REGIONAL RESILIENCE IN THE THEORETICAL AND EMPIRICAL PERSPECTIVES: THE CASE OF THE INDUSTRIAL POLE OF CUBATÃO, SÃO PAULO[1]

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Abstract

The debate on regional development has recently expanded from an increasingly comprehensive view on the resilience regarding regions, in response to a very diverse matrix of external shocks, including financial crises, dangerous climate changes, terrorist movements and extreme environmental disasters. In this way, the notion of location resilience emerges as a specific ability of localities in reacting, responding and dealing with changes and uncertainties facing adversity, as natural disasters or artificial ones. In Brazil, an emblematic case of regional resilience can be identified in the region of the Industrial Pole of Cubatão, São Paulo where it is possible to analyze how a region which has been called the "Valley of Death" in the 1980s, managed to reverse an imminent situation of losing its industrialization through joint efforts. After 30 years it is possible to affirm that the critical framework of environmental degradation has been reversed and it is close to normality. This study aims to present the main theoretical approaches of regional resilience and verify their applicability in the case of the Industrial Pole of Cubatão. It is structured in three sections, first we present the main conceptual approaches on regional resilience and analysis models to empirical research; in the sequence, it will be performed a narrative of the Industrial Pole of Cubatão, in the perspective of the analytical framework based on Evolutionary Economy and then it will performed an analysis of the Plan of Action for Environmental Recovery, performed over 25 years (1983-2008) from the perspectives of the resultant achievement indicators and territorial competences, indicating the adaptability stage of the region in the long term. The final considerations highlight the efforts that are being promoted in an attempt of solving issues that still exist in the region and suggestions for future studies.

Key words: Regional Resilience; Evolutionary Economy; Territorial Competences, Industrial Pole of Cubatão.

[1] Apoio FAPESP: 2011/51267-1

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1. **Introduction**

The debate on regional development has recently expanded from an increasingly comprehensive view on the resilience regarding regions, in response to a very diverse matrix of external shocks, including financial crises, dangerous climate changes, terrorist movements and extreme environmental disasters.

Recent studies raise an interesting question: why the resilience concept has become so popular in this historic moment, considering that the adaptation and recovery processes are certainly not new. Possibly, attention to resilience arises from a widespread sense of uncertainty and insecurity and a pursuit for adaptation and survival solutions.

In this way, the use of the concept may have originated either from an increased sense of economic, political or environmental risk or also by the perception that the emerging processes in the post-industrial society have sharpened social, economic and political inequalities in the localities. The link between a social and an environmental crisis increased the sense of vulnerability and, therefore, has boosted the pursuit for new ways in understanding resilience in the localities[2].

Many researches belonging to a research network in the USA, sponsored by MacArthur Foundation, have been adopting the metaphor of resilience in researches regarding regional economic development[3], from psychology, ecology and environmental disasters studies. Hassink (2010) refers to some research groups from Massachusetts Institute of Technology (MIT) who are also performing the transposition of the resilience metaphor for other issues, such as the studies of Professor Yossi Sheffi for business analyzes (resilient companies) and professors Lawrence Valley and Tommaso Campanella in analyzes of urban planning (resilient cities).

[2] Hudson (2010); Pike et al (2010); Christopherson et al (2012); Pendall et al (2010).

[3] These studies are mentioned by many authors, specially by Pike et al (2010); Christopherson et a (2012) Hassing (2010); Pendall et al (2007); Swanstrom (2008).

Despite the growing importance of the resilience idea in regional studies, Hill et al (2008) write that the concept still lacks a precise and careful definition and suggest three dimensions of analysis aimed to its understanding, in particular regarding regional economic resilience : (1) equilibrium (2) path dependence and (3) systemic and long term perspective.

In Brazil, Mendonça's (2011) studies extend the notion of resilience beyond economic aspects. The author explores the potential vulnerabilities of the regions from three ways of risks manifestations: natural, technological and social. Each of them can occur alone, however, when there is the combination of two or more forms, human society is endangered, and however, it does not affect everyone in the same way. For example, the formation of dangerous weather situations reveals a condition of natural risk to the planet; however, social, political, economic and cultural differences among population reveal, meanwhile, weaknesses that compound to the vulnerabilities to extreme events.

In this sense, it is highlighted the reflection of Simmie and Martin (2010) who develop a questioning about the ambiguity existent in the interpretation of the expression resilience applied to regional studies. The authors suggest a combination of concepts, dimensions and variables involved in the studies on this issue, in order to consider the degree of resistance of the region on suffering shocks, because the behavior of regions directly depend on this variable. It is very likely that weakened regions take longer to recover than other more structured.

Another important issue is the future of the region, i.e., the ability of a regional economy maintaining its structure despite the shock or its ability to suffer a fast and "successfully" transformation (Simmie and Martin, 2010) in response to a shock. Many times, the two senses are combined and time is also an important variable, because the meaning of "fast transition" depends on the nature of the shock, how long the economy needs to be transformed and especially the factors that determine the change.

In summary, it is possible to notice that there are no ready recipes to analyze the resilience of regions, opening an interesting field for empirical research. As written by Pike et al (2010) and Christopherson et al (2010), the growing popularity of the expression resilience is due to its flexibility with respect to its possible meanings.

In this way, we have identified in Região Metropolitana da Baixada Santista (RMBS) [Santos Metropolitan Region] an emblematic case of regional resilience in Cubatão. Galvão

Filho (1987) performs a narrative of "Cubatão Phenomenon" in which it is possible to analyze how a region that has already been called the "Valley of Death" in the 1980s, managed to reverse an imminent situation of losing its industrialization through joint efforts. After 30 years of the beginning of the Action Plan for Environmental Pollution Control in Cubatão (1983-2008) it is possible to affirm that the critical framework of environmental degradation has been reversed and it is close to normality, in the perspective of the results indicators obtained.

Thus, this study aims to explore the concept of regional resilience from theoretical perspectives and analyze their applicability in a reality, in order to contribute with empirical findings about the resilience of regions in the presence of exogenous shocks or natural disasters.

2. Resilient Regions in Theoretical Perspective

In environmental studies, the expression resilience describes the biological capacity of living beings in adapting and thriving in adverse conditions. On the other hand, in economic studies, the notion of resilience has been used as the ability to strike a fixed and strictly defined equilibrium as maintenance of employment and income, economic growth, or, in a more liberal view, economists seek to identify multiples equilibrium. In the case of the social sciences in general, the notion of resilience has become quite popular because of its association with the regional adaptation (Pike et al, 2010; Christopherson et al, 2012) and, therefore, has strong links with evolutionary economic geography.

Resuming the studies of Hill et al (2008), the authors highlight three aspects that guide researches on regional economic resilience, briefly presented below.

(1) **Equilibrium:** For some economists, the most natural meaning of resilience is the ability of a regional economy to maintain the pre-existing equilibrium before a certain shock. This is a typical situation of equilibrium in the presence of some kind of external shock. Despite only few economic studies explain the term resilience, most of the literature on microeconomics defends the idea that resilience is the ability of a given region to return to the stage previous to the shock, in terms of performance rates of economic growth and

unemployment level of the population. The main researches of this view are Blanchard and Katz, 1992; Rose and Liao, 2005; Briguglio et al, 2006, Feyrer, Sacerdote and Stern 2007[4].

