José Goldemberg. "THE STATE OF SÃO PAULO STRATEGY FOR FUEL ETHANOL", p.19-26. In Luis Augusto Barbosa Cortez (Coord.). **Sugarcane bioethanol — R&D for Productivity and Sustainability**, São Paulo: Editora Edgard Blücher, 2014.
http://dx.doi.org/10.5151/BlucherOA-Sugarcane-SUGARCANEBIOETHANOL_5

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THE STATE OF SÃO PAULO STRATEGY FOR FUEL ETHANOL

José Goldemberg

The strategy of the State of São Paulo for the expansion of ethanol production is based on a sustainable expansion with low environmental and social impacts. The main components of this strategy are:

1. Improve the efficiency of 1st generation technology presently in use. It is estimated that the average productivity over the next 10 years will increase by nearly 30%.
2. Increase cogeneration of electricity using bagasse from sugarcane.
3. Phase out manual harvesting of sugarcane and accelerate mechanization in areas with slopes less than 12%.
4. Guide the expansion of the cultivated area of sugarcane – which currently stands at 4.34 million hectares – to degraded pastures of which there are about 10 million hectares only in the State of São Paulo.
5. Promote the construction of pipelines to reduce the cost of transporting ethanol from producing regions to major consumer centers and ports for export.
6. Ecological-economic zoning – EEZ and creation of new conservation areas.
7. Introduction of advanced 2nd generation technologies for the production of ethanol.
8. Promote the development of alcoolchemistry.

We discuss below in some detail the proposed measures, some of which are already being implemented.

IMPROVING THE EFFICIENCY OF 1ST GENERATION TECHNOLOGY

Currently the production of ethanol from sugarcane in Brazil is based solely on "1st generation technology" in which the sucrose is fermented. This sucrose, however, represents only 1/3 of the energy content of sugarcane as shown in Figure 1.

Bagasse is used to produce heat and electricity required for production of ethanol, creating an additional surplus electricity that can be feed into to the grid.

The use of bagasse for this dual purpose is the reason why the energy balance of ethanol production from sugarcane is highly positive, since no fossil fuels are used in except those that are embedded in the fertilizers and pesticides in addition to the diesel oil used (in agricultural equipment) in the transport of cane from the feeds to the distillery. The energy balance in ethanol production, i.e. the ratio of energy contained in a given volume of ethanol to the fossil energy used in its preparation, is 8-10:1. In the United States energy balance for the production of ethanol from corn is only 1.3:1.

The productivity in the production of ethanol in the country has grown enormously in the last 29 years, at an average rate of 3.77% per year. (Figure 2).

This is due to improvements in the agricultural stage by selecting the best strains as well as other gains in other stages of the process:

- Increase in recoverable sugar: 1.45% per year.

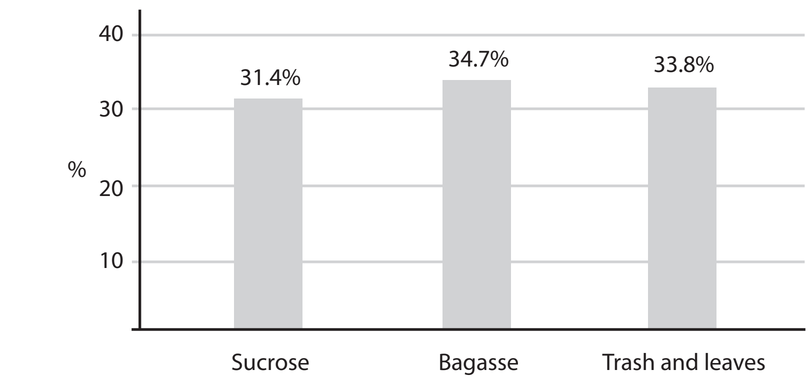


FIGURE 1 Energy contained in sugarcane.

