach on spatial analysis searches to enlighten the complexity of area reallocation through the RACM (Relative Agro-industrial Capacity Model) over climatic and spatial restrictions. Because contradictions about risks for the industry and suppliers, RACM searches to estimate industrial capacity and distance, as interrelated functions of occupation density, pointing restrictions. Eventual solutions will be in geographical, political, economical, social and institutional fields. The more complex, diversified and structured yet established society, the more difficult to install a new supply chain involving a large shared space area.

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