(2) **Path Dependence:** The idea of path dependence is related to the notion of lock-in and it is based on the premise that regional economies have multiples equilibrium, resulting from decisions made throughout history. Therefore, regional economy depends on the chosen path, but often at a 'sub-optimal' level, result of institutional forces crystallized over the time. Researchers associated to this thought, Chinitz, 1961 and Safford, 2004 suggest that the concept of regional economic resilience would be the ability of a regional economy in avoiding the lock-in resultant of the path dependence, promoting a "rapid transition" to a "better" equilibrium (Hill et al, 2008).

(3) **Systemic and long-term perspective:** The previous concepts regarding regional resilience focus on simple measures of economic performance at a given time. The systemic and long-term perspective, on the contrary, focus on the interrelationships of macroeconomic variables that persist for a long period, extending them to economic, political, social and environmental aspects, that determine its structure and economic growth. The social structure of accumulation is not static and, in this way, the regional economy would be resilient to the extent that their social structure of accumulation remains stable or is able to do a "rapid transition" to a "better" one (Hill et al, 2008).

Simmie and Martin (2010) consider the equilibrium perspective, also called "resilience engineering", as limited to analyze the resilience of a regional economy, since it focuses on the stability of a system near equilibrium or in a steady state. The authors consider that this view is much closer to the concept of "elasticity"[5] or the ability of a system to absorb and accommodate disturbance without experiencing a collapse or a relevant structural transformation. Thus, the regional economic resilience would involve the retention of the functions and the system structure before the shock. The problem is that this view carries the baggage of the equilibrist thought. In fact, the concept of resilience engineering has a close affinity with the standard use of the *mainstream* equilibrist of the economy. In this example, a shock or disturbance moves an economy out of its equilibrium and growth trajectory, but the assumption is that self-correcting forces and adjustments can bring them back to the path.

[4] Mentioned by Hill et al (2008).
[5] The authors refer to the origins of the expression resilience used in physics and engineering, as the ability of structures and materials to resist to shocks and stresses by measuring elasticity.

The obvious problem with this definition, according to Simmie and Martin (2010) is that if the regional economic resilience is defined in terms of the ability of a regional economy in maintaining (recover) its form of equilibrium after a shock, it becomes difficult to reconcile the notion of resilience with the idea of regional economic development. The implication is that the more resilient it is a regional economy, at best; produce an evolutionary model based on the maintenance of the structure and stability.

On the other hand, the approaches of path dependence and systemic and long-term perspective (also called "ecological resilience") focus on shocks and disturbances that caused a 'transformation' in the system. In this case, the measure of resilience refers to the magnitude of the shock (or disturbance) that can be absorbed before the system changes its structure. According to some authors (Simmie and Martin, 2010; Pike et al, 2010), this definition makes way for the linking of resilience with the idea of adaptability and is, therefore, much richer in the evolutionary context.

However, Simmie and Martin (2010) warn that resilience is related to the natural instability of the systems, resulting in an evolutionary and periodic dynamic in nature, in which episodic shocks cause a transition from one stable regime to another one. This concept of multiples equilibrium used in economy is that there is no single equilibrium state, but several possible states. Thus, resilient regional economies are those that adapt "successfully" to a path of long-term growth.

In this regard, it is worth to mention that the "successfully" adaptation or a "best path" are ideas put into perspective and do not present an analytical framework to analyze the 'success' determinants or the 'better growth path'. To the extent that economic evolution depends on the actions of individuals and economic agents that interfere significantly in the processes of evolution and adjustment of the systems, we propose to expand the notion of resilience from the grounds of territorial competences.

The territorial competences are all the specific advantages existing or artificially created in the territory, through proactive and voluntary action of local communities and their governments. The essential condition for the formation of territorial competences is the existence of governance systems which, if well articulated, are able to generate inter-actors synergies that produce: (1) deep commitment among people to work across organizational boundaries, (2) ability to deal with contretemps and uncertainties, as well as ensure the

capacity of auto regulation routine, (3) collective consciousness that resources should be preserved for not exhausting them over the time, (4) clarity and transparency in communications, especially in cases of persuading, negotiating, coordinating and teaching the partners involved.

Thus, from an evolutionary perspective, the most important attribute of regional resilience is the ability to adapt to a local economy after a shock or disturbance. Thus, for the purposes of this study, the regional resilience concept adopted is as follows.

Regional Resilience Concept

> Regional Resilience is the capacity of regions to adapt efficiently and effectively after an endogenous or exogenous shock, in which their social structure of accumulation remains at the same level of development or becomes a social structure of accumulation with superior performance when compared to the standard previous to the shock or disturbance.

In the perspective of the objectives of this study, the following section presents three models of analysis of regional resilience in order to create an analytical framework for the Industrial Pole of Cubatão.

3. Analysis Models of Regional Resilience

A persistent question regarding regional resilience is why some regions can overcome adversities (in the short or long term) to maintain a high quality of life and regional cooperation while others fail? Hassink (2010) writes that answering to this question bring methodological and philosophical difficulties, however, it remains an interesting issue due to its importance and also because its multiples variables involved in the region.

For some scholars, the resilience idea must be set aside making way for more significant concepts in its subjects contexts. For others, however, regional resilience provides an umbrella under which it is possible to explore multiple subject perspectives.

According to the view of Cristopherson et al (2012), this discussion is useful by itself, because an interdisciplinary discussion helps to clarify the assumptions that underlie different

perspectives regarding regional changes, as well as the creation of tools to measure it. Authors write that people with disciplinary backgrounds in different perspectives present their ideas on how to measure the resilience of a given region and, in this way, you have a clearer idea of the different dimensions and of many significant variables that affect their paths.

On the other hand, Swanstrom (2008) writes that the expression resilience is more than a metaphor; however it is not a theory. Thus, it can be described as a conceptual framework that helps us to think about regions in a comprehensive, dynamic and systematic way, despite of providing bases to formulate testable hypothesis.

The three approaches of regional resilience analysis, proposed by Hill et al (2008) - equilibrium, path dependence and long-term systemic perspective - are reaffirmed by Pendall et al (2010) and feature points of contact, respectively, with the analysis models in the mechanistic perspective (equilibrium) and with the perspective of evolutionary economy (path dependence). The systemic and long-term approach, proposed by Hill et al (2008) suggests points of contact with the multi complex systems perspective, proposed by Pendall et al (2010), however, no empirical studies were identified that point to the determinants that characterize the regional resilient economies and their adaptability over the time. Thus, we propose to expand this analysis model with the fundamentals of the territorial competences notion. The three analysis models are presented below.

3.1 Resilience in the mechanistic perspective

Probably the most comprehensive resilience notion is expressed in studies of ecology and social systems, such as the concept of return to normality. It is a mechanistic definition of resilience or 'resilience engineering'[6] which idea is to obtain stability, resistance to stresses and return to the equilibrium point.