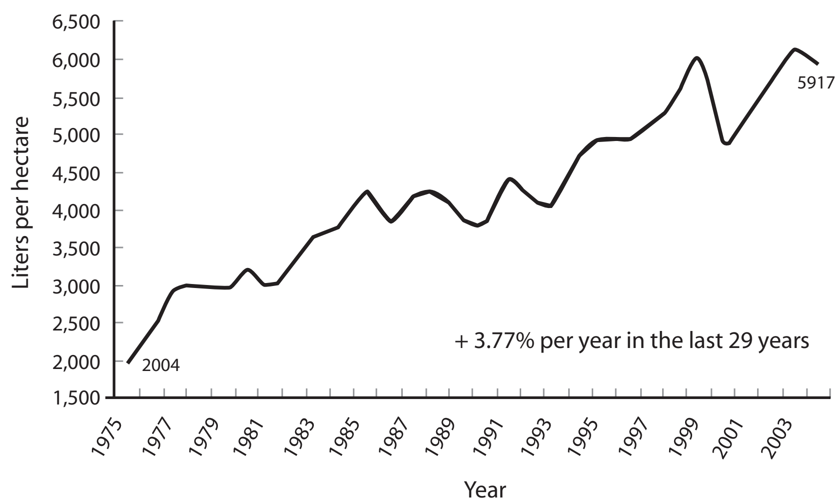


FIGURE 2 Productivity in the production of ethanol (liters/ha/year).

- Extraction of sugar: 0.3% per year.
- Increase the volume of sugarcane: 0.73% per year.
- Improvements in fermentation: 0.3% per year.

Figure 3 shows the agro-industrial productivity of a sample of 116 plants in Central-South Brazil, whose average value is 8,000 to 8,500 liters of ethanol per hectare. There are other plants with lower and higher productivities. The challenge that the State of São Paulo is facing at the moment is to increase the productivity of less efficient plants.

It is believed that there are still gains to be achieved in the next 10 years:

- 12% in the volume of cane;
- 6.4% in recoverable sugar;
- 6.2% in the fermentation process; and
- 2% in the extraction of sugar.

The efficiency of existing plants is shown in Table 1.

It is estimated that "state of the art" distilleries would cost about 20% more than the "new" distilleries.

The main potential gains may occur in the following areas:

