



## INTERNATIONAL WORKSHOP ADVANCES IN CLEANER PRODUCTION

"KEY ELEMENTS FOR A SUSTAINABLE WORLD: ENERGY, WATER AND CLIMATE CHANGE"

# Industrial Ecology as Strategic Tool for Environmental Policy-Making Process in Brazil

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### Abstract

Most of today's environmental policies in Brazil rely on controlling the growth of pollution by "command and control" techniques. During the last two decades, these instruments have been designed to control sources of environmental impacts using industrial zoning, environmental licensing, and emission standards. The present structure of environmental law and policy focuses almost entirely on the activities of manufacturing companies and does not recognize strategies related to pollution prevention and/or cleaner production — such as product life cycle assessment, environmental labeling, environmental management systems, interconnectivity of production process, extended producer responsibility strategy, and environmental certification — as important instruments for auto-regulation. Recognizing that environmental policy must become more focused on "command and covenant" than "command and control", this article attempts to provide an expanded perspective of environmental policy innovation based on a more holistic approach — Industrial Ecology — as a strategic tool for environmental policy-making process in Brazil.

*Keywords: industrial ecology; environmental policy; cleaner production.*

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## 1 Introduction

Recognizing that public policy is by nature interdisciplinary, it can be generally defined as a system of laws, regulatory measures, courses of action, and funding priorities concerning a given topic promulgated by a governmental entity or its representatives. Therefore, every generation must reinvent the institutions of society to serve their own needs [1][2]. In this context, environmental public policy aims to bridge the gap between the constantly evolving environmental problems and policy implementation. The ability to achieve this political progress is based on the environmental quality concept.

Environmental quality is based on the relation between human activities and the environment itself. The increasing speed of human actions and the environment's resilience are the key elements of this concept. This relationship is modifying vital ecosystems and, recently, modifying Earth's climate. Even though we are surrounded by many uncertainties, there is a general agreement that mankind

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represents the most powerful force of transformation on the planet [3]. Man's influence on environmental quality depends on two factors: the impact he has and the effort to undo or mitigate that impact [4]. Based on these factors, environmental policy has an important role to avoid the tragedy of the commons, where individuals acting in their own rational self-interest consume common resources, such as air or water, at rates that are unsustainable if replicated by all [5].

In the last two decades, the Brazilian environmental quality management has undergone deep changes, which are a result of a new perception of society. Therefore one of the central challenges for environmental policymakers is to keep pace with the important elements of institutional realignment that are occurring in society [6]. Although the Brazilian statutory requirements and legal instruments have brought improvements on a number of fronts, they have limitations due to the fact that national environmental policy is still focusing on "end-of-pipe" solutions and it is no surprise that its central policy tool is a set of "command and control" mandates. The country's present structure of environmental law and policy focuses almost entirely on the activities of manufacturing companies and does not recognize strategies related to pollution prevention and/or cleaner production — such as product life cycle assessment, environmental labeling, environmental management systems, interconnectivity of production process, extended producer responsibility, and environmental certification — as important instruments for auto-regulation [7][8].

Worldwide there are several reasons for the strong and growing consensus that we have to reinvent and revitalize the legal tools used for environmental quality protection. This is because "command and control" techniques have proved very difficult to influence changes beyond regulating industrial plants and other centralized sources of pollution, utilizing current emissions standards. Moreover, there is a consensus that the current regulating pollution instruments are unnecessarily cumbersome, resulting in higher economic cost than need be [9].

Recognizing that Brazil's environmental policy must become more focused on "command and covenant" than "command and control" does not mean discarding environmental licensing and other policy tools. Despite their success in controlling the growth of pollution, the "command and control" techniques are difficult to adapt to the new diversity of problems and circumstances that we are facing now and will face years ahead [9].

Another important aspect is the fact that Brazilian national priorities are focused on development. This means structural changes of the economic base are seen as the pathway to satisfy needs such as reducing unemployment, improvements in industrial and agricultural productivity, transport infrastructure, and so forth. The ranking of these priorities change in the course of development from the satisfaction of basic needs to higher-order needs (e.g. from food and housing to television and vehicle)[10].