In this analysis model, the interest and the focus are aimed to systems with a single equilibrium, such as the body temperature, fertility rate, bridge and structures loads and other ones. This notion of resilience is also very common in the psychology fields and disaster studies, in which they seek understand why people, infrastructure and places recover from intense disturbances or tensions. In psychology, resilience studies are focused on behaviors

[6] Pendall et al, 2010; Hill et al, 2008.

and attributes that allow people to coexist with each other in order to be socially successful. Under normal circumstances, when they are exposed to a disturber event, such as death of a close person, or the end of a close relationship, as well as risk situations for life.

Studies related to responses to disasters also tend to embrace the notion of mechanistic resilience. A resilient city, for example, would be one that resumes its prosperity way after a delay caused by natural or artificial externalities.

Thus, identifying resilience in the mechanistic perspective in a system involves selecting observable characteristics or results of certain phenomenas. Any discussion regarding resilience in a certain system should be preceded by the question: Resilience of what and for what?[7] In this way, the system must be defined considering: (1) the variables that describe the state; (2) nature and the measures of external shocks. The determination that a locality has recovered, or that the ecosystem is stable, assumes that the analyst paid attention to some things but not to others. For example, one can analyze the growth of regional production, population and unemployment rates, poverty or participation in the labor force in the mechanistic perspective of resilience and can be considered, at least partially, equilibrium phenomenas.

Pendall et al (2010) write that, since these variables offer great interest to researchers and to the formulation of public policies, this resilience approach offers an important and legitimate metaphor for understanding a certain region. However, this resilience perspective has limits for understanding certain systems and phenomenas, from the premise that a system can have multiples equilibrium, as we shall observe in the following approaches.

3.2 Resilience in the Evolutionary Economy perspective

The introduction of evolutionary thinking is based on the history and geography of the places, recognizing the importance of local specificities to explain how the spatial organization of production, distribution and consumption are transformed over the time. Recently, many concepts related to evolutionary economic geography, as the path dependence, lock-ins, coevolution or fragmentation of life cycles have been used to theorize about questions related to regional adaptation.

[7] Pendall et al, 2010; Pike et al, 2010.

Under these approaches, it is possible to think not only about companies and industries, but also about local and regional development policies and, in a boarder sense , in a way that environmental changes affect the dynamism and adaptability of regional economies and that measures should be taken to assist in regional economic adaptation. These concepts can potentially explain why some regional economies lose dynamism and others don't.

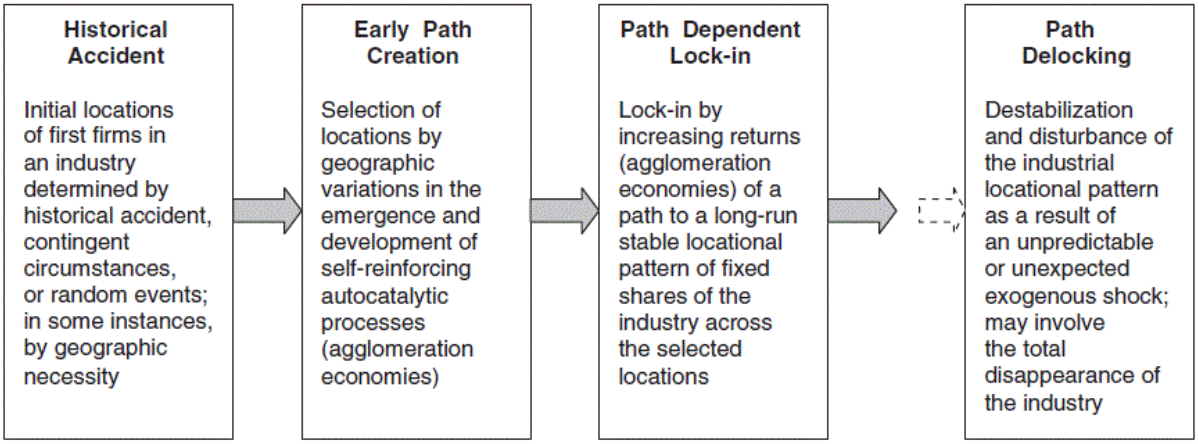
The path dependence is a process in which the performance and results of a given system evolves as a consequence of its own history. On the other hand, the concept of lock-in is associated with the necessary difficulties of restructuring for regional economies to adapt to changes. These two concepts are closely related, since the path chosen reinforces a common world view that might confuse secular trends with cyclical crises, which may difficult the necessary process for restructuring.

Another key concept derived from the evolutionary thinking is the coevolution, which can be applied to theorize about local and regional development policies. In a co-evolutionary perspective, local and regional innovation policies cover not only companies and industries, but the entire institutional environment in question. Thus, such policies may affect the entire dynamics of regional economies. In the conceptual framework of resilience, companies and industries need to be in equilibrium with its institutional environment and in case it does not occur, the equilibrium should be rebuilt.

In this line of thought, numerous scholars of economic geography and regional development seek a model that relates the path dependence and the lock-in in the spatial evolution. Some studies (mentioned by Martin, 2010) suggest that the localized nature, accumulation of a local reserve of specialized work, local knowledge disclosure and other intangible elements, called untraded interdependencies as relevant factors for a lock-in formation, that would restrict the ability of adaptation and consequent decline of old industrial districts, even causing a total end of industrialization.

The canonical model of the path dependence of the industrial space evolution identifies four moments of a system and its relations with the path dependence, lock-in and lock-in breakage, as it is shown in the following diagram.

Canonical Model of the Path Dependence of the Industrial Space Evolution



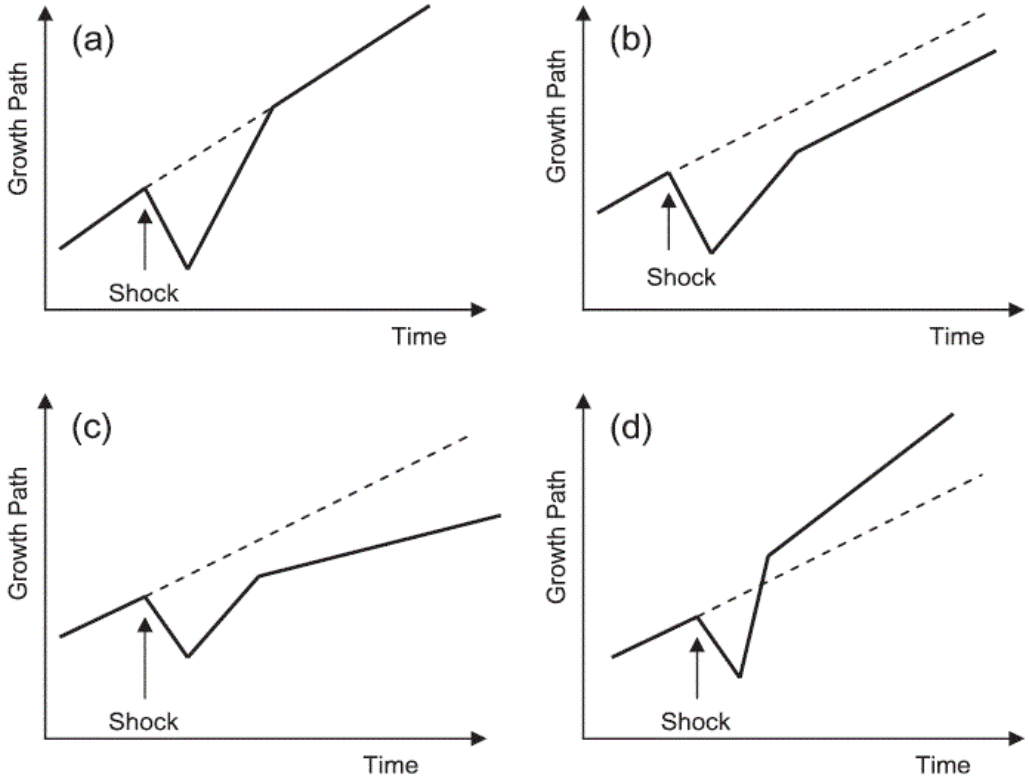
Source: Martin, 2010.