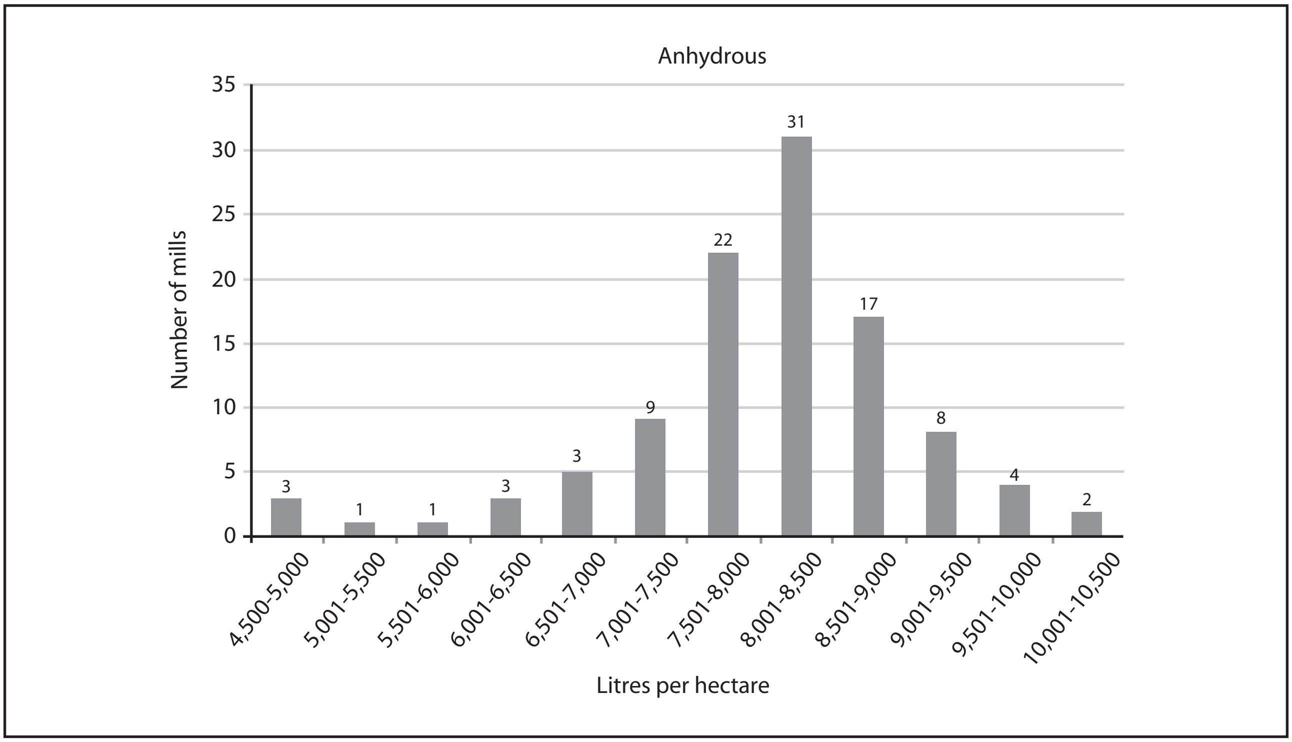


FIGURE 3 Yields at brazilian distilleries.

TABLE 1 Overall efficiency of ethanol distilleries.

Current distilleries	75%
New distilleries	81%
"State-of-the-Art" distilleries	88%

- Fermentation: current may rise 85% to 92%
- Extraction: current may rise 97.5% to 98.6%
- Distillation and dehydration: current may rise 99% to 99.7%

INCREASE THE COGENERATION OF ELECTRICITY PRODUCTION

In the past the boilers used to produce steam for the sugar processing and evaporation of fermented cane mash were of low efficiency (typically 20 bar). The amounts of bagasse found in a distillery are immense and the use of inefficient boilers was justified by the need to incinerate the bagasse which left in the fields gave rise to environmental problems. With the gradual implementation of mechanical harvesting of sugarcane the amount of biomass available for cogeneration has increased even more.

Steps taken by the Secretaria do Meio Ambietne of São Paulo led the BNDES to develop mechanisms that encourage plant owners to upgrade their boilers, creating a differential in interest rates of BNDES for more efficient cogeneration equipment for electricity and steam production.

A problem to be solved is the interconnection with the utility companies that distribute electricity. Possibility splitting the generation of electricity from the production of sugar and ethanol, exempting from taxes the exchange of energy and bagasse between the two companies.

The Department of Energy of the State of São Paulo is working on the planning of interconnections, to create transmission subsystems serving various distilleries thus reducing its costs.

The ethanol plants in operation today are providing the electricity grid with about 1,000 average megawatts, which complements the hydroelectric generation in the Southeast in the "dry season" (April-November) which is when the ethanol plants are operating at full steam. This power could be increased fourfold if all the plants in the state were modernized and the period in which electricity is produced (6 months) could be extended with the use of cane trash.