In short, this paper attempts to provide an expanded perspective of environmental policy innovation based on Industrial Ecology as strategic tool for environmental policy-making process in Brazil. This is because Industrial Ecology emphasizes that industrial processes and design are important determinants of how resources are and can be used [12]. The paper is divided into four main sections. Section 1 is the introduction, which introduces the scope and objectives. Section 2 presents the current fragmented actions of Brazil's environmental policy. The Section 3 describes a transition strategy for moving towards a holistic approach to environmental protection. Finally, in Section 4 are the conclusion remarks.

## 2 Environmental Policy in Brazil: fragmented actions and limitations

Less industrialized countries, such as Brazil, have been a fundamental part of global industrial economy, and they often are the major resources suppliers. As a result, most of their environmental policies, which have been put in place during the past few decades, were based largely on resource protection. Nowadays, the country's current environmental law and policy has changed from strict preservation practices to management performance. As a result, the existing environmental policy focuses on the activities of manufacturing companies but does not recognize strategies related to pollution prevention and/or cleaner production.

Looking back, the Brazilian environmental laws are focused on preserving natural resources, controlling industrial pollution, land use regulation, and integrating resource management [12][13]. As a result, these laws may create inefficiencies, and thus frustrate rational and efficient decision-making. This is because they were not designed to follow a chronological order of actions. They were merely designed to address a particular problem, which means that for each new environmental problem identified, a new piece of legislation was created. As a result, this "patchwork" generates legal conflicts and overlapping rules, instruments, and procedures.

The first attempt to overcome the environmental legal fragmentation was the establishment of the National Environmental Policy in 1981, which founded the national environmental management system (Sistema Nacional de Meio Ambiente – SISNAMA). The SISNAMA's purpose is to establish an articulated set of governmental institutions, agencies, responsible entities, procedures, standards and rules for protection and improvement of the environmental quality. The Figure 1 presents its organizational structure.

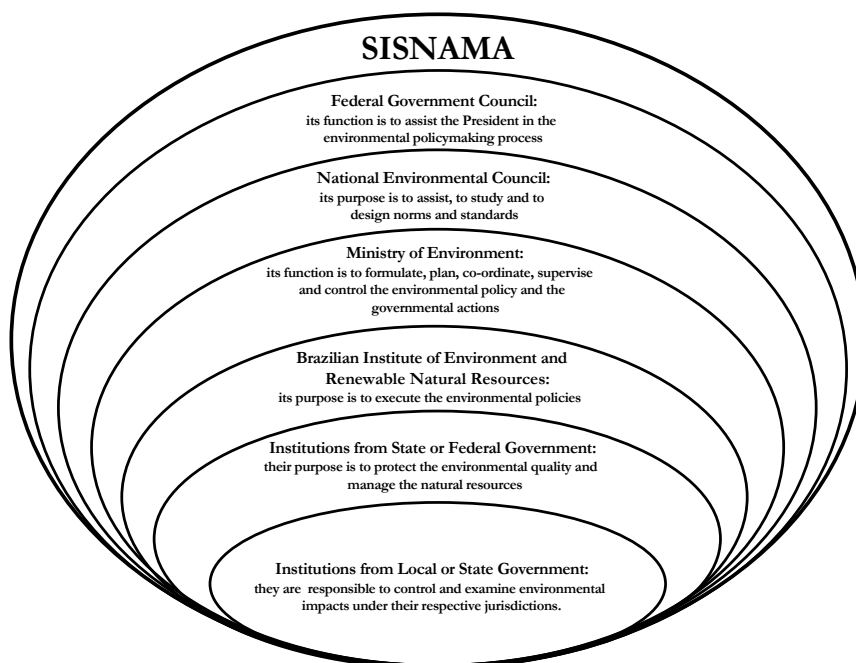


Fig. 1: Organizational structure of the national environmental management system

As a result, both intense normatization and regulation processes have marked the SISNAMA's performance in the 90's decade. The new approach is also reflected in the creation of the national water resource management system (Sistema Nacional de Recursos Hídricos), the national system of conservation units (Sistema Nacional de Unidades de Conservação – SNUC), and the environmental crimes law (Federal

Law 9.605/98).