Martin (2010) presents some criticisms to this model, because he considers the attempt to lay out the relationship between the path dependence and the lock-in a too simplistic way, what he considers being problematic, as discussed in the previous section. In a later study, Simmie and Martin (2010), propose an outspread of the "lock-in breakage" phase in four possibilities, as outline below.

The first possibility, shown in the diagram (a), is the return of the regional economy to the pre-existing situation after the shock, in which it is possible to identify points of contact with the mechanistic perspective or the resilience engineering, through the comparison of variables selected before and after the shock.

The two following possibilities (b) and (c) refer to the reduction of regional performance after the shock, and, to assess the degree of the shock impact on the regional economy it is necessary to identify the determinants involved that hardly present a pattern of behavior related to the territorial specificities.

Stylized Responses of Regional Economy to a Major Shocks



Source: Simmie and Martin, 2010.

The possibility (d) represents the regional recovery with transformations that improve its performance in the growth path after the shock. In this case it is also possible to identify points of contact with the mechanistic perspective; therefore, the assessment of the superior performance must be done through comparison of selected indicators. However, there is a limitation in this model to understand the determinants that characterize these developments over the time, to be considered in the following perspective.

3.3 Resilience in the systemic and long-term perspective

The complex multi systems perspective has stimulated numerous studies and researches, especially in the areas of political science, macroeconomics and institutional economy. Earlier models focus on measures of economic performance at a given time. The systemic and long-term perspective, on the contrary, focus on the interrelationships of

macroeconomic variables that persist for a long period, extending them to economic, political, social and environmental aspects, that determine its structure and economic growth. The social structure of accumulation is not static and, in this way, the regional economy would be resilient to the extent that their social structure of accumulation remains stable or is able to do a "rapid transition" to a "better" one (Hill et al, 2008).

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The following section presents and discusses the case of the industrial pole of Cubatão, which analysis will be based on the canonical model of path dependence of the industrial space evolution and how the territorial competences contributed to the Industrial Pole of Cubatão to achieve the objectives proposed in the Plan of Action.

4. The Case of the Industrial Pole of Cubatão

The causes that have made the city of Cubatão, in the state of São Paulo, internationally known in the 1980s are much more related to its environmental problems than to its importance as a center of wealth generator (GALVÃO FILHO, 1987). Due to high

levels of environmental pollution, Cubatão was classified by the World Health Organization (WHO) as the most polluted city in the world in the 1980s, as written by Couto (2003, p.163): "If in the 50s, Cubatão was nationally known by the deployment of the first Brazilian petrochemical complex, in the 80s, it became known around the world because of the crimes against the environment."

Cubatão is one of the 173 municipal areas that comprise the region of the Expanded Macrometropolis[8]. Located 57 km from São Paulo, it borders the municipality of São Bernardo do Campo (ABC Paulista) and belongs to the Santos Metropolitan Region, where it is located the Santos Port Complex, the largest and most important port in Latin America.

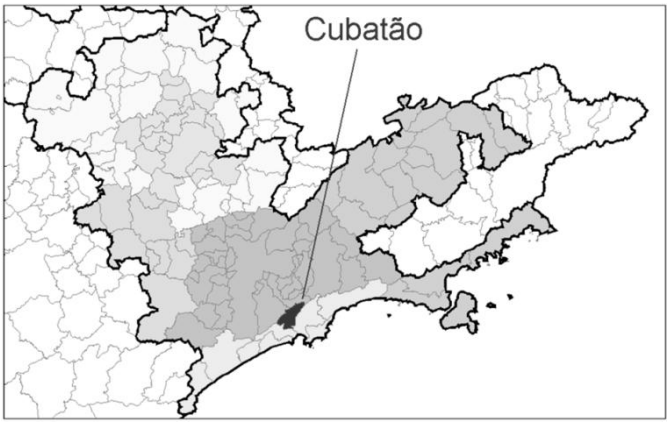
The population of the region located at the root of the Serra do Mar, bordered by the rivers Cubatão, Perequê and Piaçaguera, has begun in the sixteenth century, after the expedition of Martim Afonso de Souza that conceded the exploitation of the land to Rui de Pina and later were transferred to the Companhia de Jesus.

With the expulsion of the Jesuits in 1759, all his possessions were confiscated by the Portuguese Crown, until that in the late eighteenth century the Fazenda Cubatão was administered by the lieutenant José Antonio Carvalho. In the early nineteenth century sesmarias titles were awarded to five Azorean settlers, and in that moment, it had begun the construction of infrastructure such as the road Calçada de Lorena, which transformed the General Port of Cubatão in an important warehouse of the city of São Paulo and the embankment that served as a link between the Port of Cubatão and the city of Santos.

So they built the vocation of Cubatão as a waypoint of exportations toward the Port of Santos, facilitated by the construction of the road Vergueiro and the São Paulo Railway in the late nineteenth century (IBGE, 2012).

[8] EMPLASA (2012).

Location of Cubatão in the Expanded Macrometropolis.



Source: DPR (2011)

Couto (2003, p.26) writes that with the São Paulo Railway and Vergueiro highway, the painful paths between the Paulista Plateau and the sea were solved. "The paths of hell that used to cut Cubatão Mountain became meek paths." The railroad absorbed almost all the transportation of goods and people between the Plateau and the city of Santos and with the rapid growth of coffee exportation, Cubatão was neglected in progress, being stagnated.

With the loss of the commercial dynamism, some entrepreneurs in Cubatão began agriculture activities with bananas and other fruits, as well as coffee, sugar cane and rice. The banana plantations have generated some prosperity to Cubatão and at the end of the nineteenth century there was no unemployment, on the contrary, there was a lack of workers to work in the agriculture of bananas. In summary, it is possible to say that Cubatão in the first four centuries of its existence (with the exception of the sixteenth century), was essentially a transit route between Santos and São Paulo, but had became, in the late nineteenth century, an immense banana farm. Nothing more than that (Couto, 2003).