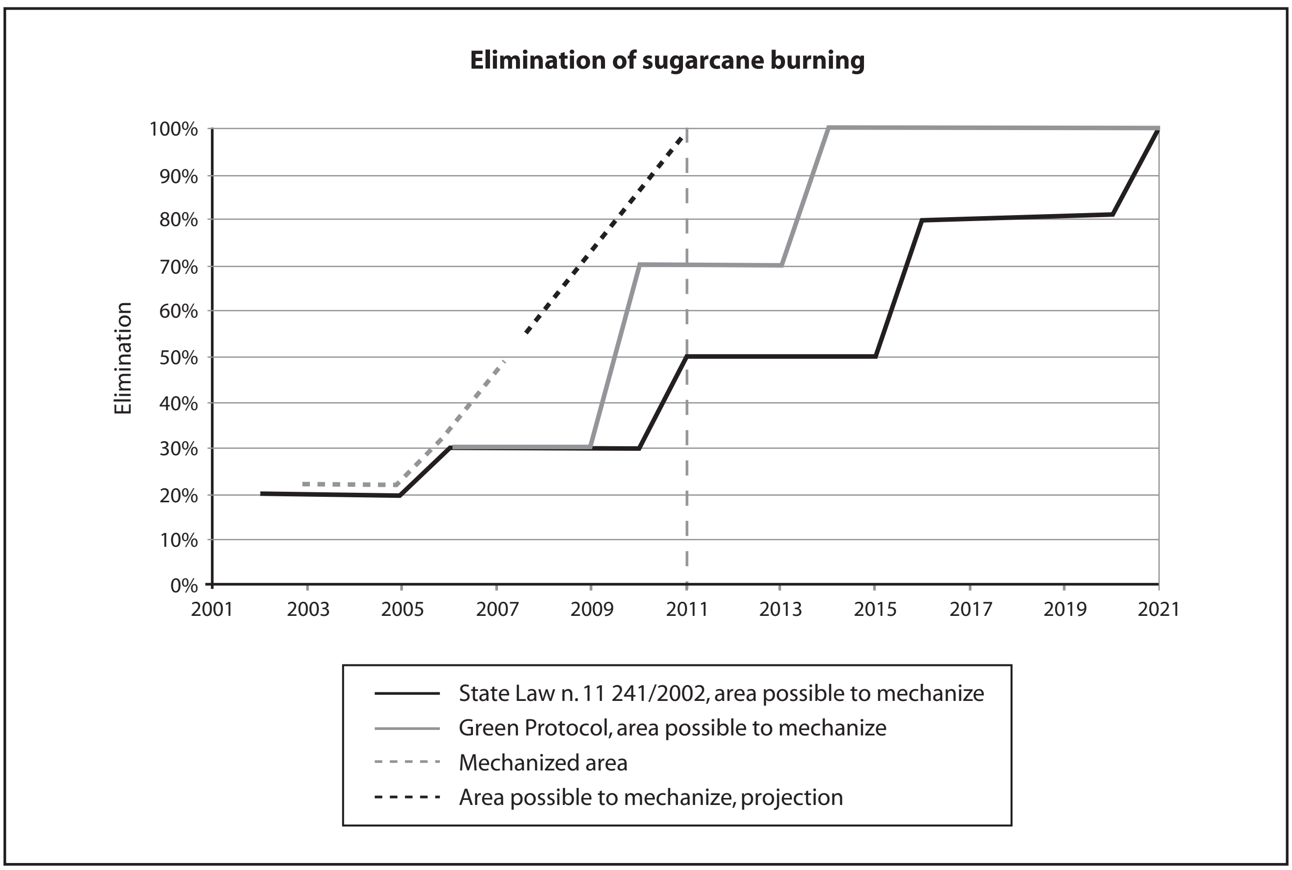
GRADUAL ELIMINATION OF MANUAL HARVESTING

The burning of the cane before harvesting is an ancient practice to facilitate cutting and eliminate animals such as poisonous spiders and snakes. But the burning can damage the tissue of sugarcane, increasing the risk of disease in the cane, causing the destruction of organic matter and damaging the soil structure due to lack of moisture increasing the risk of soil erosion.

The open fires also result in risks to the electricity lines, railroads, highways and forest reserves and cause undesirable air emissions such as CO, CH_4, non-methane organic compounds and particulate matter. The burning of sugarcane is also responsible for the increase in tropospheric ozone concentration in areas where it occurs.

For these reasons, for years attempts were made to introduce mechanized harvesting, which finally became a reality with the approval of the São Paulo State Law n. 11 241/2002. What the law has established was a timetable for the introduction of mechanized harvesting as shown in Figure 4.

In practice mechanical cutting is occurring faster than anticipated in the Law. In 2007 more than 40% of sugarcane was cut by machines and by 2009 this percentage exceeded 50%.



Source: Available at: <http://homologa.ambiente.sp.gov.br:80/etanolverde/resultado.asp>.

FIGURE 4 Evolution of mechanized harvesting for sugarcane.

In 2007 the Secretaria do Meio Ambiente and UNICA signed a voluntary agreement with the goal of rewarding good practices in the field of sugarcane. About 145 distilleries (89% of plants established in the State of São Paulo) agreed to bring forward the timetable for the complete elimination of manual cutting for 2014 in areas with scopes of less than 12% and by 2019 for higher scopes. The same protocol was also signed by Orplana, association representing 13,000 small sugarcane suppliers, in March 2008 committing the whole chain with the elimination of burning.

It is, therefore, a problem being solved in the State of São Paulo.

THE EXPANSION OF SUGARCANE IN THE STATE OF SÃO PAULO

Figure 5 shows the evolution of the area devoted to sugarcane in São Paulo since 1990.

The areas used to food production decreased very little, since the expansion of sugarcane is occurring mainly in pasture land. Moreover, sugarcane yields have increased thanks to the selection of better and more resistant cane varieties and better adapted to different climatic conditions.

The number of ethanol plants and expansion plans for the State of São Paulo are shown in Table 2 and indicate that there was an increase of

TABLE 2 Evolution of sugarcane crop and sugar and ethanol Mills in the State of São Paulo.