During the same period an important shift in environmental thinking has taken place. One important example is the establishment of the sustainable development (SD) concept, which has been broadened to become a new paradigm and form a hope for human impact mitigation. There is some consensus around its implementation; however, the imprecision of the SD concept causes worldwide debates regarding diversity of adoption and understanding. Debate varies from discussion about the neoclassic economy concept's incompatibility in incorporating the sustainability values, to the need of using differentiated economic theories to analyze the SD implementation. Others question the iniquity of the current standard of development and its unfeasibility as a model to be followed in search of sustainability. They maintain that there is a need for social strategies and policies that should be based on the ethical posture of development [14].

Clearly, the SD concept does not have an exclusive form of implementation. However, the model that is used in industrialized countries cannot be adopted as a solution for less industrialized countries because any development process is closely related to the cultural background where it is implemented. These factors cannot be evaluated independently. The priorities of less developed nations are different, and for that reason their priorities are sometimes forgotten [14].

An important aspect of SD concept is the "Think Globally, Act Locally" motto, which could explain the growing trend of local governments — state or municipal environmental agencies — assuming more responsibilities for environmental management. As a result, federal government actions are taking into consideration the local way of becoming sustainable.

In Brazil, this motto is also present and has fostered the creation of environmental management structures at the municipal level — such as environmental city council, environmental management department, and local environmental ordinances — but their actions are still ineffective because environmental polices enforcement is by and large associated with lack of human and financial resources. Therefore, institutional weakness is probably the main factor that contributes to environmental quality degradation. It is a result from:

- Unclear definition of institutional responsibilities;
- Low budget that prevents infrastructure development and purchase of equipment necessary to support the basic activities of environmental protection agencies;
- Unqualified personnel;
- Poor implementation capacity.

These factors in addition to overlapping responsibilities among institutions from various levels of government end up transmitting contradictory signs related to environmental impact control requirements [15][16].

Most of today's environmental policies rely on controlling the growth of pollution by "command and control" techniques. Therefore, the Brazilian environmental law has to make clear distinctions between safe versus unsafe and permissible versus impermissible levels of pollution. On the other hand, the current environmental problems are often related to consumer lifestyles and consumption patterns rather than emission control. Both of these are particularly difficult to influence using "command and control" instruments [9].

During the last two decades, these instruments have been designed to control sources of environmental impacts using industrial zoning, environmental licensing, and emission standards. They were clearly developed to regulate large targets — such as manufacturing plants, iron-producing plants, refineries, chemical plants, and others “big dirties” — but the contemporary environmental problems are caused by smaller and more diffuse sources of pollution, which are more difficult to control using the traditional regulatory approach [15][16][17].

There is not doubt that standards — commands that specify which potential polluters must comply — and stringent monitoring and enforcement — control regulation — have achieved some success, especially in reducing air and water pollution. However, this approach is widely seen as inflexible and raises concerns over whether it inhibits innovation because it fails to charge polluters the full cost of their activities. Innovation only occurs where there is an economic advantage. For example: How is it possible to improve environmental performance of companies that already have met the legal requirements? How is it possible to promote new environmental management systems? How is it possible to spread new cleaner technologies, programs, and production practices?

Self-regulation can be seen as an alternative to “command and control” instruments, which can be defined as regulation by organizations or associations; not only creating the rules, but also monitoring compliance with these rules and enforcing them against their own members.

An example of self-regulation is wide evidence that firms adopting an environmental management system (EMS) like ISO 14001 improve their environmental performance. This is because ISO 14001’s third-party audits reduce the chance firms will wilfully fail to comply with regulations, and the EMS procedure reduces the chances firms will be in non-compliance due to ignorance. On the other hand, it is a challenge to make the connection between the private interests for the use of self-regulation and the public interests.

In this context, there are three categories or different approaches of self-regulation [18]:

Pure self-regulation is a strict private parties initiative and government is not involved but it accepts the results as long as they are not against general rules such as those on fair competition (e.g. ISO 14.000 series).

Substitute type of self-regulation is also a private actors initiative but government oversees the process in order to safeguard the public interest that may be at stake (e.g. consumer rights).