4.1 Historical Accident

The model proposed by Martin (2010) suggests identifying the moment when the 'historical accident' occurred, i.e.: "the initial leasing of the first companies in a certain industry that occurred for historical reasons, contingent circumstances, random events or

geographical factors." Couto (2003) identifies an important geographical factor that may have contributed to the historical accident:

> "Every day it rains in Cubatão." This was how foreign travelers and ancient inhabitants of the small town of Cubatão characterized the region where they lived, in the early nineteenth century. This characteristic of high rainfall indicated by massive precipitation of water throughout the year would be a major pull factors for the future industries of the twentieth century (p. 5).

Couto (2003) explains that although the climate was harmful to humans, due to be favorable to microbial life, the climate was favorable for plants. Therefore, the region was rich in food; the rivers and mangrove supplied fish in abundance. But in the early 1910s, things began to change. That economic life, typically a "farm" would not be unique anymore. Three major industry companies, called "pioneers", settled in Cubatão: Cia Curtidora Marx; Cia de Anilinas, Produtos Químicos e Material Técnico and Cia Santista de Papel.

The next step to the historical accident, in the path dependence of the spacial evolution model and lock-in, is related to the selection phase of the surrounding localities that presented geographical conditions favorable for the development of agglomeration economies. It is the creation of the path, described below.

4.2 Early Path Creation

The period of the two world wars was marked by ups and downs for these industries, however, the creation of the path is justified by the assertion that "an industry is never an isolated incident" and in 1925 the energetic crisis lived by São Paulo, initiated the construction of the largest hydroelectric plant in the country: plant of Cubatão. The increased demand in electricity was a direct result of the growth of the state of São Paulo, especially its industrial area and, in 1961, the plant of Cubatão was responsible for approximately 14% of the installed energy power in the country and for approximately 90% of the energy power production of the state of São Paulo (Couto, 2003). The author emphasizes, however, that the industries located in Cubatão (Costa Moniz, Química and Santista de Papel), despite representing large complexes, had no influence on the installation of the Plant of Cubatão. What prevailed was the large amount of water in the region and the scarp of the Serra do Mar, aiming to generate power for the region of the extended São Paulo.

However, from the presence of the plant, we can begin to understand the location of the Industrial Pole of Cubatão, which would intensify in the 1950s. While in operation since 1926, the Plant of Cubatão did not bring, due to its presence, any new industrial enterprise for Cubatão until the deployment of the oil refinery of Petrobrás.

The construction of Via Anchieta (1942-1947) was another relevant component in the creation of the path. Couto (2003) writes that with the ascending route of Via Anchieta it was possible to go through the Mountain in just 13 kilometers and it begins a fast transfer from the railway to the road between the port of Santos and the Paulista plateau. The descending road built in 1953 completed the logistics that greatly facilitated the production flow between the corridor of the Paulista plateau and the port of Santos.

To complete the necessary infrastructure for the creation of the path, it was resumed, in 1947, the idea of building a pipeline linking São Paulo to the Port of Santos, designed in the late 1920s. The justification for the construction of an oil pipeline was simple, as Couto writes (2003, p.59):

> In the mid-'40s, the fuel transportation between the Port of Santos and the city of São Paulo was above a million tons per year (...) the high cost of transporting this fuel mobilized a huge amount of specialized logistics material (for railways and highways) and a huge fuel consumption. These rising costs each year had a relative weight in the Brazilian trade balance.

In fact, there was a close relationship between the movement of creating a logistics infrastructure between the Paulista Plateau and the Port of Santos with the historical moment that Brazil was living in the 1940s and 1950s, as writes Carvalho Jr (2008): "Brazilian society was going through a time of intense changes marked by the beginning of the industrialization process and the resume of democratization in the post-war." The context was favorable to discuss proposals for national development. Because of the significant increase in fuel imports it was necessary to discuss proposals to increase the domestic oil production. In this way, through a bill, signed into law by the President of the Republic General Eurico Gaspar Dutra and sent to Congress in May 1948, it was included in the Plan SALTE[9] the construction project of the Pipeline Santos-São Paulo. The mobilization regarding the campaign "O Petróleo é Nosso" [The Oil is Ours] prioritized discussions, culminating in the promulgation

[9] The plan SALTE was sent to Congress in May 1948 and was intended to coordinate government spending to expand investments in health, food, transportation and energy fields.

of the 1946 Constitution and the founding of Petrobrás in 1953 (CARVALHO JR, 2008; COUTO, 2003).

The scene was almost ready for Cubatão to become the industrial phenomenon with increasing agglomeration economic returns, suggesting a stable pattern and self-reinforcing of long term for all companies that would be installed in the narrow valley between the plateau and the sea, identifying, in this way , the next step of the path dependence and lock-in that follows.

4.3 Path Dependent and Lock-In

Among the locations evaluated for the construction of a second oil refinery in Brazil[10] the ones that stand out are Rio de Janeiro, Santos, São Paulo and Cubatão. The choice for Cubatão was published in the newspaper A Tribuna on 10/07/1949:

> The main points to be considered are especially transportation, through highways and railways, the electricity supply, the nature of the subsoil in more favorable areas and the true value as well as the selling prices of lands. In Santos, given the topographic nature of the city, the areas to study are not very large and work will consist primarily in examining the conditions of two areas that seem most appropriate, especially one situated at the foot of the mountain of Cubatão.

Couto (2003) writes that the largest oil refinery in the country began to be settled in Cubatão in the early 1950s. "Thousands of people coming from all parts of the country invaded the small town in a progression that did not seem to finish." The first bank branch arose in September 1950, Banco Cruzeiro do Sul and numerous houses were built. "It was a revolution, the biggest of all that that the region has faced during its four centuries of history."

The construction of the petrochemical complex near the refinery of Cubatão and the attraction of other companies was a direct consequence of this decision and, in two decades the Industrial Pole of Cubatão was constituted. Galvão (1987) writes that the inadequacy of the area to house an industrial area of such large dimensions and complexities is consensus among current and accepted views about the phenomenon Cubatão. There are 23 industrial

[10] The first refinery of Petrobrás was Landulpho Alves - Mataripe. The refinery Mataripe started being constructed in 1949 and is directly linked to the discovery of the first oil wells in the country, precisely in the Recôncavo Baiano. With the creation of Petrobrás, in 1953, the refinery was incorporated to the assets of the company, and started being called Refinaria Landulpho Alves-Mataripe, in honor of the engineer and politician from Bahia who fought a lot for the oil issue in Brazil (PETROBRAS, 2012).

complexes, with 111 factories and more than 300 pollution sources of air, water and soil, located on a narrow strip of land surrounded by the sea and scarfs of Serra do Mar.