	Harvest 2005/2006	Harvest 2006/2007	Harvest 2007/2008	Harvest 2008/2009
Number of mills	154	166	177	190
New mills	4	12	11	13
Production of sugarcane (million tons)	243	264	296	340*

* Estimative by UNICA.

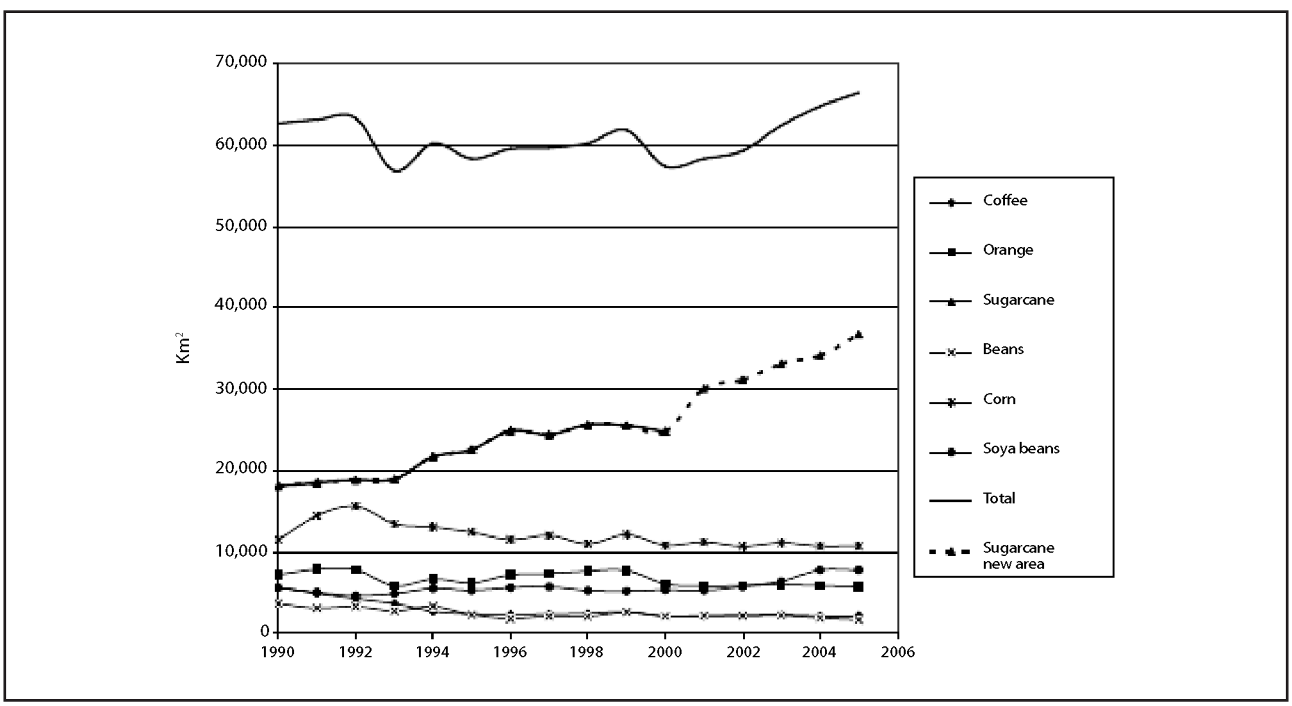


FIGURE 5 Evolution of area occupied by sugarcane in the State of São Paulo.

about 30% in the last two years in the State. The Secretaria do Meio Ambeitne – which licenses the construction of new ethanol plants – is required to comply with environmental legislation in all the new ventures.

THE CONSTRUCTION OF ETHANOL PIPELINES

The transport of ethanol from production areas to major consumption centers (mainly the metropolitan area of São Paulo) and export through the port of Santos – which requires about 500,000 truck trips per year – ends up increasing by 20% the cost of products delivered or in the port of Santos.

With the anticipated increase in production and exports of ethanol this problem will get worse, making it imperative to build ethanol pipelines from the region of Ribeirão Preto, São Paulo (and Santos), or from the new agricultural frontiers.

The TRANSPETRO and a private group organized by UNICA have conducted studies and proposals for the construction of one or more pipelines, using in part the Tietê-Paraná waterway.