Conditioned self-regulation means that public and private interests are intertwined (e.g. “command and covenant” instruments). As a result, this self-regulation approach is subject to a type of government structuring or supervision and the advantages are:

- “Command and covenant” regulation can be used on the basis of a legislative act.
- The “command and covenant” regulation mechanism must be in the interest of the general public.
- The government establishes the essential aspects of the regulation.
- The government determines to what extent defining and implementing the measures can be left to the parties concerned.

- In cases where using the “command and covenant” mechanism has not produced the expected rules, the right is reserved to make a traditional legislative proposal.
- The principle of transparency of legislation applies to the “command and covenant” mechanism. The agreements and implementation modalities must be made public.
- The parties concerned must be considered to be representative, organised and responsible.

The traditional Brazilian environmental regulatory system is built on the roles of governments, corporations, and citizens as autonomous actors operating in linear relationships. This system has evolved from predominantly resource protection based approach to environmental regulation focused on “end-of-pipe” solutions for manufacturing activities.

In short, by introducing a new concept — Industrial Ecology — it is possible to build on a new set of relationships where autonomy is replaced by a more holistic model. As a result, the regulatory responsibilities will be based on shared responsibility, shared membership, and shared decision making of government and corporations.

### 3 Industrial Ecology as strategic tool in policy-making

Development is shaped by a variety of forces — economic, social, environmental and political. Such processes usually cannot be changed without encountering opposition from well-established interests. Balance among these conflicting interests requires the articulation of broad social goals by political leaders. Tying together development interests “in ways that are both productive and ecologically sound is a formidable undertaking, given the inertia of our political and economic structures” [19]. Thus, the principal conceptual questions are when and how Brazilians policymakers should intervene.

Worldwide businesses already have a number of incentives to move toward “greener” products and processes such as waste prevention strategies — which reduce materials use and energy consumption, and thereby reduce the costs of manufacturing and waste disposal, while limiting potential liabilities. Moreover, international surveys indicate that a growing number of consumers are willing to pay a premium for environmentally sound products. However, there are a number of technical, behavioural, economic, and informational obstacles that need to be addressed. This is because the “greening” process of industrial systems costs has to be internalized. Thus, the first question often asked about environmental friendly design is “what does it cost?” Typically, environmentally sound design and production decisions are likely to remain economically unattractive, which raises another question: more than what? More than comparable systems, more than the available funds, or more than the production processes would have cost without the “green” design features?

A number of studies have confirmed that environmental design has more expensive initial cost, however, it is not as high as current perception. In addition, the studies confirmed that investors often believe that “green” design is not worth the extra cost. As a result, the internalization is not easily fostered by economic incentives; it has to be achieved by regulation [20].

As stated earlier, most of today’s environmental policies in Brazil rely on controlling the growth of pollution by “command and control” techniques. Therefore, the

environmental law has to make clear distinctions between permissible versus impermissible levels of pollution. In contrast, the country's environmental problems are often related to diffuse sources of pollution, consumer lifestyles and consumption patterns — which are particularly difficult to influence using “command and control” instruments — rather than single-source emission control [9].

Regulations based on “command and control” techniques can produce fast and reasonably expected results, but they can also impose unnecessary costs on industry and stifle environmentally innovative designs. As an example, some environmental regulations discriminate against new technologies by prescribing rigid design standards such as “best available technology” (BAT) approach, which is adopted by the environmental agencies as a reference in the environmental permits requirements and usually considers only widely applied technologies. As a result, well-recognized technologies not listed as BAT have their use held up, such as co-processing waste in cement ovens and burning municipal solid waste as a fuel. This is because environmental laws have been generally written as if the world were static [19].

Following the same concept, the Brazilian “command and control” approach is based on differentiating pollution by media, which is followed by a several fragmentation categories such as type of pollutant, life-cycle stage, and organizational characteristics. Therefore, each law for each medium developed different definitions, standards, approaches and governmental agencies in charge. As a result, the “command and control” approach has not succeeded to account for instances where pollution is merely shifted from one medium or location to another rather than being reduced or eliminated. Moreover, this regulation is focused on single-source approach and does little to reduce environmental problems caused when parts or materials used in a single industrial plant have already been produced by suppliers elsewhere. Nor does it address the environmental impacts that a product can cause during use-phase chain — distributors, retailers, and/or end-consumers [16][21][22].