The choice of a particular region to install a new refinery, according to Petrobrás (2012), strongly depends on the presence of oil-producing fields and on a location near the region where the oil derivatives consumption is more pronounced. In the case of the first refinery Landulpho Alves-Mataripe in Recôncavo Baiano, it prevailed the location of the oil well, especially designed to process the oil from the fields in the region. In the case of Cubatão it prevailed the greater ease and lower cost of oil transportation, besides the existence of an infrastructure that would support the installation of the refinery, availability of skilled manpower, electricity and water and, especially, the proximity to a large consumer area and for strategic reasons of defense of its facilities.

Goldenstein (1965) writes that the decision to build an oil refinery in Cubatão was much more political and military, based on strategic reasons, however, as it seems to be, the deployment of such colossal industrial complex at the root of Serra do Mar, was motivated by the interests of economic groups of São Paulo.

In turn, Couto (2003) writes that the installation in Cubatão was mainly due to the possibility of being located next to the largest hydroelectric power plant in operation in the country. All other reasons mentioned were consequences, less important factors, though as a whole they provided better working and installation conditions. The implementation of the Refinery in Cubatão did not have as a concern the supply of jobs or the economic and social development of the region, but the supply of petroleum products for the main consumer center in Brazil. It also intended to decrease dependence on imported petroleum derivatives, since one of the concerns of Petrobrás in its publications was always to show foreign exchange savings due to the domestic oil refining.

Many explanations have been given for the phenomenon Cubatão, as Galvão Filho (1987) writes. The physical environment, its topography and environmental conditions expose the error of the decision, as well as also explains the development model adopted that, if did not focus on planning as a tool for growth, it also has not adopted an array of environmental protection that could anticipate and save effective measures for the ecological changes that would happen.

Under the justification of development, here reduced to economic growth, the increasing returns from the agglomeration economy created the path dependence and lock-in in a stable and self-reinforcing process of long-term, as theorizes Martin (2010).

Galvão Filho (1987) writes that for three decades the relentless and constant liquid and gas emissions from the chemical, petrochemical industries, emissions of a giant steel and nearly a dozen fertilizer industries, did just confirm that natural resources become exhausted and saturable. Environmental contamination has led to death of several ecosystems. The misery of the population and low wages, for example, had imposed to them spaces totally inadequate for housing. People started living, or at least tried to live, on the scarps of the hills that make up the rock mass of Serra do Mar, in villages born within the pollution cauldron (Vila Parisi, known as one of the world's most polluted neighborhoods), on stilts over the devastated mangrove, in wooden shacks under the pipelines that remind us of the tragedy of Vila Socó[11].

The reasons that made that Cubatão appeared in the worldwide headlines were many - synonymous of pollution, contamination, savage capitalism, anencephaly, respiratory diseases and tragedies. Galvão Filho (1987) writes that the achieved notoriety in the state, national and international level gave to Brazil the paternity of an "abnormal" and little desired child. Given the fact, it is only possible to regret the fact that the it was not observed the law of the self-purification capacity of natural resources, which are finite and, in the case of Cubatão, were very small.

The 'conquest' of the title of most polluted city in the world given by the World Health Organization (WHO) in the 1980s, seems to have been a destabilizing factor, or a disturbance in the industrial space locational pattern, resulting from an exogenous shock unexpected or unpredictable and that could cause the complete extirpation of the industry, as theorizes Martin (2010). The following years were devoted to promoting actions that led to the rupture of the lock-in, as follows.

[11] The author refers to one of the greatest tragedies of Cubatão after the formation of the petrochemical complex. The fire of a Petrobrás pipeline passing under a slum, Vila Socó, which completely destroyed it and 93 people died in 1984.

4. 4 Path Delocking

The deployment and development of the "Action Plan for Environmental Pollution Control of Cubatão", of the government of the State of São Paulo, through the Companhia de Tecnologia de Saneamento Ambiental (CETESB) [Society of Environmental Sanitation Technology], from July 1983 aimed to reverse the situation of environmental degradation. Galvão Filho (1987) explains that the plan adopted a methodology for environmental control never seen before in the country to face the huge challenge, it was considered the size and complexity of the problem as well as the need for a multidisciplinary activity involving all areas of the institution.

The resilience notion in the perspective of multi complex systems, proposed by Pendall et al (2010) and Hill et al (2008), can be observed in the proposition of the action plan, which stressed conditions to transform a system that had a certain type of equilibrium in a "better" one. In this case, the important measure of resilience was the magnitude or the disturbance scale which could be absorbed before changes in the structure of the system.

The transparency of actions to be developed was essential, as well as the participation of institutions which could contribute with information to define the control actions required - the scientific, business and technical communities, government, politicians and the population were listened and invited to participate. The outcome of discussions culminated in three projects. The first aimed to control pollution, the second aimed to provide technical support to control actions and the third was intended to environmental education and community participation, aimed mainly at political leaders, such as political parties, trade unions, friends' society of Cubatão, schools and churches. The survey of polluting industries registered more than three hundred sources of air, water and soil pollution. Each pollutant source received instruction on the technology to be adopted to stop emissions and about the effects of each pollutant agent (GALVÃO FILHO, 1987).

It is observed that the attributes of territorial competences are explicit in the formulation of the presented programs. The essential condition for the formation of territorial competences is the existence of governance systems that, if they are well articulated, are able to generate inter-actors synergies that produce: (1) deep commitment among people to work across organizational boundaries, (2) ability to deal with contretemps and uncertainties, as

well as ensure the capacity of auto regulation routine, (3) collective consciousness that resources should be preserved for not exhausting them over the time, (4) clarity and transparency in communications, especially in cases of persuading, negotiating, coordinating and teaching the partners involved.

Surveys conducted in polluting industries and consequent causes and effects of each pollutant allowed to define: (1) the variables responsible for the current state of the system that would be measured along the transformation process; (2) nature and the measure of external shocks. This step of the process can be identified with the resilience of the mechanistic perspective, or as write Pendall et al (2010) and Hill et al (2008), the resilience engineering.

The basic variables used to implement the control strategy were: (1) existing environmental quality, (2) existing levels of emissions**;** (3) environmental quality standards to be achieved, (4) required degree of emission reduction, (5) establishment of emission standards or performance and, (6) the legal framework for companies with requirements of control plans and their related schedules.

The strategic measures to reduce local pollution levels - one of the main problems of Cubatão - should set long-term goals (between ten and twenty years) and appropriate control plans. In the case of Cubatão, the adopted strategy was a local one, although it is known that atmospheric emissions reached the municipalities of Grande ABC and Baixada Santista.

Galvão Filho (1987) writes that it would be necessary to adopt an inter-regional and state strategy that would require studies of at least three to four years, which would not meet the increasingly emerging needs of Cubatão. However, to obtain a rational and feasible plan, it was necessary to take into account the technological difficulties, the social and economic costs and political framework that permeated and involved all the decisions. The development of the control strategy for Cubatão showed what should be the priorities, what should be the way for the safe application of the available legislation as well as what should be the size of the organizational structure involving front line professionals (engineers and control technicians), as well as support teams in São Paulo and Santos.

The technological, economic and social variables were established to obtain the return to normality in six years and the political variable considered a period of four years to achieve the goals proposed. Galvão Filho (1987) notes that in areas similar to Cubatão elsewhere in

the world, similar plans have been effectively deployed in periods of ten to twelve years from the decision of controlling pollution.