Two Protocols have been signed with the São Paulo State Department of Transport with TRANSPETRO and UNICA for studies on ethanol pipelines in order to find a form of collective action, to make the project viable. It is important to allow the use of the waterway, the connection between the waterway and Paulínia and the easy access of the pipeline, to remove the truck traffic from roads of São Paulo.

One factor that delays the implementation of these agreements is the fact that groups who wish to build the pipeline how required long-term supply commitments from ethanol plant owners to enable the return on their investments. As the transactions in this sector are usually made on the spot market these conditions are difficult to achieve.

ECOLOGICAL-ECONOMIC ZONING AND THE CREATION OF NEW CONSERVATION UNITS

The first agricultural zoning of São Paulo State was made in 1974 and complemented in 1977, when remote sensing satellites were not available there were only meteorological stations in the state, against the current 450. Moreover, at the time the socio-environmental aspects were not considered. The new reality of reducing the cost of remote sensing resulted in improvement in weather monitoring, providing information on weather conditions, water availability in the soil, the likelihood of disease, drought and hail.

As a result agricultural zoning studies will be conducted, through coordinated action by the São Paulo State Department of Agriculture, so that patterns of land use, climate and risk conditions are incorporated as important instruments of public policy decision support to agribusiness and the expansion of sugarcane crops.

In addition to that it was proposed, the creation of 14 new protected areas in the state, totaling approximately 90,000 hectares, which were identified by the BIOTA FAPESP project as priorities for the conservation of biodiversity of both flora and fauna in the regions of were sugarcane is expanding.

INTRODUCTION OF 2ND GENERATION TECHNOLOGIES

“2nd generation technologies” are identified as “disruptive” because they could leads to a new level production of bioethanol. The most important “2nd generation technologies” are:

1. Gasification of biomass, which could delivers suitable fuel for efficient generation of electricity and/or the synthesis of liquid fuels (biorefineries). Expectations for the commercial viability of such projects are between 2015 and 2025, but there are a few pilot units being listed around the world there is the need for further research efforts in this area.
2. Acid hydrolysis and enzymatic hydrolysis or the combined acid/enzyme process, which allows the conversion of cellulose into sugars and from there, the production of ethanol and other products. It is expected that the first units will be operating commercially between 2010 and 2020.

There are major efforts in research and technological development in this sector in Europe, the United States and Asia.

3. Genetically modified varieties of sugarcane, which could significantly increase productivity. From the mapping of the genome of sugarcane in Brazil there are several research groups working with dozens of transforms varieties. One expects of gains in yield from greater disease resistance, precocity, sucrose, total biomass etc. Just as an example, increasing the sucrose content of 13.5% to 14.5%, – feasible in a short period of time – would produce the same amount of sugar and ethanol in an area of 300,000 hectares smaller or increase production ethanol in São Paulo State nearly 2 billion liters. It is difficult to estimate the time required for implementation of these efforts because it is not just a technical problem. The release of these new varieties (even for field testing) depends on approval from federal agencies. The groups working in the area are both private (CTC, Allelyx) and public research institutions.

STIMULATING ALCOOLCHEMISTRY

Increased production of sugarcane in the São Paulo State leads naturally to the possibility of the production of chemicals (monomers and polymers) from renewable raw materials derived from sugars, ethanol, biomass, glycerol and other by-products of the production of biofuels.

An example of the interest that exist in this area is the agreement between FAPESP and BRASKEN which aims to invest 50 million reais (US$ 1 = R$ 1.75 at the end of 2009) in numerous studies in this area. Examples of are as follows:

- Development of routes for obtaining ethylene, propylene, butene-1, hexene-1 and octene-1 from renewable raw materials.
- Production of synthesis gas from the gasification of glycerol.
- Production of propanol from synthesis gas.
- Production of biopolymers in plants, bacteria and fungi.
- Catalysts and kinetics of hydroformylation of ethylene production of n-propanol.
- Catalysts and kinetics of dehydration of alcohols to olefins.

FINAL CONSIDERATIONS

The expansion of ethanol production from sugarcane in the State of São Paulo is occurring at a rapid pace to meet growing domestic demand and eventually to overseas demand. The strategies adopted by the State Government intended are aimed to prevent this expansion with insurmountable bottlenecks of various types and, negative social and environmental consequences.

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