In the quest for better environmental policies, there is a consensus about two key requirements [11]:

- Near-term actions: The full cycle of human impact on environmental quality must be considered by focusing on the production/consumption processes such as cost-effective reprocessing and reuse of discarded materials;
- Long-term actions: The industrial and natural worlds must be considered as a system in a holistic model including the effects of flow, use, and transformation of resources.

The concept of Industrial Ecology joins theses two requirements into a single concept which is defined as “the study of the flows of materials and energy in industrial and consumers activities, of the effects of these flows on the environment, and of the influences of economic, political, regulatory, and social factors on the flow, use, and transformation of resources” [23].

A policy model built on Industrial Ecology is more likely to look at the whole life cycle system. This is because the holistic view transcends the fragmentation of the media — air, water, and soil — paradigm by tracing the impacts of all three categories. For example, the environmental policy would be not only focused on waste management system but also on the production system that precedes it and the entire value chain. In doing so, the regulation provides rather different

incentives to producers to become more involved with how materials are used and their recycling properties (e.g. extended producer responsibility strategy) [11].

The only drawback is the fact that systemic analysis — such as holistic view approach — is quite data intensive and may lead some to conclude that Industrial Ecology requires a high level of comprehensive knowledge before any policy decision is made. However, the “effort to understand and connect the industrial and natural worlds is large and important endeavour that requires us to regularly scan horizon and fundamentally re-examine whether we have defined our policy problems accurately” [11].

Under the Industrial Ecology approach, industries would be required to meet government-determined performance standards but would be freer to determine for themselves how to achieve the established targets. Their success in meeting the requirements would be monitored by independent auditors, similar to those that review the financial statements of companies under the Securities and Exchange Commission rules. Limited government enforcement resources could then be targeted toward those failing to live up to their environmental obligations [22]. Therefore, a “command and covenant” system creates increased flexibility and opportunities for innovation, while maintaining accountability in a very competitive market [9].

#### 4 Conclusion remarks

As society in Brazil begins to struggle in with the potentially serious environmental impacts of its economic and industrial growth, the systems perspective provided by Industrial Ecology is likely to be one answer to how policymakers could intervene. This is because environmental problems faced by modern society are not new; mankind has just recently been able to understand the complexity and interdependency of various factors. The more we learn, the more we find that current environmental problems are not isolated events which can be easily understood detached from other events. The factors involved that shape the problems are systemic, interlinked and interdependent [14].

Industrial Ecology is based on innovation and opportunities for new technologies and/or processes, which are both economically and environmentally beneficial. Its theoretical framework rests on a comprehensive search for basic principles from economy, material and energy flows to thermodynamics and ecology. This approach provides a long-term perspective, fostering the overall development of both technologies and policies for sustainable resource utilization, sustainable production/consumption patterns, and environmental protection into the future [16][21][22][24].

The Industrial Ecology's broad framework — for thinking and acting in the sustainability area — promotes a holistic view of production/consumption systems where any system under analysis must be viewed in a macro context. This framework is quite challenging and requires the development of a set of instruments to bridge different scales, from site or product specific analysis to whole diagnostic — from the economic to the socioenvironmental dimension — thus resulting in a multi-disciplinary set of analytical tools and regulatory alternatives [16][21][22][24].

Using systems-oriented strategies such as product life cycle assessment, environmental labelling, environmental management systems, interconnectivity of production process, extended producer responsibility strategy, and environmental certification, Industrial Ecology can overcome the limitations of Brazilian national



environmental policy. This is because current “command and control” techniques in place are very difficult to influence changes beyond regulating centralized sources of pollution.

The debate about regulatory alternatives to “command and control” has led many researchers to promote, or at least consider, the use of self-regulation to improve the environmental performance of industry. However, much of the discussion has been characterized by a choice between two exclusive policy options: “strict command and control” on one hand, and “pure self-regulation” on the other [25]. The Industrial Ecology may offer a much richer range of policy options, which would fit somewhere between theoretically polar extremes. This article presented that there are a number of “command and covenant” techniques which policymakers can use to adjust regulatory options to suit the specific circumstances of the environmental policy-making process in Brazil.

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