After two years of its beginning, CETESB program showed positive results, with pollutants reductions in two years (1984-1986), as shown in the table below.

Reductions of air pollutants in Cubatão 1984-1986

Kind of pollutant	Emissions (ton/day)		Reduction(%)
	july 1984	july 1986	
Particulate material	236,6	49,7	79
Sulfur dioxide	78,4	49,5	37
Nitrogen dioxide	61,1	52,7	14
Fluoride	2,6	1,1	58
Ammonia	8,7	2,6	70
Hydrocarbons	90	27,5	69

Source: CETESB, 1986

Couto (2003) writes that major emitters of particulate material were the fertilizer industries, through the grinding of phosphate rock and Usiminas (formerly Cosipa), through its coal deposits. Water pollution index had a slightly smaller improvement. Out of the 44 pollution sources identified, 25 were controlled in 1986. As for pollution by industrial solid waste, deposited in the soil of Cubatão 38 sources were controlled out of a total of 46.

Given the strict controls on the reductions of air pollutants, the companies located in the Industrial Pole of Cubatão were forced to promote technological innovations in their processes, causing an economic destabilization in the industries in the short term. Couto (2003) writes that the first half of the 1980s was indigestible to the Industrial Pole of Cubatão. The economic crisis and the environmental disaster led industries of Cubatão to a great uncertainty about the direction of their investments. Expansion projects were aborted, ongoing expansions were stalled, mainly from Usiminas, and new industries not even acquired lands in Cubatão.

> Producing in Cubatão started being associated with the death of children without brain[12], landslides, explosions, smoke, among other calamities, reaching in a harmful way, the image of the industry towards its customers and shareholders (p.208).

The author writes that the severe fines and factories interdictions applied by CETESB had a relevant effect on breaking down resistance by the firms. "Several industrial units had to be shut down for equipment installation or were required to reduce production" (p.209). The result was a large drop in the production of the industrial pole of Cubatão in 1985 of 28.2% compared to 1984, which explanation was a decrease of almost 2/3 of the production of the Presidente Bernardes Refinery (Petrobrás) in 1985 and 1986.

In turn, Galvão Filho (1987) notes that the most important result of the environmental program of pollution control in Cubatão lies in the fact that all industries in the region rose from an initially defensive position, facing control requirements, for another way of facing reality, certainly more positive. This change took place mainly from the environmental diagnosis that the CETESB technical team held in each source, for each company, diagnosis that anticipated the negotiations of the control plans. Thus, it was possible to enable the future of these industries, even with the adoption of rigid concepts of pollution control.

However, if we compare the experience of Cubatão with other realities that promoted the lock-in breakage, it is possible to say that it was a successful experiment. Pike et al (2010) identified similar situations in their studies and write that the lock-in breakage requires in most cases, extreme changes that may prevent adaptability in the long term. They cite as an example, old industrial regions, whose resilience crystallizes from a pre-designed template and successful in the past, however, adaptability implies abandoning a successful path in the past in favor of a new trajectory. The challenges faced by the economic development, tolerance and ability to cope with economic inefficiencies and political unpopularity can cause a prolonged decline, with difficult economic weakness to return to normality.

[12] The author refers to the phenomenon of the birth of anencefalous babies in Cubatão (SP), far above the WHO statistics, associated with the pollution in Cubatão, according to a report published by Folha de São Paulo, in 2008: “30 years after the boom of anencefalous, Cubatão (SP) records a few cases. 30 years ago, Cubatão (58 km from SP) became known as the city of "babies without brains." It was also regarded as one of the most polluted cities in the country. The relationship was almost immediate: experts pointed industrial emissions as the main factor for the boom of anencephaly cases (...) " (Folha de São Paulo, 09/01/2008).

5. Resilience in the territorial competences perspective

The 2000s was emblematic for Cubatão by the endless media reports related to the achievements made after the start of the Action Plan for the Environmental Recover of Cubatão. As an example, we can mention: O Estado de São Paulo (07/25/2008) "Pollution decreases 98.9% in Cubatão, shows study"; magazine Cidades do Brasil (February 2000): "Environmental recover: Cubatão, which has once been the most polluted city in the world, today is an example and a worldwide reference in environmental recovery "; the magazine Veja (07/22/2010): "The city that had been synonymous of pollution has became a symbol of environmental recover"; magazine Panorama Ambiental (May 2009): "Cubatão, a sustainable municipality; Folha de São Paulo (09/01/2008): "30 years after the *boom* of anencefalous, Cubatão (SP) records a few cases. The optimism of the press publications is confirmed by Couto (2003, p.228):

> Through visits to the industries of the Industrial Pole of Cubatão, checking their investments in modernization and expansion, we can quietly affirm, and without fear of equivocation, that the Industrial Pole of Cubatão is now a modern and efficient industrial center, able to conquer markets not only in the country but also abroad. The foreign market became, in this way, the target of the most important industries of Cubatão, mainly Cosipa and Presidente Bernardes Refinery (p.228).

The figures also confirm the progress made. Data disclosed by FIESP-CIESP (2008) show that in addition to reducing the emission of air pollutants, in thirteen years (1995-2008) there was no record of critical pollution state (warning, alert or emergency) and a raise of 39% (production in 1997 was 12.757 thousand tons / year and in 2008 the recorded production was 17.73 thousand tons / year). The picture below shows the reductions of air pollutants in Cubatão over the 25 years of the Action Plan for the Environmental Recover of Cubatão.

Reductions of air pollutants in Cubatão 1983-2008

Kind of pollutant	Emissions (ton/day)		Reduction (%)
	1983	2008	
Particulate material	363,37	3,68	98,98
SOx (Sulfur Oxides)	56,17	15,63	72,17
NOx (Nitrogen Oxides)	22,36	20,36	8,96
Fluoride	5,67	0,50	99,11
Ammonia	3,48	0,20	99,43
Hydrocarbons	32,80	1,38	95,79

Source: FIESP-CIESP, 2008

Foreign direct investments (FDI) made from the 1990s suggest that Cubatão is currently a growing industrial center. Couto (2003) writes that economic openness demanded modernization of the industries established and attracted foreign capital for the opening of large industrial complexes allied to transnational capital through the privatization process of the 1990s. Currently the Industrial Pole of Cubatão is dominated by transnational capital. The only two companies that are Brazilian owned are Petrobrás Refinery and Usiminas.

Despite the optimism of the news broadcasted and the reality of the numbers presented, the municipality of Cubatão still presents problems of difficult solution, originated by the Industrial Pole, as noted in the testimony of the Education Director of the Education Department, Simone Eleno de Oliveira Loureiro[13]:

> Nowadays our difficulty is migration - we have many migrants, we receive many people from other regions and other states, precisely because of the Petrochemical Complex, which attracts many people for basic jobs without qualification. They come indicated by the workers that are working in the complex. These people do not create relationships with the city. That's what makes it harder for us. They do not want to create an identity with the city, they want to stay nearby, living in stilt houses, because at any moment they take their bags and return to their origin city. But while they are here, they charge for the city resources. And we have a great difficulty in serving them - we create 700 nursery vacancies and it was not enough. We do not know from where does it come so many children.

Visits to the municipality of Cubatão and interviews done showed relevant issues related to public policies related to housing, education and employment generation for the

[13] Interviewed on August 1, 2012.

local population. Two questions point to a major contradiction in the matter of employment and housing in the region. If there is a population that lives in Cubatão and could work in the Industrial Pole, why is there such a migration? Do these migrants live in stilt houses because the city has no structure to absorb these people? The testimony of Simone Eleno de Oliveira Loureiro presents evidence that there is no integration between public policies and actions of the Industrial Pole:

> This demand is very large, and it is not fixed. People come and go. We have housing projects, for example, CDHU is moving all people from stilts to another region - Jardim Casqueiro - but they have no interest in going to these apartments because living in stilt is 'comfortable' for them - they do not pay rent, water or electricity. Since they do not want to put down roots in the city, they work for a period and leave.

It is worth to remember that all sustainability actions become ineffective when facing this dynamic, because while laws and institutions are created for the management and preservation of the environment, the dynamics of employment generation of the Industrial Pole reproduces a contradiction that doesn't allow the day-by-day in the region.

Another issue investigated in this study is related to the population esteem with so many negative news about Cubatão over the past years. Did the process of environmental recovery rescued population esteem in Cubatão? Simone Eleno de Oliveira Loureiro thinks so:

> Surely now the resident is proud to say that lives in Cubatão. I am a daughter of Cubatão, my parents are children of Cubatão, and my grandmother came here when the city was emancipated. I have the history of what was it and what it is today. We realize that in the past we were ashamed of saying we were from Cubatão, because the resident of Cubatão had a stigma - the person from Cubatão has no nose, no mouth, should have no brain, because he lives there, because it is polluted.

Finally, it is important to highlight the ineffectiveness of inter-actors articulations, especially on issues involving decisions of local powers, regional entities, the government of the state of São Paulo and environmental protective institutions. An example that illustrates this perception is the lack of solution for Ponte Preta in Cubatão. Ponte Preta is the main link that connects the neighborhoods of Água Fria and Pilões, where about 10 thousand people live, and which structure was condemned by the Civil Defense of Cubatão in late 2011. However, the link over Cubatão River joins two neighborhoods that lie in areas of environmental preservation whose responsibilities are of the State of São Paulo (Água Fria) and of the Municipality of Cubatão (Pilões). The mayor of Cubatão, Marcia Rose, led the

discussion of the reform of Ponte Preta and the possible construction of a new dry connection between the neighborhoods of Água Fria and Pilões for the first meeting in 2011 of the Development Council of Baixada Santos (Condesb). Marcia Rose asked the state government of São Paulo to help the municipality of Cubatão in finding solutions to this impasse. The equipment was interdicted by the justice after the State Public Prosecutor's Office brought a Public Civil Action charging arrangements on the conservation of the fragile equipment.

In a statement to A Tribuna, Mayor Marcia Rose explained that "in order to carry out the restoration work, required by the justice, we need environmental permissions that are granted by the State." The Forest Foundation, an organization linked to the state government, administrator of the State Park of Serra do Mar, said it is available to the city to expedite the process of granting an environmental license for the reform of the bridge, as soon as the city submit the draft for the work execution.

Meanwhile, in the court decision, the judge Sergio Martins Ludovico, from the 1st Civil Court of Cubatão, determined that the city must interdict the access to the bridge. The conclusion of the case is far from its end. A resident of the Pilões neighborhood took a compilation of reports to the State Public Ministry (MPE - Ministério Público Estadual) in order the organ to intervene in an attempt to expedite the reform of the bridge. The MEP joined the Justice and it was granted an injunction requiring that the City Hall either reform the equipment or isolate it so that the residents did not run when crossing the bridge. As an emergency situation, the city hall built a wall to interdict the bridge; however, the wall was overthrown by the population a few minutes after being built. A few days later an iron grid was welded. The obstacle was also removed. The last action of the Municipality was extracting all the boards of the bridge to prevent the movement of pedestrians, cyclists and motorcyclists and offered a bus that is available to take residents from one neighborhood to another (A TRIBUNA, 2012; JB, 2012).

6. Summary and Conclusions

After the findings of the achievements over the past 30 years, it is worth to return to the question that motivated this study: is it possible to consider the Industrial Pole of Cubatão as a resilient region?

Regarding the economic aspects and objectives proposed in the Action Plan for Environmental Recover, it is possible to affirm that there was a regional transformation with superior performance compared to the situation prior to the shock. Resuming the possible developments of the lock-in breakage, proposed by Simmie and Martin (2010), it is possible to state that the presented indicators of economic growth and reduction of air pollutants, the situation that best describes the developments of the growth path after the lock-in breakage is (d), in which the growth path acquired a better performance over the time.

It is also possible to identify the determinants of territorial competences that are explicit in the formulation of the presented programs, but there's a gap between rhetoric and practice. There was, indeed, a deep commitment among the actors to work across organizational boundaries in implementing the Action Plan; however, the reasons that led to the commitment of the actors are directly related to CETESB penalties through fines and operating restrictions for companies that do not fit the requirements. The actors involved demonstrate attention to deal with contingencies and uncertainties, however, the articulation skills are still poor, which affects the ability of a routine self-regulation, as shown on the issue of the reform of Ponte Preta. The population has developed self-esteem and rescued the sense of belonging to the region, as noted in reports disclosed by the media, testimonials, interviews and direct observations. The testimonial of Simone Eleno de Oliveira Loureiro illustrates this perception:

> The environmental problems that we have suffered the entire life brought a mystification, a difficulty for the city resident, because they always labeled the city and its residents. The resident from Cubatão has always been a badly viewed person in the region. Not today, because there was a great incentive to contain the dispersion of pollutants.

Moreover, despite reports disclosed in the media, there was not a diffusion of information in an appropriate extension to reverse the negative image created by the environmental problems in the decades 1970-1980. The clarity and transparency in communications need to be intensified, because it was possible to notice that for the inhabitants of other regions, the image of Cubatão - as the Valley of Death - still prevails. The process of creating a collective consciousness that the resources should be preserved for not exhausting over the time is a concern that still does not have systematized solutions, especially in the process of persuading, negotiating, coordinating and teaching the partners involved.

However, it worth no note that this study was based only on certain variables and the success of a resilient region goes beyond the indicators analyzed. The limits of this study open up opportunities for further research, for example, to establish indicators to measure the determinants of the territorial competences that contribute to the development of resilient regions. Such indicators should include greater detailing about 'deep commitment' between people to work beyond organizational boundaries; what kinds of skills must be developed to deal with uncertainties and contingencies and also the ability of maintaining auto regulation; what is degree of consciousness of the involved actors in the preservation of natural resources and, ultimately, the degree of systematization of appropriate communication processes to obtain clarity and transparency in communications, both to prevent accidents and also to disseminate knowledge and generation of collective learning.

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